EPA/600/8-79/004

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Municipal Environmental Research
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EPA-600/8-79-004
August 1979

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Urban Rainfall-Runoff-Quality Data Base

Update with Statistical Analysis

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EPA-600/8-79-004
August 1979

URBAN RAINFALL-RUNOFF-QUALITY DATA BASE

Update With Statistical Analysis

by

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FOREWORD

The US Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air,foul water, and spoiled land are tragic testimony to the deterioration of our natural environment. The complexity of that environment and the interplay between its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution and it involves defining the problem, measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems for the prevention, treatment, and management of wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, for the preservation and treatment of public drinking water supplies and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research, a most vital communications link between the researcher and the user community.

This report documents urban rainfall, runoff and quality data available for testing of urban hydrologic and water quality models and characterization of component processes. Quality data are included for eleven cities with rainfall-runoff data only for an additional 14 cities. Many potential locations of data are also discussed. In addition, statistical analyses are presented for the quality data cities.

Francis T. Mayo
Director
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PREFACE

A common denominator of mathematical models of urban hydrologic processes is the need for adequate data with which to calibrate and verify model representations of physical processes. Such data need to be collected at short time intervals during several storms and are typically time consuming and expensive to obtain. However, the data also serve the very useful purposes of characterization of urban rainfall-runoff-quality processes in terms of statistics and loadings (e.g., pounds per acre) and extrapolation of such characteristics to ungaged catchments. It has been difficult in the past to obtain data for either modeling or characterization purposes.

This project was initiated on the assumption that many such data must exist; they need only be "found" in unpublicized deposits in widely scattered firms, universities and government agencies. The results of searching for these data indicate that there are indeed many potential sources, but the accessibility and documentation of most are deficient enough to render them difficult to use at best. However, the data for 47 catchments in 25 cities documented in this report represent an effort to aggregate available data into one accessible data base. The data base itself consists of a magnetic tape with data organized in a readily accessible format. Note that the emphasis has been upon assembling and processing of data rather than construction of a sophisticated computerized data storage and retrieval system. EPA's STORET system is now being used for the latter purpose.

The project has depended entirely upon the cooperation and good will of groups who have contributed their data. The University of Florida and EPA actively solicit new data from all sources in order to improve the data base described in this report. Holders of useful data are encouraged to contact UF directly. UF has also been designated as a recipient of data collected under EPA Section 208 studies; however, few 208 studies appear to have collected suitable data. The most promising new sources may be the EPA/USGS cooperative urban runoff monitoring studies presently being initiated. The overall goal is to build upon this initial effort in order to provide a large enough data base to allow selectivity in choice of model calibration-verification procedures and to provide statistically significant urban runoff characterizations.

ABSTRACT

Urban rainfall-runoff-quality data gathered by others have been assembled on a storm event basis for 25 catchments in the following eleven cities: San Francisco, CA; Broward County, FL; Lincoln, NB; Durham, NC; Windsor, ONT; Lancaster, PA; Seattle, WA: Racine, WI; West Lafayette, IN; Greenfield, MA; and Northampton, MA. Rainfall-runoff data have been assembled for 22 more catchments in an additional 14 cities: Baltimore, MD; Chicago, IL; Champaign-Urbana, IL; Bucyrus, OH; Falls Church, VA; Los Angeles, CA: Portland, OR; Houston, TX; and Salt Lake City, UT. The 25 cities contain data for a total of 47 catchments. Descriptions of the catchments, parameters and sampling procedures are provided in this report. Actual data have been placed on a magnetic tape and are also being placed on the EPA STORET data retrieval system. Additional data for the above cities and data for other cities will be included in the form of addenda to this report.

This report also includes a statistical analysis of data from all catchments that include quality sampling. For each storm event (as defined by the sampling agency) the clock times, duration and volume of rainfall and runoff are given. For quality parameters, ranges, flow weighted means, standard deviations and loadings (i.e., pounds per acre-inch of runoff) are provided on an average basis across all events. The same statistics are available for individual storm events in the form of voluminous computer output.

This report is a reprint with additional material of the report:

Huber, W.C. and J.P. Heaney, "Urban Rainfall-Runoff-Quality Data Base," EPA-600/8-77-009, (NTIS PB-270 065), Environmental Protection Agency, Cincinnati, OH, July 1977.

That report was submitted in partial fulfillment of Contract No. 68-03-0496 by the University of Florida under sponsorship of the U.S. Environmental Protection Agency. It covered the period June 1, 1974 to April 30, 1977, and work was completed as of April 30, 1977.

This addended report was also submitted in partial fulfillment of Contract No. 68-03-0496 and covers the period May 1, 1977 to November 17, 1978. Work was completed as of November 17, 1978. Additional assembly of data and statistical analyses are being performed as a continuation of the work described herein under EPA Contract No. 68-03-2663.

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ABBREVIATIONS

APWA	American Public Works Association
ARS	Agricultural Research Service
ASCE	American Society of Civil Engineers
COA	Canada - Ontario Agreement
Colif	Coliforms
DWF	Dry Weather Flow
ENDEX	Environmental Data Index (data retrieval system of NOAA)
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
FWPCA	Federal Water Pollution Control Administration
FWQA	Federal Water Quality Administration
GPO	Government Printing Office (Washington, D.C. 20402)
HEC	Hydrologic Engineering Center of the Corps of Engineers
HSP	Hydrocomp Simulation Program
Hwy	Highway
IASH	International Association for Scientific Hydrology
IHD	International Hydrological Decade
ILLUDAS	Illinois Urban Drainage Area Simulator
Ind	Industrial
JWPCF	Journal of the Water Pollution Control Federation
METRO	Municipality of Metropolitan Seattle
NAWDEX	National Water Data Exchange (data retrieval system of the USGS)

ABBREVIATIONS (concluded)

NERC	National Environmental Research Center
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NTIS	National Technical Information Service (5285 Port Royal Rd., Springfield, Virginia 22161)
NWS	National Weather Service
OASIS	Oceanic and Atmospheric Scientifc Information System (data retrieval system of NOAA)
OWRT	Office of Water Resources Technology
PHS	Public Health Service
Res	Residential
RRL	Road Research Laboratory of Great Britain
Set	Settleable
Sol	Soluble
STORET	Storage and Retrieval (data retrieval system of the EPA)
STORM	Storage, Treatment, Overflow, Runoff Model
Susp	Suspended
SWMM	Storm Water Management Model
Tot	Total
UF	University of Florida
US	United States
USGS	United States Geological Survey
WATSTORE	Water Data Information and Retrieval System (data retrieval system of the USGS)
WMO	World Meteorological Organization

ACKNOWLEDGMENTS

Considerable interest, encouragement and useful advice was received from EPA colleagues. The efforts of Richard Field, Harry Torno, Chi-Yuan Fan, Douglas Ammon, and Richard Traver are gratefully acknowledged.

More so than most projects this one depended upon the cooperation and good will of many contributors of data. The project could not have been performed without them. At the risk of omission, individuals associated with different locations are recognized below: Broward County - Harold C. Mattraw, Jr ., USGS, Water Resources Division, Miami; Seattle - John M. Buffo and Glen D. Farris, Metro, Seattle; Lincoln - Dewey R. Anderson, Department of Civil Engineering, University of Nebraska, Lincoln and Robert Sallach, Heningson, Durham and Richardson, Inc., Omaha; Racine - Tom Meinholz and Dick Race, Envirex, Milwaukee; Lancaster - Arthur E. Morris and Warren Farmer, Dept. of Public Works, City of Lancaster; Windsor - James P. Hartt, Dept. of Civil Engineering, University of Windsor, Windsor; San Francisco - Harold C. Coffee, Jr., Dept. of Public Works, City and County of San Francisco; Champaign-Urbana, Philadelphia, Bucyrus, Falls Church, Winston-Salem, Jackson, Wichita, Westbury - Michael L. Terstriep, Illinois Sate Water Survey, Urbana; Los Angeles - Donald C. Tillman, City Engineer, and Aaron Aarons, Bureau of Engineering, Department of Public Works, City of Los Angeles; Portland - David G. Lorenzen, Dept. of Public Works, City of Portland and Allen L. Davis, CH2M-Hill, Corvallis; Houston - Steven L. Johnson (now with USGS, WRD, Miami) and Robert E. Smith, USGS, Water Resources Division, Houston; Greenfield and Northampton - Thomas K. Jewell, Department of Civil Engineering, University of Massachusetts, Amherst, MA (now with Department of Civil Engineering, Union College, Schenectady, NY); Salt Lake City - Joel E. Fletcher, Utah Water Research Laboratory, Utah State University, Logan; West Lafayette - Felix T. R. McElroy III, School of Civil Engineering , Purdue University, West Lafayette, IN. Additional information about catchments described in the first report is acknowledged from: Broward County - Harold C. Mattraw, Jr., USGS, Water Resources Division, Tallahassee, FL, Robert A. Miller, USGS, WRD, Orlando, FL, Marshall E. Jennings, USGS, Bay St. Louis, MS; Bucyrus - Larry D. Culler, Burgess and Niple Ltd., Columbus, OH.

At the University of Florida, several staff members made important contributions. Coding, retrieval and transferal of the data were supervised by W. Alan Peltz. Data reduction, cross checking and figure preparation were performed by William C. Taylor. Much of the original data reduction was organized by Harry L. Crotzer. The first structure of the data base was devised by Amuri A. Arroyo. Dedicated typing was performed by Grace Provenza and Linda Trawick. New figures were drafted by Anthony Dana. Computations were performed at the Northeast Regional Data Center at the University of Florida. Dr. Russell G. Mein, on leave from Monash University, Australia, reviewed and revised the reduction of quantity data for Lancaster, PA.

SECTION I

SUMMARY AND CONCLUSIONS

OBJECTIVES AND SCOPE

Since 1974 the University of Florida has been engaged in aggregation o. urban rainfall-runoff-quality data collected by others. These data are intended for urban runoff model calibration and verification, characterization of urban runoff on a nationwide basis, and synthesis of data for new locations. Broadly, objectives have been to:

1. identify sources of data,
2. acquire available data,
3. process and computerize the data,
4. disseminate data and ancillary material, and
5. perform statistical analyses on the data.

This report was first published in 1977 as:

Huber, W.C. and Heaney, J.P., "Urban Rainfall-Runoff-Quality Data Base," EPA-600/8-77-009, (NTIS PB-270 065), Environmental Protection Agency , Cincinnati, OH, July 1977.

This present edition reprints the material that was first published along with information on six new catchments and statistical analyses for 25 catchments with quality data.

The page numbering system has been altered such that each section is numbered as 6-1, 6-2, etc. Thus, as new data locations are processed in the future, their documentation may be added to the end of appropriate sections. Project work continues under EPA contract no. 68-03-2663. The University of Florida actively solicits new data in care of the authors of this report.

DATA SUMMARY

Locations for which data have been assembled and placed on a magnetic tape are shown in Table I-1 and Figure I-1. Rainfall, runoff and quality data are available for eleven locations while the remaining number have only rainfall runoff data at present. Data are provided on a storm event basis; no long-term (continuous) records are presently included. Receiving water data are also not included.

Many of these so... may be updated using data collected more recently or using data prese...eing collected under various programs, such as EPA 208 and National ...Runoff Program projects and EPA/USGS cooperative urban runoff monitor...jects. As noted in Section V, a large volume of urban runoff data exists, much of which may be included in the data base at a futu...

...t results are provided in three forms:

...final report (this volume), which includes descriptions and ...erences of data sources utilized and pending.

A magnetic tape containing the actual rainfall-runoff-quality data from each source on a storm event basis. Copies of the tape will be provided at cost. In addition, all data are being placed on the EPA STORET data retrieval system for more general accessibility.

3. A limited amount of in-house modeling data (maps, plans, photos, etc.) at UF, available for short-term loan.

STATISTICAL ANALYSES

Data for all catchments subject to water quality monitoring have been analyzed statistically for flow and time weighted means and standard deviations as well as ranges of parameters and surface loadings (i.e., pounds of pollutant per acre-inch of runoff). Summary values for each catchment and pollutant are given for each statistical parameter. In addition, hydrologic information such as rainfall and runoff depth and duration is given for each storm event. Statistical analyses of the quality parameters for each individual storm event for each catchment are voluminous and available upon request to the authors of this report.

Table I-1. Summary of Data

Location	Catchment	Area ac	Area (ha)	Drainage[b] System	No. Storms with Quantity	No. Storms with Quality
Broward County, FL	Residential	47.5	(19.2)	S	35[a]	35[a]
	Commercial	39.0	(15.8)	S	14[a]	14[a]
	Transportation	28.4	(11.5)	S	14[a]	4[a]
San Francisco, CA	Baker St.	168	(68)	C	4	4
	Mariposa St	223	(90)	C	4	4
	Brotherhood Way	180	(73)	C	4	4
	Vicente St., N.	16	(6.5)	S	1	1
	Vicente St., S.	21	(8.5)	S	1	1
	Selby St.	3400	(1380)	C	8	8
	Laguna St.	375	(152)	C	2	2
Racine, WI	Site I	829	(336)	C	9	9
Lincoln, NB	39 & Holdrege	79	(32)	S	20	20
	63 & Holdrege	85	(39)	S	15	15
	78 & A	357	(145)	S	14	14
Windsor, ONT	Labadie Rd.	29.5	(11.9)	S	22	22
Lancaster, PA	Stevens Ave	134	(59.2)	C	7	7
Seattle, WA	View Ridge 1	630	(255)	S	30	30
	View Ridge 2	105	(43)	S	5	5
	South Seattle	27.5	(11.1)	S	31	31
	Southcenter	24	(9.8)	S	30	30
	Lake Hills	150	(61)	S	7	7
	Highlands	85	(34)	S	4	4
	Cent. Bus. Dist.	27.8	(11.3)	C	5	5
Durham, NC	Third Fork	1069	(433)	S	19	4

Table I-1 (continued)

Location	Catchment	Area ac	Area (ha)	Drainage System	No. Storms with Quantity	No. Storms with Quality
Baltimore, MD	Northwood	47.4	(19.2)	S	14	-
	Gray Haven	23.3	(9.4)	S	29	-
Chicago, IL	Oakdale	12.9	(5.2)	C	21	-
Champaign-Urbana, IL	Boneyard Creek	2290	(927)	S	28	-
Bucyrus, OH	Sewer Dist. 8	179	(72.5)	C	10	-
Falls Church, VA	Tripps Run	332	(130)	S	10	-
Winston-Salem, NC	Tar Branch	384	(155)	S	17	-
Jackson, MS	Crane Creek	285	(115)	S	17	-
Wichita, KS	Dry Creek	1883	(762)	S	8	-
Westbury, NY	Woodoak Dr.	14.7	(6.0)	S	10	-
Philadelphia, PA	Wingohocking	5326	(2156)	C	16	-
Los Angeles, CA	Echo Park	252	(102)	S	18	-
Portland, OR	Eastmoreland	75	(30)	C	24	-
Houston, TX	Hunting Bayou (Cavalcade St.)	768	(311)	S	8	-
	Hunting Bayou (Falls St.)	2509	(1016)	S	11	-
	Bering Ditch	1894	(767)	S	10	-
	Berry Creek	3110	(1259)	S	10	-

Table I-1. (concluded)

Location	Catchment	ID Code	Area (ac)	Area (ha)	Drainage System	No. storms with Quan.	No. storms with Qual.
West Lafayette,IN	Ross-Ade(upper)	IN0101	29	(11.7)	S	12	10
Greenfield,MA	Maple Brook	MA0101	1014	(410)	S	5	5
Northampton,MA	Market St. Brook	MA0201	380	(154)	S	6	6
Salt Lake City,UT	Layton	UT0101	1.35	(0.55)	S	23	0
	Parleys Canyon I	UT0102	0.54	(0.22)	S	42	0
	Parleys Canyon II	UT0103	0.55	(0.22)	S	42	0

[a]Additional data currently being reduced by USGS.

[b]C = Combined sewer, S = Storm sewer and/or open channels.

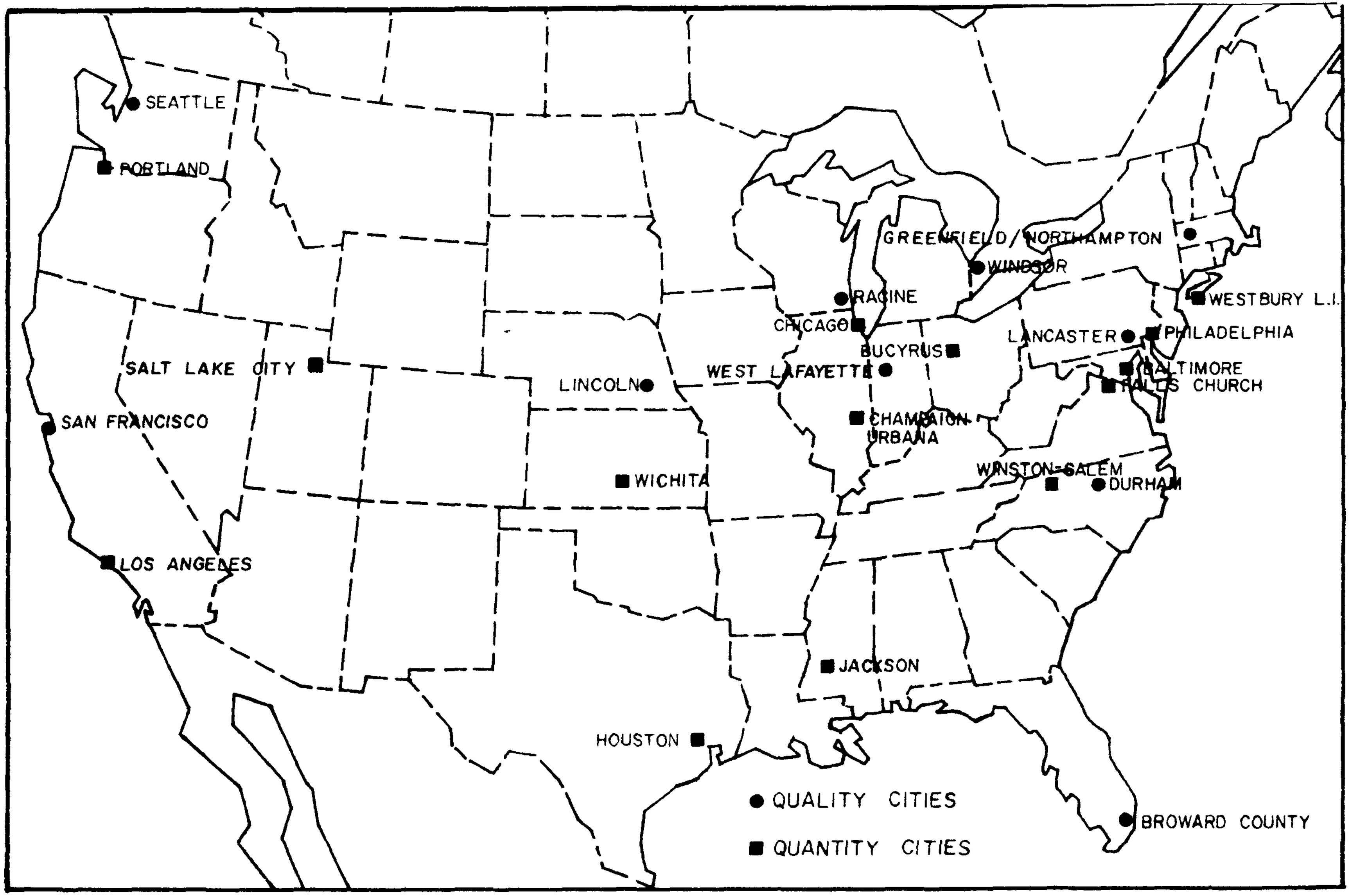

Figure I-1 Location map for cities with rainfall-runoff-quality data (quality cities) and rainfall-runoff data (quantity cities).

SECTION II

RECOMMENDATIONS

1. Rainfall, runoff and quality data are needed for model development, urban runoff characterization, data synthesis and other purposes. Hence, potential data sources should be cultivated and added to the present data base. The University of Florida (in care of the authors of this report) and EPA actively solicit all such data.

2. Confusion exists frequently as to the exact water quality parameter being reported--sampling method, type of sample (e.g., total or dissolved, fixed or volatile), laboratory procedure and units. Future providers of data should carefully document each of these items. Assignment of an EPA STORET code to the parameter provides a relatively unambiguous description.

3. Elementary statistical analyses should continue to be applied to the extant data to develop loadings and to provide characterization information. Eventually, these results can be coupled with hydrologic, physical and demographic information to determine causative relationships.

4. No long term, continuous, urban rainfall-runoff-quality data are known to exist. Such data are needed to verify planning-level analyses of urban areas and should be collected.

5. Receiving water sampling should be performed concurrently with runoff sampling in order to assess the impact of urban runoff on receiving water quality.

SECTION III

INTRODUCTION AND OBJECTIVES

In an effort to provide useful planning tools for abatement of quantity and quality problems caused by urban stormwater runoff, many mathematical models have been developed to simulate the various components of urban hydrological processes (1,2). These models range from very simple, to very sophisticated, yet all share a common need--adequate data for development, calibration and verification. Specifically, these data consist of detailed measurements of rainfall, runoff and quality parameters taken at frequent intervals during storms, such that the full dynamic and spatially variable nature of the urban runoff may be studied. Since most recent urban hydrologic models define the complete hydrograph or pollutograph during a storm event, measurement of only, say, peak flows or average concentrations is inadequate for calibration of these models. Such models are being used in ever increasing applications and the need for relevant data has intensified.

Another important data requirement arises from the need to characterize urban runoff in a variety of ways. Examples of such needs are:

1) determination of rainfall and runoff volumes, intensities, peaks, durations, interevent times and associated statistics;

2) identification of quality parameters found in urban runoff;

3) determination of ranges, arithmetic and flow-weighted means, medians, variances, and other statistics of quality parameters;

4) computation of total mass emissions of quality parameters;

5) computation of quality "loadings" such as pounds per acre, pounds per curb-mile, pounds per inch of rainfall, pounds per day, etc. and combinations, and;

6) evaluation of causative relationships among rainfall, runoff, quality, demographic and abatement factors.

Several of the above needs require collection of both runoff and quality data; e.g., calculation of total pollutant loads, flow-weighted averages, etc. requires simultaneous measurement of flows and concentrations. Thus, concentration data by themselves are insufficient for many required analyses. Characterization results may then be used to synthesize data at unmonitored locations.

Data collected for characterization purposes are not always compatible with modeling needs since infrequent sampling times and/or omission of key parameters are likely. However, data suitable for model usage are usually also well suited for characterization purposes provided enough of a sample exists. It is desirable that characterization data be representative of an entire year or season and thus result from samplings of many storms since one group of data may be used for model calibration while the remaining group may be used for verification.

This project has obtained data, collected by others, to fulfill the modeling needs as first priority with attention also to the characterization needs. As described subsequently, there have been a surprisingly large number of studies devoted to collection of data useful for modeling, although collection of good quality data is more difficult and lags the quantity data by a considerable degree. The overall objective of this research, then, has been to find these data and publish them.

Specific objectives are, broadly:

1. identify sources of data,
2. establish criteria for collection of data,
3. acquire available data,
4. construct initial data base,
5. define how continuing maintenance of the data base is to be accomplished,
6. define how data dissemination should be done, and
7. perform elementary statistical analyses on the data.

These items are addressed individually and collectively in this report. Viable, current data sources are described within the report, and the actual data from these sources have been placed for easy access on magnetic tapes. The data are also being placed on the EPA STORET system for more general access.

The data collection and evaluation process is a continuous one, especially in light of current EPA Section 201 and 208 projects. Hence, the data sources described herein may be considered as an initial effort only. Data are continually being acquired as part of the project, and addenda with new data from new or the same sources will be issued periodically. To underscore this point, it should be noted that it is the responsibility of the University of Florida to review data received from 208 agencies and incorporate them into the data base where possible. Under the auspices of the Areawide Waste Management Group within EPA, 208 agencies and others are thus encouraged to provide UF with relevant data as they become available (in care of the authors of this report).

SECTION IV

CRITERIA FOR DATA COLLECTION

INTRODUCTION

It is easy to be overwhelmed by the sheer magnitude of urban hydrologic and water quality data presently available. Hence, consideration must be given to the methods by which such data were collected prior to inclusion of them in a data base. On the whole, data collected directly by federal agencies (e.g., National Weather Service, U.S. Geological Survey) are gathered under standardized, documented procedures. However, the techniques used by almost all other agencies exhibit extreme variations. For instance, rainfall data may be collected using everything from a tipping bucket rain gage to a graduated cylinder read periodically. Such variations in sampling procedures may still be acceptable if they are at least documented; however, many project reports are lacking in this aspect. Since standardized procedures do exist for many phases of urban hydrologic sampling, these will be reviewed briefly, along with special considerations for different parameters.

PRECIPITATION DATA

Measurement of most meterological data is quite standardized. Publications of the National Weather Service (3) and others (4,5) describe instruments and techniques for measurement of rainfall and other pertinent variables. Accurate sampling of the time history of snowfall is seldom required; rather, the time history of snow melt is the record of concern. Hence, only measurement of rainfall is addressed here.

Most urban hydrologic models require rainfall inputs (usually intensities) at frequent time intervals (typically five minutes or less), with the required time interval decreasing as the response time of the catchment decreases, e.g., models of steep, small, impervious catchments require more frequent rainfall inputs than for flat, large, pervious ones. Eagleson and Shack (6) relate required sampling frequency to catchment and storm properties. However, some models require only hourly rainfall totals (7,8), available already tabulated from the National Weather Service for all first-order meteorological stations in the U.S. It is apparent that less frequent data can always be generated from averages of data taken at short time intervals.

Perhaps the best rain gages for this purpose are of the tipping bucket variety, in which the time of occurence of every 0.01 in. (0.25mm) of rainfall is recorded. However, by far the most common gage is the standard weighing-bucket gage used at most National Weather Service (NWS) installations. When a 24 hour chart is used on these gages, it is difficult to interpolate the chart at less than 15-minute intervals. Hence, this is often an unfortunate constraint on the temporal accuracy of rainfall data.

In the event that gages being used for modeling are only operated intermittently, antecedent conditions for rainfall may sometimes be evaluated using the nearest NWS gage, since these data are published regularly (9). The applicability of "nearby" data will depend heavily on the spatial distribution of rainfall, discussed below.

The spatial extent of the gaging network is the other critical factor. It is important, though not always essential, that at least one gage be located within the catchment under consideration. This requirement becomes more binding as the size of the catchment and the likelihood of convective rainfall (e.g., thunderstorms) increases. When, as is all too often the case, there are no gages within a catchment that may otherwise have good flow and quality measurements, the recourse is to interpolate as best as possible from nearby gages. If the rainfall is uniform in time and space (as is sometimes the case for storms of cyclonic origin), such data may adequately serve modeling needs. Quantitative methods are available for determination of the number of gages required as a function of catchment and storm characteristics (10, 11).

Point rainfall from a single gage may be converted to a spatial average using standard NWS curves (e.g., reference 5, p. 359) or more recent methods (12). Multiple-gage data averaged by the Thiessen or other techniques may create special problems, because high frequency time variations are frequently lost when station records are combined. If possible, it is preferable to input data from separate gages in a discrete manner into a model, i.e., formulate a model that is distributed enough to accept multiple rainfall inputs. Another alternative, if high frequency time variations are to be retained, is to use only one "most representative" gage for model input. In practice, the question of averaging or choice of gages is usually academic, however, since it is rare that data from more than one gage are available!

RUNOFF DATA

Quantity (runoff) measurements in urban areas are frequently difficult to perform because of a lack of an adequate hydraulic control along sewer outfalls. Almost all basic data consist of stages measured at some location, from which flows are derived, either by 1) calibration (by means of associated velocity measurements), or 2) known stage-discharge relationship (e.g., at a weir, flume or orifice constriction), or 3) theoretical stage-discharge relationship (e.g., application of Manning's equation to depth measurements in a conduit). The last of the three methods is the most common and least accurate. However, from a record of stages, users can sometimes compute their own flows, given other data on geometry and roughness. In addition, models are occasionally programmed to print out depths as well as flows, although this is uncommon. (Most data included in this report were taken by methods 1 and 2 above.)

Standardized procedures for flow measurements have been published by federal agencies (13), notably the U.S. Geological Survey (USGS) in various chapters of their Techniques of Water Resources Investigations and their older Surface Water Techniques. Useful references from this series include numbers 14-17, and most are summarized in reference 13. Survey articles are available (5, 18, 19) that describe the hydraulics of flow measurements with reference to various agency techniques.

Surveys of available techniques as applied to urban areas are also available (20-22). All measurement aspects of urban runoff studies are documented in a recent study by Wullscheleger, et al. (23). For gaging installations in which surcharged conditions (full-conduit flow) are unlikely to exist, various critical depth devices are the most suitable for continuous stage monitoring, for example, flumes (22, 24, 25) or the venturi constriction used by the USGS (26). When surcharged conditions are likely or when velocity measurements are needed, instruments ranging from propeller meters to ultrasonic, doppler and electromagnetic flow meters are available (22, 23).

Most stage data are recorded continuously on various types of recorders. The majority of installations utilize recorders located at the site. A few telemeter data to a central location. In these cases, and for certain other types of recorders, the stage gages are "interrogated" at frequent time intervals (usually fractions of a minute), as opposed to production of a continuous inked line on a chart. With few exceptions, adequate temporal definition of the hydrograph is not a problem. Rather, the calibration or method used to calculate flow rates is of prime concern.

QUALITY DATA

Most quality data consist of concentrations of various parameters. Some parameters may be measured *in situ* (e.g., pH, conductivity, temperature, D.O.), but the majority must be obtained by laboratory analysis of samples of the flow. The principal consideration in the use of quality data for urban modeling is the method by which these samples are taken. Again, a prime concern is the time frame.

Many studies have been made in which a general characterization of urban runoff is required. For this purpose, composite quality samples have often been taken in which flow is withdrawn into a sample container over a relatively long period (e.g., from 15 minutes to one hour). Sometimes, in the interest of economy, composites are made for laboratory analysis from samples taken at shorter time periods. In any event, composite samples are of much less usefulness for most current urban runoff quality models, because predicted pollutograph ordinates need to be calibrated against instantaneous concentrations. (Note that concentrations, mg/l, may be readily converted to mass rates, lb/min, if the flow rate, cfs, is known.) Composited quality samples may thus be "better than nothing," but must be treated carefully if model verification is an objective.

Another aspect of sampling frequency concerns definition of first flush effects. A common practice is to sample frequently during the initial portion of a storm, and less frequently thereafter. This is accomplished by sampling frequently during the whole storm but providing laboratory analyses of only selected samples and discarding the remainder, to economize on the related expense. For example, it is common for a study to analyze three quality samples on the rising limb of the hydrograph, one near the peak and two on the hydrograph recession.

Even data that are usually termed instantaneous, may be inherently composited. This is due to the nature of automatic quality samplers, installed at many of the sampling locations. These samplers require a certain time to draw liquid into the sample jars, ranging from several seconds to several minutes depending upon the type of sampler and the volume of sample required. Larger volumes are required when a larger number of parameters is to be analyzed. Thus, some locations have quality samples withdrawn at 20-minute intervals, but the sample bottle requires ten minutes to fill. Hence, the result is ten-minute composites taken at 20-minute intervals. This is not necessarily incompatible with modeling applications, since quality predictions are sometimes averages over the time step used in the model.

Concerning selection and installation of automatic samplers themselves, recent studies have evaluated their characteristics and compared different types and makes (23, 27, 28). Manually obtained "grab samples" are also encountered frequently in the literature, especially when only a few runoff events are monitored. These may be quite acceptable if the procedure is well documented. Suggested water quality sampling procedures for various federal agencies are described in reference 13.

Few, if any, quality monitoring studies have sampled from more than one location within the cross sectional area of the flow. For the usual turbulent flow conditions, this is a reasonable practice, except for solids, in which some variation may be expected over the cross section. However, this is usually neglected.

It is very important that water quality parameters being sampled are identified exactly. Urban runoff quality sample analysis frequently requires variations from procedures given in Standard Methods (29) because of the emphasis in that text on analysis of domestic water and wastewater (23). Moreover, it is not always sufficient to state simply that analytical procedures follow those given in Standard Methods since there are frequently multiple options available for determination of a given parameter. For example, coliforms may be determined by both plate counts and membrane filters, using different growth media for either. Furthermore, the word "coliforms" by itself is ambiguous since total, fecal or other types may be implied. Another unnecessarily ambiguous parameter is phosphorous, since it is frequently measured as total P, phosphate, ortho-phosphate, hydrolizable P, organic P, etc. and may also be given as only the dissolved fraction.

As important as the parameter itself and type of sample (e.g., total, dissolved, fixed) are the units associated with the parameter. Again, phosphorus is a frequent culprit, in which a three-fold difference results from listing a concentration as mg/l as P versus mg/l as PO_4.

A relatively unambiguous parameter identification may be achieved by the assignment of a STORET code to each parameter. "STORET" is the acronym describing EPA's Water Quality Control Information System (30). Units are clearly specified as are many analytical methods and types of sample. Water quality parameters and their STORET codes encountered during this study are given in Section VI.

COMPREHENSIVE EXAMPLES

Wullscheleger et al. (23) have prepared an excellent review and procedural guide as to all aspects of urban runoff sampling. In addition, a briefer review is provided by Lager and Smith (31) and the USGS (13). Flow measurement techniques are well covered by Shelley and Kirkpatrick (22). Case studies may be consulted for useful background information (e.g., 32-35).

TIME SYNCHRONIZATION

The fundamental model verification data are the rainfall-runoff-quality measurements discussed above. Of considerable importance is the relative time of each sample. Ideally, rainfall and runoff are recorded on the same chart (typical of USGS installations) and a mark is also made on the chart when the automatic quality sampler is switched on. This provides absolute timing on a relative scale, even if the chart is not synchronized perfectly with the time of day.

At many locations, however, isolated rain gages are used. In the absence of telemetry to a central location, the temporal correlation of rainfalls and flow rates may be questionable. One solution to this problem may result from the use of the models themselves in which predicted and measured hydrographs may differ only by a constant time shift. This time shift may then be considered as the necessary adjustment between the clocks of the rain gages and the flow recorder.

MODELING DATA

Data required for models run the gamut from generalized demographic, land use and meteorological data to the details of sewer conduit geometries, slopes, etc. Such data are nearly always available from the city or municipality or other source, but it is of great usefulness if it has been gathered already by a group interested in applying models. Thus, even though different models will require different levels of detail, most will draw upon the same basic set of input requirements, e.g., topography, land use and soil parameters, demographic data, meteorology, drainage definition, and treatment, storage and cost descriptions.

Where possible, input data suitable for urban runoff models have been collected as part of this study where such data have already been prepared as part of other studies. For all cases, attempts are being made to obtain the relevant basic data mentioned earlier. In several instances, however, it is necessary to contact the data-collecting agency or municipality directly for the required input information.

SECTION V

DATA SOURCES

INTRODUCTION

A typical conclusion in many reports related to urban hydrology is that "more data are needed." It is not always clear what purposes additional data will serve, but the attitude is almost inevitably, "the more data, the better." In spite of this generality, it has been observed during the course of this study that vast amounts of rainfall-runoff-quality data already exist, and even more are currently being collected. Of course, only a minority of these data are suitable for purposes such as modeling, although a larger fraction may be useful from the characterization viewpoint. An even smaller fraction are actually accessible in a well documented, tabulated fashion. Finally, many sources, especially university studies, are only discovered by accident; no clearinghouse for such studies exists.

Still, many data sources have been uncovered during the course of this study and new ones continue to arrive. Only the ones considered most promising from a modeling viewpoint are given herein, and it is regrettable that suitable sources have probably been omitted through oversight. It is the purpose of this section to describe past and present summaries and sources of urban runoff data and to describe specific sites for which promising data exist but which were omitted from the data base prepared during this study for various reasons. Sections VII and VIII describe in detail data sources included in the data base itself.

PUBLISHED DATA SUMMARIES

American Society of Civil Engineers

The ASCE Urban Water Resources Research Council has conducted relevant studies of urban hydrology since 1967. Among the most widely used rainfall-runoff data are those collected at the Northwood catchment in Baltimore (36) and the Oakdale catchment in Chicago (37) and published under ASCE auspices. Later summaries by Tucker on monitored rainfall (38, 39) and other urban rainfall-runoff data (40, 41, 42) remain the only conveniently published information for many catchments, including some included in this report. Thus, references 36,37, 40, 41, and 42 should still be considered as prime data sources.

Other recent ASCE publications include modeling applications (43) and a summary of activities of the Council (44). Recent NSF-sponsored work has produced summaries of available urban hydrologic data and modeling activities in the U.S. (45), Australia (46), Canada (47), the United Kingdom (48), West Germany (148), Sweden (149), France (150), Norway (151), The Netherlands (180) and Poland (181). McPherson's report (45) contains a summary of U.S. and other catchments that have actually been used for testing of several current urban hydrologic models.

Illinois State Water Survey

During 1971 the Illinois State Water Survey evaluated the capabilities of the British Road Research Laboratory (RRL) model for use in urban drainage design (49). This study included testing on ten U.S. catchments. The Survey later extended the capabilities of the RRL model to create the Illinois Urban Drainage Area Simulator (ILLUDAS) model (50). For this study, ILLUDAS was tested on rainfall-runoff data from 23 different catchments, all of which are described by Terstriep and Stall (50). The 23 include nine from the RRL study, and the report (50) provides very useful capsulized information about each catchment.

U.S. Geological Survey

The USGS has collected many of the data currently available for urban basins, and their urban hydrology programs are continuing. Several of the data sources utilized in the ILLUDAS study (50), for instance, were from the USGS. Current (1976), detailed sampling of urban rainfall-runoff-quality is being conducted in Denver, Philadelphia and Broward County, Florida. (The latter site is included in this report.) The main difficulty in utilizing USGS data is in obtaining published references to the studies. The extensive Catalogue of Information on Water Data (51), published biannually, apparently only contains references to continuing stream, lake, etc. gaging programs. Schneider's 1968 survey (52) contains some information, but is dated. A survey by the Water Resources Scientific Information Center (53) contains references to USGS urban hydrology studies as well as others. However, direct inquiries can be made to state USGS offices for information on relevant studies. In addition, most USGS quality data are placed in the EPA STORET file or the Water Data Information and Retrieval System (WATSTORE) file of the USGS itself (54) and are thus fairly easily accessible. Finally, the USGS has also established its National Water Data Exchange (NAWDEX), whose purpose is to point users to relevant data files in the manner of a clearinghouse (55).

Office of Water Resources Technology

The OWRT has sponsored several projects related to urban hydrology and data collection. Included among them have been recent studies at Rutgers, Cornell, Virginia Polytechnic Institute, University of Maryland and University of Massachusetts. Final reports from these studies are forthcoming. Data from one OWRT-sponsored study in Lincoln, Nebraska (56) are included in this report.

Environmental Protection Agency

Under the EPA and its predecessors (PHS, FWPCA, FWQA) many urban runoff studies have been conducted involving extensive sampling programs, some of which are included in this report. Although better documented than most studies, many of the earlier reports contain samples of only a few storms at several sites or rely upon composited samples, thus making them unsuitable for modeling applications. Such reports may still contain useful characterization data, however, and several are utilized for this purpose by Heaney et al. (57).

The number of potentially useful EPA-sponsored studies is too large to list each individually in this report. Also, the number is increasing because of EPA Section 201 Construction Grant and Section 208 Areawide Waste Management Grant studies currently in progress under the 1972 Amendments to the Federal Water Pollution Control Act. However, reference to some reports is made in subsequent sections.

Other Agencies

Other federal agencies also publish hydrologic data, but few data are specifically for urban applications. For example, the Agricultural Research Service (ARS) has published rainfall-runoff data for many agricultural watersheds (58) that are useful for hydrologic modeling in general. The National Weather Service (NWS), Office of Hydrology, has compiled some data for use in their river forecasting and modeling efforts, but engage in little or no acquisition themselves. Of course, the NWS through its National Climatic Center at Asheville, North Carolina is the prime source of precipitation and other meteorological data collected at NWS and some other installations. For instance, although precipitation data are routinely reduced only at hourly intervals, photocopies of the original weighing bucket charts may be obtained from which data may be reduced at finer time intervals. In addition, the parent arm of the NWS, the National Oceanic and Atmospheric Administration (NOAA), has established their ENDEX/OASIS data retrieval system for access to environmental-related data within their jurisdiction (59). However, the emphasis is upon marine data.

The Hydrologic Engineering Center (HEC) of the Corps of Engineers engages in extensive model development activities (e.g., 7) but few data collection activities. However, they have sponsored urban runoff monitoring in the San Francisco Bay region (160), which is listed in Table V-1 to follow.

References to other available hydrologic data, (though not necessarily urban), may be found in many reports, theses, dissertations, papers, etc. A report prepared as part of the International Hydrological Decade (60) contains information on 60 experimental watersheds in the U.S., but few are urban in character. A report prepared by the National Technical Information Service (NTIS) on data files available from federal agencies (61) contains only one reference to hydrologic data (to test data included with the NWS Office of Hydrology river forecast models).

DATA SOURCES IN OTHER COUNTRIES

Programs in urban hydrology in several countries have been summarized by the ASCE as discussed previously (45-48, 148-151, 180,181). Several Canadian studies are referenced in subsequent sections of this report, and data from

Windsor, Ontario are included in the data base. A summary of current activities related to urban runoff in the Great Lakes region is available (152). Another recent publication provides a useful review of available snow quality data for urban areas (62).

As additional sources to the ASCE report on Australia (46), Heeps and Mein (153) describe rainfall-runoff monitoring in Canbera and Melbourne, and Cordery (154) describes quality measurements in Sydney. Reports on urban runoff measurements in Paris (155) and Munich (156) have also been published. Additional references to monitored West German catchments may be found in other model studies (126, 174). Lindh (149) discusses data for the Bergsjön catchment near Gothenberg, Sweden. Rainfall-runoff data for this catchment may be found in reports published by Arnell and Lyngfelt (157, 158).

POTENTIAL DATA SOURCES NOT INCLUDED IN FIRST RELEASE OF DATA BASE

During the course of this study, many promising data sources were uncovered, but only a portion are included in this first release of the data base. These locations are described in detail in Sections VII and VIII. Other locations showing promise as to modeling data are listed in Table V-1 with related information. Some sources will probably be included in future addenda to this report as data are reduced or computerized for inclusion. Some sources are definitely deserving of inclusion, but were simply not available in time. Note that the vast number of sources owing to EPA 201 and 208 studies are generally <u>not</u> included in Table V-1, as these studies are either being initiated or have been underway for too short a period to obtain and reduce useful data. Moreover, little is known about most of them except at the local level. However, as these sources become viable and provide data to the University of Florida, they will be included in future addenda.

Table V-1. Potential Sources of Data Not Included in First Release of Data Base

City, Catchment, and Major Land Use	Area ac(ha)	Drainage Systems	Reasons for Exclusion	Quantity Data(Years)	Flow Meas. Technique	Quality Data(Years)	Contact	References
Atlanta, GA							1,2	63,64
Confederate Ave.(Res.)	1129(457)	C	$1_3,1_4$	r_2,(69,73)	f_8,f_2	q_4,(69,73)		
Boulevard(Res.)	2421(980)	C	$1_3,1_4$	r_2,(69,73)	f_8,f_2	q_4,(69,73)		
McDaniel St.(Res.)	968(392)	C	$1_3,1_4$	r_2,(69,73)	f_8,f_2	q_2,(69,73)		
Harlan Dr.(Res.)	954(386)	S	$1_3,1_4$	r_1,(69)	f_8	q_1,(69)		
Casplan St.(Res.)	517(209)	S	$1_3,1_4$	r_2,(69)	f_8	q_1,(69)		
Fed. Prison(Open)	1498(606)	S	$1_3,1_4$	r_1,(69)	f_8	q_1,(69)		
Burlington, ONT							3	62,66,67
Malvern(Res.)	57.6(23.3)	S	1_2	r_3,(73-75)	f_2	q_4,(73-75)		
Commercial	17.0(6.9)	S	1_2	r_3,(74-75)	f_2	q_4,(74-75)		
Cincinnati, OH							4	
Bloody Run(Res.)	2380(964)	C	1_4	r_2,(70)	f_1, f_2	q_3,(70)		68,102,129
Mt. Washington(Res.)	27(11)	S	1_5	r_2,(62-64)	f_2	q_1,(62-63)		40,50,69
Cleveland, OH							5	70
Madison(Res.)	2550(1030)	C	$1_1,1_2,1_3$	r_1,(66-67)	f_1	q_1,(66-67)		
Edgewater(Res.)	1840(745)	S	$1_1,1_2,1_3$	r_1,(66-67)	f_2	q_1,(66-67)		
Denver, CO							6	42,71,72
Several residential		S	$1_1,1_2$	r_1,(69-date)	f_1,f_2,f_6	q_5		
Des Moines, IA							7	73
Several residential		C&S	1_3	r_1,(69)	f_2	q_1,(69)		

Table V-1. (continued)

City, Catchment, and Major Land Use	Area ac(ha)	Drainage Systems	Reasons for Exclusion	Quantity Data(Years)	Flow Meas. Technique	Quality Data(Years)	Contact	References
Detroit, MI							8	42, 130, 170
Oakwood(Res.)	1500(607)	C	$1_1,1_2,1_3$	r_2,(74-date)	f_7	q_5		
Greenfield, MA							9	74
Maple Brook(Res.)	547(221)	S	1_2	r_1,(74-75)	f_2	q_1,(74-75)		
Halifax, N.S.							10	75,76,77, 78
Quinpool Rd.(Com.)	1.0(0.4)	C[a]	1_3	r_1,(69-70)	f_2	q_1,(69-70)		
Cambridge St.(Res.)	2.4(1.0)	C[a]	1_3	r_1,(69-70)	f_2	q_1,(69-70)		
Total area	168(68)	C[a]	1_3	r_1,(69-70)	f_4	q_1,(69-70)		
Hamilton, ONT							11	79
Hamilton Mt.(Res.)	176(71)	C	1_2	r_1,(75-76)	f_2	q_2,(75-76)		
Houston, TX								
Woodlands(Res.)	multiple sites	S	1_3	r_3,(73-76)	f_8	q_4,(73-76)	12	80, 169
Other Houston		S	1_1	r_2,(65-69)		q_5	13	41,42,50, 164-168
Kingston, ONT							14	62,81,82
Calvin Park(Res.)	36(15)	S	1_5	r_2,(73-74)	f_2	None		
Lafayette, IN							15	42, 161
Multiple sites		S	$1_1,1_3,1_5$	r_1,(74-75)		q_5		
Louisville, KY							16	50,83,84
Multiple sites		S	$1_1,1_5$	r_1,(45-47)	f_8	None		

[a]Surface runoff samples taken.

Table V-1 (continued)

City, Catchment, and Major Land Use	Area ac(ha)	Drainage Systems	Reasons for Exclusion	Quantity Data(Years)	Flow Meas. Technique	Quality Data(Years)	Contact	References
Lubbock, TX							17	85
Clapp Park(Res.)	223(90.2)	S	1_5	r_2,(71-72)	f_3	q_4,(71-72)		
Milwaukee, WI							18	32,41, 162
Humbolt Ave.(Res.)	570(231)	C	1_3,1_4	r_3,(71-72)	f_2,f_8	q_4,(71-75)		
Occoquan Watershed, VA							19	86
Several Urban		S	1_5	r_3,(74-date)	f_2,f_8	q_4,(74-date)		
Orlando, FL							20	87,88,89
Lake Eola(Com.)	28(11.3)	S	1_2,1_6	r_1,(73-74)	f_1	q_1,(73-74)		
Lake Eola(Res.)	16(6.5)	S	1_2,1_6	r_1,(73-74)	f_1	q_1,(73-74)		
Richmond, VA							21	
Multiple Sites		S	1_2			q_5		
Rochester, NY							22	
Multiple sites		C,S	1_1,1_2,1_3	r_3,(74-76)	f_2,f_9	q_4,(74-76)		147, 173
Salt Lake City, UT							23	159
Layton(Hwy.)	1.35(0.54)	S^b	1_5	r_3,(72-73)	f_6	None		
Parleys(Hwy.)	0.54(0.22)	S^b	1_5	r_3,(72-73)	f_6	None		

[b] Open channel, roadside drainage.

Table V-1 (continued)

City, Catchment, and Major Land Use	Area ac(ha)	Drainage Systems	Reasons for Exclusion	Quantity Data(Years)	Flow Meas. Technique	Quality Data(Years)	Contact	References
San Francisco Bay, CA							24	160
Castro Valley[Hayward] (Res.)	3200(1300)	S	1_5	r_3,(72-76)	f_2	q_4,(72-76)		
Peralta Cr. [Oakland] (Res.)	1280(520)	S	1_5	r_1,(73)	f_2	q_2,(73)		
Ross Cr.[San Jose] (Res.)	4480(1810)	S	1_5	r_1,(73-74)	f_2	q_2,(73-74)		
Strong Ranch Sl. [Sacramento] (Res.)	3200(1300)	S	1_5	r_3,(73-76)	f_2	q_4,(73-76)		
Syracuse, NY							22	147
Maltbie St.(Com.)	135(54.6)	C	1_1,1_3	r_3,(73-76)	f_2	q_4,(73-76)		
Newell St.(Res.)	54(21.9)	C	1_1,1_3	r_3,(73-76)	f_2	q_4,(73-76)		
Tallahassee, FL							25	90
Meginnis Arm(Res.)	1780(721)	S	1_1,1_3, 1_5,1_6	r_3,(74-75)	f_8	q_4,(74-75)		
Toronto, ONT								
North York, Brucewood (Res.)	48.3(19.5)	S	1_1,1_3,1_5	r_3,(74-75)	f_2	q_4,(74-75)	3	62,91-93
East York(Res.)	383(155)	C	1_1,1_2,1_3	r_2,(76)	f_2	q_2,(76)	27	62,94
Int. Airport	495(200)	S	1_1,1_3	r_1,(74-75)	f_1	q_1,(74-75)	26	62,95
West Toronto(Res.)	2330(943)	C	1_1,1_4	r_3,(69-76)	f_2	None	28	62,63

Table V-1 (concluded)

City, Catchment, and Major Land Use	Area ac(ha)	Drainage Systems	Reasons for Exclusion	Quantity Data(Years)	Flow Meas. Technique	Quality Data(Years)	Contact	References
Tucson, AZ Multiple sites		S	l_3	r_3,(67-75)	f_3	q_4,(67-75)	29	96-99
Washington, DC Kingman Lake(Res.)	4200(1700)	C	l_3,l_6	r_3,(69)	f_1	q_1,(69)	30	100,102
Winnipeg, MAN Bannatyne(Com.)	542(219)	C	l_5,l_6	r_3,(69-71)	f_2	q_1,(69-71)	31	62,63

Notes for Table V-1

Codes--

f_1 Stage measurement in conduits converted to flow using Manning equation

f_2 Weir

f_3 Parshall flume

f_4 Other critical depth measurement

f_5 Dye dilution

f_6 Calibrated flow constriction

f_7 Pumping records

f_8 Stage discharge calibration

f_9 Flow meter

l_1 Lack of sufficient documentation

l_2 Program being initiated or too few data to date

l_3 Data not in suitable form for transmittal or further reduction required

l_4 Data questionable or requiring re-analysis

l_5 Data unavailabe to UF in time

l_6 Large sampling interval, portions missing, or unsuitable for modeling

q_1 Yes, few parameters, < 10 storms

q_2 Yes, several parameters, < 10 storms

q_3 Yes, few parameters, > 10 storms

q_4 Yes, several parameters, > 10 storms

q_5 Program being initiated

r_1 Yes, < 10 storms

r_2 Yes, 10-20 storms

r_3 Yes, > 20 storms

C Combined sewer systems

S Storm sewer and/or natural drainage system.

Notes for Table V-1 (continued)

Contacts--

1. Mr. Allen Fields, Environment and Streets, City of Atlanta, City Hall, Atlanta, Georgia 30303.

2. Black, Crow & Eidsness, Inc., Consulting Engineers, 1261 Spring St. NW, Atlanta, Georgia 30309.

3. Mr. J. Marsalek, Hydraulics Research Division, Canada Centre for Inland Waters, Box 5050, Burlington, Ontario L7R 4A6.

4. Dr. H.C. Pruel, Dept. of Civil Engineering, University of Cincinnati, Cincinnati, Ohio 45221.

5. Mr. L.W. Curtis, Havens and Emerson, Ltd., 1220 Leader Bldg., Cleveland, Ohio 44114.

6. Mr. J. Biesecker, District Chief, U.S. Geological Survey, Water Resources Division, Stop 415, Box 25046, Denver Federal Center, Denver, Colorado 80225.

7. Henningson, Durham and Richardson, Inc., 8404 Indian Hills Drive, Omaha, Nebraska 68114.

8. Mr. D. Suhry, Director of Engineering, Detroit Metro Water Department, Water Board Bldg., Detroit, Michigan 48226.

9. Dr. D.D. Adrian, Dept. of Civil Engineering, University of Massachusetts, Amherst, Massachusetts 01002.

10. Dr. D.H. Waller, Dept. of Civil Engineering, Nova Scotia Technical University, Box 1000, Halifax, Nova Scotia.

11. Mr. C.W. Eicher, Gore and Storrie, Ltd., 1670 Bayview Avenue, Toronto, Ontario M4G 3C2.

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18. City of Milwaukee, Dept. of Public Works, Milwaukee, Wisconsin 53202.

19. Dr. T. Grizzard, Laboratory Director, Occoquan Watershed Monitoring Laboratory, Virginia Polytechnic Institute, Box 773, Manassas, Virginia 22110.

20. Dr. M. Wanielista, College of Engineering, Florida Technological University, Box 25000, Orlando, Florida 32816.

21. Mr. K.C. Das, Director, Division of Special Projects, Piedmont Regional Office, State Water Control Board, Box 11143, Richmond, Virginia 23230.

22. Mr. D. Carleo, O'Brien & Gere Engineers, 1304 Buckley Rd., Syracuse, New York 13201.

23. Utah Water Research Laboratory, Utah State University, Logan, Utah 84322.

24. Mr. Bill S. Eichert, Director, The Hydrologic Engineering Center, Corps of Engineers, 609 2nd St., Davis, California 95616.

25. Dr. R.C. Harriss, Dept. of Oceanography, Florida State University, Tallahassee, Florida 32306.

26. Dr. P.E. Wisner, James F. MacLaren Ltd., 435 McNicoll Ave., Willowdale, Ontario M2H 2R8.

27. Mr. E. Larsen, M.M. Dillon Ltd., 50 Holly St., Toronto, Ontario M4S 2E9.

28. Mr. C.S. Kitchen, Data Retrieval and Reporting, Dept. of Public Works, 24th Floor, East Tower, City Hall, Toronto, Ontario M5H 2N2.

29. Dr. S. Resnick, University of Arizona, Water Resources Research Center, Bldg. No. 28, Tucson, Arizona 85721.

30. Roy F. Weston, Inc., Weston Way, West Chester, Pennsylvania 19380.

31. Mr. G.E. Burns, Manager of Engineering, Waterworks, Waste and Disposal Division, City of Winnipeg, 455 Ellice Ave., Winnipeg, Manitoba R3B 1Y6.

SECTION VI

DATA BASE FORMAT

TYPES OF INFORMATION

At least four types of information are potentially available for each location utilized as a data source:

1. physical, demographic, etc. descriptions of the sites, plus maps, parameters and sampling methods;

2. published reports and other written documentation;

3. the rainfall-runoff-quality data themselves; and

4. associated modeling data, e.g., maps, plans, photos, etc.

Sections VII and VIII contain item 1 in write-ups for each location. A standardized tabular format is used for all sites. Item 2 is handled through a list of references for each location. Item 3 is handled separately, wherein all data have been coded and placed on a magnetic tape, the format of which is explained below. UF has been able to obtain a limited amount of data needed for model input, item 4. These will be available for short-term loan. The remainder of such data will have to be obtained from contacts with individuals at each location. In addition, input data for the EPA Storm Water Management Model, SWMM (101-103) are available for a few locations.

DATA IDENTIFICATION

Location Identification

For computer coding, all locations are given a state, city and catchment code. State codes are the standard two-character mnemonics used by the Postal Service. These are listed in Table VI-1. Canadian provinces are identified in the same manner, as given in Table VI-1. Since each mnemonic must be unique, the most logical two-character provincial identifier is not always used in order to avoid conflicts with state mnemonics.

A two-digit numeric code is arbitrarily assigned to each data location within a state. Similarly, a two-digit numeric code is then assigned to each catchment at a given location. These numbers have been assigned strictly on the basis of the order in which each location has been processed for the data base. They are identified along with each description, in Sections VII and VIII. An index is provided in Table VI-2.

Table VI-1. State and Provincial Mnemonics

Area	Mnemonic	Area	Mnemonic
Alabama	AL	Nevada	NV
Alaska	AK	New Brunswick	NK
Alberta	AB	Newfoundland	NF
Arizona	AZ	New Hampshire	NH
Arkansas	AR	New Jersey	NJ
British Columbia	BC	New Mexico	NM
California	CA	New York	NY
Colorado	CO	North Carolina	NC
Connecticut	CT	Nova Scotia	NS
Delaware	DE	Ohio	OH
District of Columbia	DC	Oklahoma	OK
Florida	FL	Ontario	ON
Georgia	GA	Oregon	OR
Hawaii	HI	Pennsylvania	PA
Idaho	ID	Prince Edward Island	PI
Illinois	IL	Puerto Rico	PR
Indiana	IN	Quebec	PQ
Iowa	IA	Rhode Island	RI
Kansas	KS	Saskatchewan	SS
Kentucky	KY	South Carolina	SC
Louisiana	LA	South Dakota	SD
Maine	ME	Tennessee	TN
Manitoba	MB	Texas	TX
Maryland	MD	Utah	UT
Massachusetts	MA	Vermont	VT
Michigan	MI	Virginia	VA
Minnesota	MN	Virgin Islands	VI
Mississippi	MS	Washington	WA
Missouri	MO	West Virginia	WV
Montana	MT	Wisconsin	WI
Nebraska	NB	Wyoming	WY

Table VI-2 Index to Location ID Codes

Code	State	City	Catchment
CA 1 1	California	San Francisco	Baker St.
CA 1 2			Mariposa St.
CA 1 3			Brotherhood Way
CA 1 4			Vicente St., N.
CA 1 5			Vicente, St., S.
CA 1 6			Selby St.
CA 1 7			Laguna St.
CA 2 1	California	Los Angeles	Echo Park
FL 1 1	Florida	Broward County	Residential
FL 1 2			Transportation
FL 1 3			Commercial
IL 1 1	Illinois	Chicago	Oakdale
IL 2 1	Illinois	Champaign-Urbana	Boneyard Creek
KS 1 1	Kansas	Wichita	Dry Creek
MD 1 1	Maryland	Baltimore	Gray Haven
MD 1 2			Northwood
MS 1 1	Mississippi	Jackson	Crane Creek
NB 1 1	Nebraska	Lincoln	39 & Holdrege
NB 1 2			63 & Holdrege
NB 1 3			78 & A
NC 1 1	North Carolina	Winston-Salem	Tar Branch
NC 2 1	North Carolina	Durham	Third Fork
NY 1 1	New York	Westbury	Woodoak Dr.
OH 1 1	Ohio	Bucyrus	Sewer District 8
ON 1 1	Ontario	Windsor	Labadie Rd.
OR 1 1	Oregon	Portland	Eastmoreland
PA 1 1	Pennsylvania	Lancaster	Stevens Ave.
PA 2 1	Pennsylvania	Philadelphia	Wingohocking

Table VI-2 (concluded)

Code	State	City	Catchment
TX 1 1	Texas	Houston	Hunting Bayou (Cavalcade St.)
TX 1 2			Hunting Bayou (Falls St.)
TX 1 3			Bering Ditch
TX 1 4			Berry Creek
VA 1 1	Virginia	Falls Church	Tripps Run
WA 1 1	Washington	Seattle	View Ridge 1
WA 1 2			View Ridge 2
WA 1 3			South Seattle
WA 1 4			Southcenter
WA 1 5			Lake Hills
WA 1 6			Highlands
WA 1 7			Cent. Bus. Dist.
WI 1 1	Wisconsin	Racine	Site I
		1979 Additional Locations	
IN 1 1	Indiana	West Lafayette	Ross Ade (Upper)
MA 1 1	Massachusetts	Greenfield	Maple Brook
MA 2 1	Massachusetts	Northampton	Market Street Brook
UT 1 1	Utah	Salt Lake City	Layton
UT 1 2	Utah	Salt Lake City	Parleys Canyon I
UT 1 3	Utah	Salt Lake City	Parleys Canyon II

Parameter Identification

Each quantity and quality parameter is identified with its appropriate five-digit STORET code (30). Where these codes are missing, arbitrary codes have been assigned by UF. These are in the 90000 range so as to avoid conflict with STORET codes which go no higher than the 80000 range. All codes for parameters encountered during the processing of data are given in Table VI-3 with the units used. As discussed previously, in most cases, STORET codes have the advantage of implying the units, type of sample (e.g., total, fixed, dissolved) and analytical technique used. Slight variances with STORET definitions are indicated in Table VI-3. A complete list of STORET codes may be found in the STORET manual (30).

CODING FORMAT

All data have been placed on standard punched cards for later entry onto magnetic tapes. Each card contains the location ID followed by the date, time and up to five parameters, as shown in Figure VI-1. Although this format is far from being compressed, it does allow easy identification and filing of each card. Also, new data may easily be added to a given location. Decimal points are always punched, and no scaling is performed. All values are instantaneous values at the indicated time except for rainfall, for which the value given is an average intensity over the time interval beginning at the indicated time. In a few instances, cumulative rainfall depth is given to avoid calculation of intensities over varying time intervals.

Coliforms and streptococci are treated differently because their range (1 to 10^9) is greater than the seven-character field width of the format used for data entries. Hence, all such data are entered on the cards as $100 \cdot \log_{10}$ (MPN/100ml). (The multiplier of 100 is used to provide extra significant figures when an F7.2 format is used.) Users should be careful to remember this fact when reading values of these parameters.

A typical grouping of punched data is shown in Figure VI-2. Note that a header card containing the name of city, state and catchment precedes the data for that catchment. All data from one storm event are grouped together, although rainfall, flow and quality cards may appear in a different order for different catchments. Occasionally, as in Seattle, a few storm parameters (e.g., dry days, total depth) may precede the storm data itself.

ACCESS AND USE

The emphasis of this project was not upon formulation of a sophisticated storage and retrieval system for management of the data base. Rather, it was to obtain and document as much data as possible. Hence, the "data base" itself is merely a magnetic tape containing card images of the type shown in Figure VI-2. On the tape, data are blocked according to cities, as sketched in Figure VI-3. The first block contains information on STORET codes and card format, and material accompanying the tape explains the location (block number) of data for each city.

Table VI-3. STORET and University of Florida Parameter Codes.

Note: Codes above 90000 assigned by UF

Code	Parameter and Units	Chemical Symbol or Abbreviation
10	Temperature, [°C]	
11	Temperature, [°F]	
45	Precipitation, total, [in./day or in./storm[a]]	
53	Catchment area, [acres]	
61	Flow, instantaneous stream or conduit[b], [ft^3/sec = cfs]	
65	Stage, [ft]	
70	Turbidity, [Jackson Turbidity Units = JTU]	
80	Color, [Platinum Cobalt Units = PCU]	
94	Conductivity, field [micro mhos = μmho]	
95	Conductivity, at 25°C [μmho]	
299	Oxygen, dissolved, by probe, [mg/l]	DO
300	Oxygen, dissolved, [mg/l]	DO
301	Oxygen, dissolved, [% saturation]	DO
310	Biochemical oxygen demand, 5-day, [mg/l]	BOD_5
311	Biochemical oxygen demand, 5-day, dissolved, [mg/l]	Diss. BOD_5
324	Biochemical oxygen demand, 20-day, [mg/l]	BOD_{20}
340	Chemical oxygen demand, high level, [mg/l]	COD
341	Chemical oxygen demand, dissolved [mg/l]	Diss. COD
400	pH	
405	Carbon dioxide, [mg/l as CO_2]	CO_2
410	Alkalinity, total, [mg/l as Ca CO_3]	
440	Bicarbonate ion, [mg/l as HCO_3]	
445	Carbonate ion, [mg/l as CO_3]	CO_3

Table VI-3(continued)

Code	Parameter and Units	Chemical Symbol or Abbreviation
480	Salinity, [parts per thousand = ppt]	
500	Residue, total, (total solids), [mg/l]	TS
505	Residue, total volatile (total volatile solids), [mg/l]	TVS
515	Residue, total filterable, (total dissolved solids), [mg/l]	TDS
530	Residue, total nonfilterable, (total suspended solids),[mg/l]	TSS or SS
535	Residue, volatile nonfilterable (volatile suspended solids), [mg/l]	VSS
540	Residue, fixed nonfilterable (fixed suspended solids), [mg/l]	FSS
544	Residue, volatile settleable (volatile settleable solids), at 45 min[c], [mg/l]	
545	Residue, settleable (settleable solids) at 45 min[c], [ml/l]	Set. S
546	Residue, settleable (settleable solids) at 45 min[c], [mg/l]	Set. S
600	Nitrogen, total, [mg/l as N]	Tot. N
605	Nitrogen, total organic, [mg/l as N]	Org. N
610	Nitrogen, total ammonia, [mg/l as N]	NH_3-N
615	Nitrite nitrogen, total, [mg/l as N]	NO_2-N
620	Nitrate nitrogen, total, [mg/l as N]	NO_3-N
625	Nitrogen, total Kjeldahl, [mg/l as N]	TKN
630	Nitrite plus nitrate, total (one determination), [mg/l as N]	NO_2-N+NO_3-N
650	Phosphate, total, [mg/l as PO_4]	TPO_4-PO_4
653	Phosphate, total soluble, [mg/l as PO_4]	TPO_4-PO_4(sol)
660	Orthophosphate, total, [mg/l as PO_4]	OPO_4-PO_4
665	Phosphorus, total (wet method), [mg/l as P]	Tot. P
666	Phosphorus, dissolved (wet method), [mg/l as P]	Dis. P
669	Phosphorus, total hydrolyzable, [mg/l as P]	Tot. hyd-P

Table VI-3 (continued)

Code	Parameter and Units	Chemical Symbol or Abbreviation
671	Orthophosphate, dissolved, [mg/l as P]	OPO_4-P(sol.)
680	Carbon, total organic, [mg/l as C]	TOC
685	Carbon, total inorganic, [mg/l as C]	
690	Carbon, total [mg/l as C]	Tot. C
901	Hardness, carbonate, [mg/l as $CaCO_3$]	
916	Calcium, total, [mg/l as Ca]	Ca
927	Magnesium, total, [mg/l as Mg]	Mg
929	Sodium, total, [mg/l as Na]	Na
937	Potassium, total, [mg/l as K]	K
940	Chloride, [mg/l as Cl]	Cl
945	Sulfate, [mg/l as SO_4]	SO_4
955	Silica, dissolved, [mg/l as SiO_2]	SiO_2(soluble)
1002	Arsenic, total, [μg/l as As]	As
1027	Cadmium, total, [μg/l as Cd]	Cd
1034	Chromium. total, [μg/l as Cr]	Cr
1037	Cobalt, total, [μg/l as Co]	Co
1041	Copper, suspended, [μg/l as Cu]	Cu(susp.)
1042	Copper, total, [μg/l as Cu]	Cu
1045	Iron, total, [μg/l as Fe]	Fe
1051	Lead, total, [μg/l as Pb]	Pb
1055	Manganese, total [μg/l as Mn]	Mn
1067	Nickel, total, [μg/l as Ni]	Ni
1082	Strontium, total, [μg/l as Sr]	Sr

Table VI-3 (continued)

Code	Parameter and Units	Chemical Symbol or Abbreviation
1092	Zinc, total, [μg/1 as Zn]	Zn
1107	Aluminum, total, [μg/1 as Al]	Al
31501	Coliform, tot., membrane filt., immed., M-endo. media, 35°C, [MPN/100ml][d]	Tot. Colif.
31503	Coliform, tot., membrane filt., delayed, M-endo. media, 35°C, [MPN/100ml][d]	Tot. Colif.
31504	Coliform, tot., membrane filt., immed., Les endo. agar, 35°C, [MPN/100ml][d]	Tot. Colif.
31505	Coliform, tot., MPN, confirmed test, 35°C, [MPN/100ml][d]	Tot. Colif.
31615	Coliform, fecal, MPN, Ec. media, 44.5°C, [MPN/100ml][d]	Fec. Colif.
31616	Coliform, fecal, membrane filt., M-ec. broth, 44.5°C, [MPN/100ml][d]	Fec. Colif.
31679	Streptococci, fecal, [MPN/100ml][d]	Fec. Strep.
50055	Depth of flow in pipe or conduit, [in.]	
70299	Solids, suspended by evaporation at 180°C, [mg/1]	TSS or SS
70351	Grease, hexane-soluble, [mg/1]	
70507	Orthophosphate, total, [mg/1 as P]	OPO_4-P
71886	Phosphorus, total, [mg/1 as PO_4]	Tot. P-PO_4
71887	Nitrogen, total, [mg/1 as NO_3]	Tot. N-NO_3
71889	Orthophosphate, soluble, [mg/1 as PO_4]	OPO_4-PO_4(sol.)
71900	Mercury, total, [μg/1 as Hg]	Hg
90035	Cumulative rainfall at given time, (in.) sixth gage	
90036	Cumulative rainfall at given time, (in.) fifth gage	
90037	Cumulative rainfall at given time, (in.) fourth gage	
90038	Cumulative rainfall at given time, (in.) third gage	
90039	Cumulative rainfall at given time, (in.) second gage	
90040	Cumulative rainfall at given time, (in.) principal gage.	
90045	Rainfall intensity, beginning at indicated time, [in./hr], sixth gage	

Table VI-3(continued)

Code	Parameter and Units	Chemical Symbol or Abbreviation
90046	Rainfall intensity, beginning at indicated time,[in./hr], fifth gage	
90047	Rainfall intensity, beginning at indicated time,[in./hr], fourth gage	
90048	Rainfall intensity, beginning at indicated time,[in./hr], third gage	
90049	Rainfall intensity, beginning at indicated time,[in./hr], second gage	
90050	Rainfall intensity, beginning at indicated time,[in./hr], principal gage	
90051	Storm duration, [min]	
90052	Minimum flow, lower bound when flow reported only over a range, [cfs]	
90053	Maximum flow, upper bound when flow reported only over a range, [cfs]	
90055[f]	Floatables, [mg/l]	
90060	Residue, settleable (settleable solids) at 30 min, [ml/l]	Set. S
90063	Settled COD, [mg/l]	Set. COD
90064	Settled BOD_5, [mg/l]	Set. BOD_5
90065	Percent suspended solids on 75μ filter, [%]	
90066	Percent suspended solids on 14μ filter, [%]	
90067	Percent suspended solids on 5μ filter, [%]	
90068	Percent suspended solids on 0.45μ filter, [%]	
90069	Bioassay, percent survival in undiluted waste, 96 hrs, [%]	
90070	Toxicity, percent survival in undiluted waste, 96 hrs,[%]	
90100	Dry days preceding storm, [days]	

[a]Code also used for total storm depths as defined by data source, (i.e., the storm duration may be unequal to one day).

[b]Code also used for conduit flows (most urban data).

[c]Code also used for settleable solids at 60 min.

Table VI-3 (concluded) Footnotes

[d] Note: On data tape, coliforms, etc. are given as $100 \cdot \log_{10}$ (MPN/100ml).

[e] Storm duration given in absence of detailed rainfall hyetograph.

[f] Parameters 90055 - 90070 used only for San Francisco (34,35).

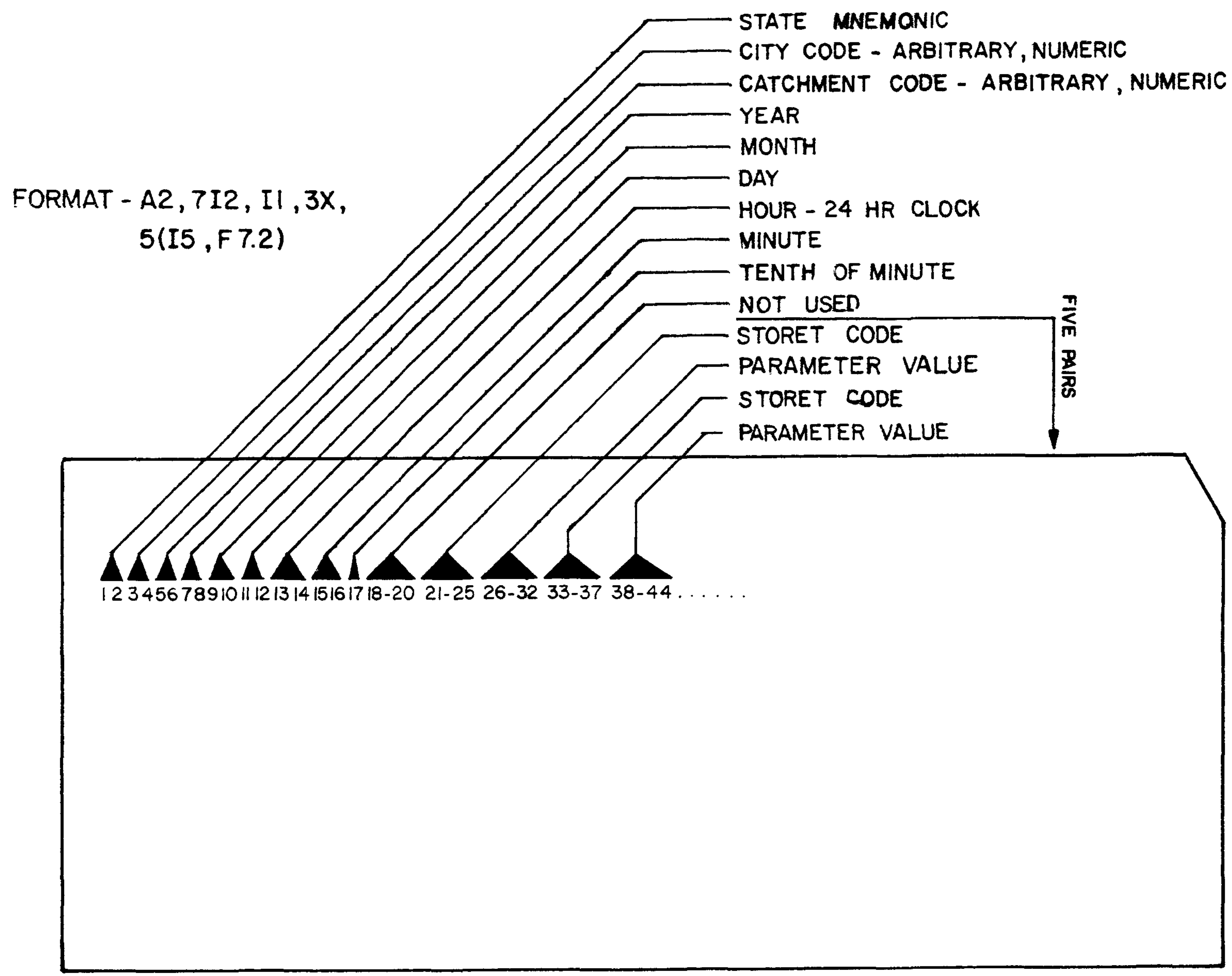

Figure VI-1 Arrangement of identification codes and data on computer card.

			SEATTLE, WASHINGTON		VIEW RIDGE 1 (VR1)				(WA 1 1)			
WA	1	17510022100	90050	0.0								
WA	1	17510022115	90050	0.04								
WA	1	17510022130	90050	0.0								
WA	1	17510022145	90050	0.0								
WA	1	17510022200	90050	0.04								
WA	1	17510022215	90050	0.0								
WA	1	17510022330	90050	0.0								
WA	1	17510022345	90050	0.04								
WA	1	17510022400	90050	0.04								
WA	1	17510030015	90050	0.0								
WA	1	17510030030	90050	0.04								
WA	1	17510030045	90050	0.04								
WA	1	17510030100	90050	0.0								
WA	1	17510030115	90050	0.04								
WA	1	17510030130	90050	0.12								
WA	1	17510030145	90050	0.08								
WA	1	17510030200	90050	0.20								
WA	1	17510030215	90050	0.28								
WA	1	17510030230	90050	0.16								
WA	1	17510030245	90050	0.04								
WA	1	17510030300	90050	0.04								
WA	1	17510030315	90050	0.0								
WA	1	17510030345	90050	0.0								
WA	1	17510030400	90050	0.04								
WA	1	17510030415	90050	0.0								
WA	1	17510030515	90050	0.0								
WA	1	17510030530	90050	0.04								
WA	1	17510030545	90050	0.0								
WA	1	17510030645	90050	0.0								
WA	1	17510030700	90050	0.04								
WA	1	17510030715	90050	0.0								
WA	1	17510022430	90100	16.00	53	630.00	45	0.33				
WA	1	17510022430	61	0.93								
WA	1	17510022445	61	1.01								
WA	1	1751003 100	61	1.39								
WA	1	1751003 115	61	1.49	665	1.5270507		0.26	605	9.99	610	1.19
WA	1	1751003 115	630	1.41	530	308.00	70	44.00	94	250.00	1027	4.00
WA	1	1751003 115	1051	1240.00	1092	600.00						
WA	1	1751003 130	61	2.18	665	1.3670507		0.26	605	7.62	610	1.39
WA	1	1751003 130	630	1.24	530	1420.00	70	43.00	94	208.00	1027	4.00
WA	1	1751003 130	1051	910.00	1092	480.00						
WA	1	1751003 145	61	2.85								
WA	1	1751003 200	61	2.57	665	0.9170507		0.28				
WA	1	1751003 215	61	2.18	665	0.9470507		0.28	605	5.18	610	1.37
WA	1	1751003 215	630	1.16	530	476.00	70	38.00	94	160.00	1027	4.00
WA	1	1751003 215	1051	620.00	1092	330.00						
WA	1	1751003 230	61	6.45	665	1.0970507		0.20	605	4.73	610	1.26
WA	1	1751003 230	630	0.94	530	176.00	70	57.00	94	140.00	1027	4.00
WA	1	1751003 230	1051	740.00	1092	340.00						
WA	1	1751003 245	61	4.82	665	1.1070507		0.25	605	4.18	610	0.92
WA	1	1751003 245	630	0.71	530	500.00	70	33.00	94	108.00	1027	4.00
WA	1	1751003 245	1051	1720.00	1092	480.00						
WA	1	1751003 300	61	8.83								
WA	1	1751003 315	61	6.67	665	0.9670507		0.24	605	3.01	610	0.49
WA	1	1751003 315	630	0.55	530	1040.00	70	37.00	94	77.00	1027	4.00
WA	1	1751003 315	1051	890.00	1092	320.00						
WA	1	1751003 330	61	7.12								
WA	1	1751003 345	61	6.67	665	0.6670507		0.24				
WA	1	1751003 400	61	4.45								
WA	1	1751003 415	61	2.85								
WA	1	1751003 430	61	2.44								
WA	1	1751003 445	61	2.05								
WA	1	1751003 500	61	1.70	665	0.2970507		0.16				
WA	1	1751003 515	61	1.60								
WA	1	1751003 530	61	1.60								
WA	1	1751003 545	61	1.49								
WA	1	1751003 600	61	1.39								
WA	1	1751003 615	61	1.39	665	0.3470507		0.14	605	1.60	610	0.13
WA	1	1751003 615	630	0.92	530	260.00	70	18.00	94	116.00	1027	4.00
WA	1	1751003 615	1051	290.00	1092	130.00						
WA	1	1751003 630	61	6.01	665	0.4370507		0.21	605	1.71	610	0.28
WA	1	1751003 630	630	0.54	530	156.00	70	19.00	94	77.00	1027	4.00
WA	1	1751003 630	1051	390.00	1092	150.00						
WA	1	1751003 645	61	3.45	665	0.3370507		0.19				
WA	1	1751003 700	61	2.85								
WA	1	1751003 715	61	2.30								
WA	1	1751003 730	61	1.98								
WA	1	1751003 745	61	1.70								
WA	1	1751003 800	61	1.60	665	0.2470507		0.11	605	1.00	610	0.04
WA	1	1751003 800	630	1.17	530	55.00	70	4.50	94	146.00	1027	4.00
WA	1	1751003 800	1051	100.00	1092	110.00						
WA	1	1751003 815	61	1.49								

Figure VI-2 Example of data grouping for Seattle, Washington

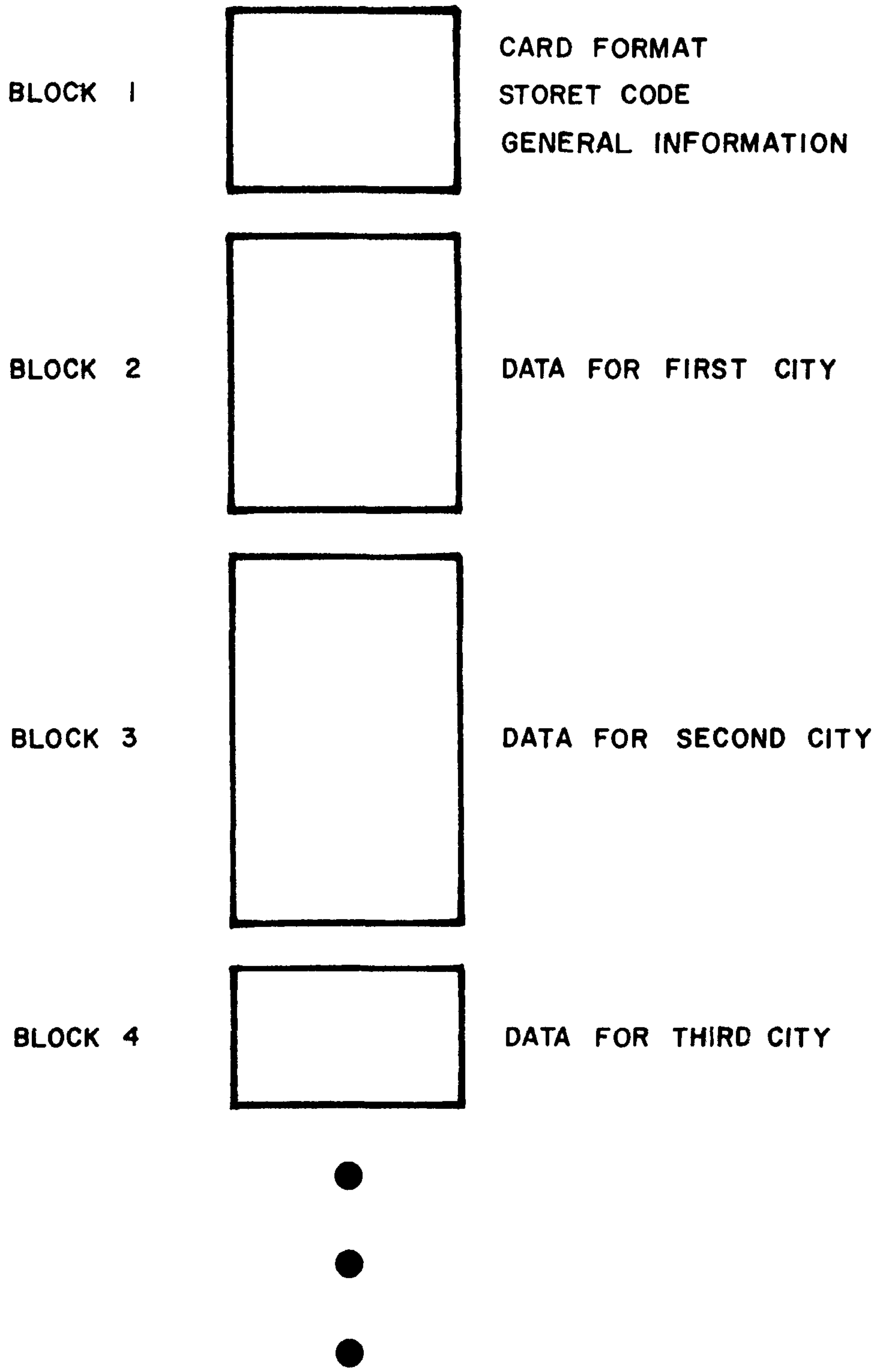

Figure VI-3 Arrangement of data on magnetic tape. Data within each block resemble those shown in Figure VI-2.

Data may be utilized for comparison with modeling results simply by obtaining a listing ("dump") of the tape contents. Alternatively, only selected parameters may be retrieved from the tape if desired. The tape itself may be utilized for statistical analyses and characterization purposes, although in practice such manipulations will be better served after having placed the data onto a disk, drum or other rapid-access storage device.

In the future, the data will also be entered directly into the STORET system. This should facilitate nationwide access as well as permit use of STORET software for statistical and other analyses. Future addenda will provide necessary information to permit access to the data when they are placed on STORET.

SECTION VII

DESCRIPTION OF RAINFALL-RUNOFF-QUALITY DATA BASE SOURCES

INTRODUCTION

The following subsections describe locations for which rainfall, runoff and quality data have been obtained that are suitable for the data base. Additional locations with rainfall-runoff data only are described in Section VIII.

Sources included in this section were chosen primarily on the basis of known high quality of the data, availability and documentation. The first consideration was checked primarily by familiarization with the sampling program, careful review of the documentation and personal conversations with the responsible personnel. The latter two considerations were the keys to actually obtaining, reducing (in some cases), key punching, etc. the data for inclusion on the magnetic tape. Since UF is distant from most of the sources, the only way in which these operations could be accomplished was to have good documentation provided in some form. In all cases, data values were inspected visually for reasonableness. Where data were key punched at UF, spot checks were made against the source listing.

Each location has tables describing the catchments, quantity sampling program, quality sampling program, quality data sampled, and, in a few cases, additional information. Similar tables for different locations differ in content according to the available information at each location. In all cases, additional useful information may be obtained from the cited references.

The amount of modeling data contained in-house by UF varies considerably from location to location and is increasing with time. Requests should be made directly to UF to the persons indicated below for information on data for individual catchments.

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BROWARD COUNTY, FLORIDA

The Water Resources Division of The Miami office of the U.S. Geological Survey (USGS) initiated monitoring of stormwater runoff at three sites with different land uses in northeast Broward County (Fort Lauderdale area) in 1974 in cooperation with the county and with the Florida Department of Transportation (104, 105). In addition to the extensive amount of quality sampling being done, an added advantage of this program is that all quality data are being placed directly into the STORET system, and are thus accessible by many users. Flow and rainfall data are not in the STORET files and were obtained by UF directly from USGS. Early data have been used for model comparisons (172).

All quality data were retrieved from STORET and placed in the same format as other data on the data tape. Further data will be added to the data tape as they become available. Overall, these data are among the very best included in the data base, in terms of volume, care in sampling, sophistication of instrumentation and accessibility.

Recent references make the data all the more useful. A complete data tabulation for the residential, transportation and commercial sites is given in references 190-192, respectively. The instrumentation and data management systems are described in references 193-194. Further study information and modeling efforts are presented in references 195-197. Results of a statistical analysis of residential and transportation site data are summarized in reference 198. Finally, one of the most valuable contributions from the study is a report documenting basin characteristics for modeling purposes (199). Containing maps, drainage plans, photos, and tabulations of pertinent data, it is an excellent adjunct to the data themselves. It also contains information on a fourth, multifamily residential site in Dade County, from which data will be included in the Data Base in the future.

State and City Code: FL 01

Table VII-1. Catchments - Broward County

No.	Name	Area, ac (ha)	Population	Drainage System	STORET Location ID	Land Use
1	Residential (near NE 31 St. and US1)[b]	47.5 (19.2)	351[a]	Storm[f]	261615080055900	House roofs, 19%;drive ways,9%; roads,11%; lawns,61%.
2	Transportation (Sample Rd. near I-75)[b]	39.0 (15.8)		Storm	261629080072400	Arterial Highway(does not include interstate hwy. drainage).[d]
3	Commercial (Coral Ridge Shopping Plaza, near NE 35 St. and US1)[c]	28.4 (11.5)		Storm	261002080070100	Shopping Center[e]

[a]Estimated using 151 single family houses.

[b]North of Pompano Beach, Florida

[c]In north Ft. Lauderdale, Florida

[d]Roadway and connected parking lots 13.7 ac (5.6ha), permeable lawns 24.3 ac (9.8ha) and rooftops 1.0 ac (0.4ha).

[e]Pavement 19.7 ac (8.0ha), vegetation 0.4 ac (0.16ha) and rooftops draining to sewer 8.3 ac (3.4ha).

[f]Open-channel, swale drainage

Table VII-2. Quantity Data - Broward County

No.	Catchment	Flow: Type of flow meas.	Flow: Sampling Interval, min	Rain: Gages Used: No. in Catchment	Rain: Gages Used: No. near Catchment	Rain: Type	Rain: Sampling Interval, min	No. of Storms	Period
1	Residential	f_1	5[a]	3	0	r_1	5[a]	35[b]	4/74-9/75
2	Transportation	f_1	5	2	0	r_1	5	14[b]	4/75-9/75
3	Commercial	f_1	5	1	0	r_1	5	4[b]	

f_1 - Fiberglass U-shaped, venturi-type constriction mounted in 36 in. (914 mm), 54 in. (1372 mm), and 36 in. (914 mm) pipes at sites 1, 2 and 3, respectively. Calibrated in laboratory. Stage measured by nitrogen gas bubbler tube.

r_1 - Weather Measure Model P-501 tipping bucket gage; bucket capacity = 0.01 in. (0.25 mm). Average of gages is used at sites 1 and 2.

[a]Flow and rain monitored continuously, but data are reduced to 5 min. increments.

[b]Rain/flow data pending reduction by USGS

Time synchronization, flow-rain: Excellent since data are telemetered to same multiple pen strip chart recorder.

Table VII-3. Quality Sampling - Broward County

No.	Catchment	Sampling Method	Sampling Interval, min.	Sampling Location	No. of Storms	Period
1	Residential	s_1	1-15	Outfall pipe	35[a]	4/74-9/75
2	Transportation	s_1	1-15	Outfall pipe	14[a]	4/75-1/76
3	Commercial	s_1	1-15	Outfall pipe	4[a]	

[a]Number of storms currently (8/76) in STORET file. More to be added.

s_1 - USGS continuous flow automatic sampler 2ℓ (0.53 gal.) bottles

Time synchronization, flow-quality: Good since time of sample noted on same strip chart recorder as used for rain-flow.

Table VII-4. Quality Parameters - Broward County

Not all parameters are available for all storms at all catchments.

Parameter	STORET Code	Units
Temperature	10[a]	°C
Stage	65[a]	ft
Turbidity	70	JTU
Color	80	PCU
Conductivity	95	µmho
Dis. Oxygen	300[a]	mg/l
DO, % saturation	301	%
BOD_5	310	mg/l
COD	340	mg/l
pH	400	
CO_2	405	mg/l as CO_2
Tot. Alkalinity	410	mg/l as $CaCO_3$
HCO_3 ion	440	mg/l as HCO_3
CO_3 ion	445	mg/l as CO_3
Tot. Solids	500	mg/l
Dis. Solids	515	mg/l
Tot. N	600	mg/l-N
Tot. Organic N	605	mg/l-N
NH_3-N	610	mg/l-N
NO_2-N	615	mg/l-N
NO_3-N	620	mg/l-N
TKN	625	mg/l-N
NO_2 + NO_3-N	630	mg/l-N
Tot. P	665	mg/l-P
Tot. Organic C	680	mg/l-C
Tot. Inorganic C	685	mg/l-C
Tot. C	690	mg/l-C
Cl	940	mg/l
Dis. Silica	955	mg/l as SiO_2
Cd	1027	µg/l
Cr	1034	µg/l

[a]No values yet stored on STORET file

Table VII-4. **(concluded)**

Parameter	STORET Code	Units
Cu	1042	μg/1
Fe	1045	μg/1
Pb	1051	μg/1
Zn	1092	μg/1
Tot. Colif.	31501	MPN/100 ml[a]
Fec. Colif.	31616	MPN/100 ml[a]
Fec. Strep.	31679	MPN/100 ml[a]
Susp. Solids by evap @ 180°C	70299	mg/1
OPO_4-P	70507	mg/1-P
Tot. N as NO_3	71887	mg/1 as NO_3

[a]On data tape, coliforms reported as 100 x $\log_{10}$ (MPN/100 ml).

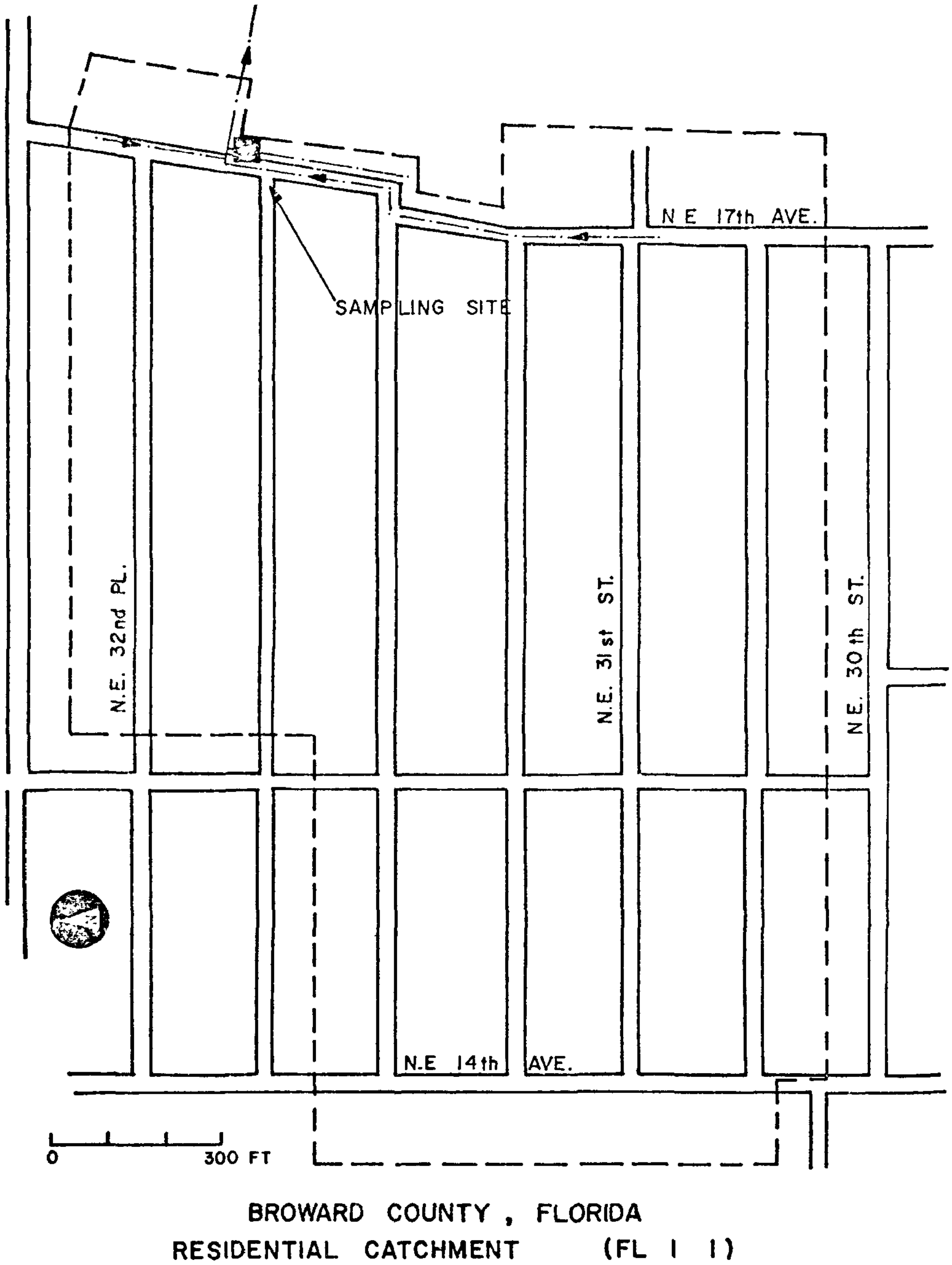
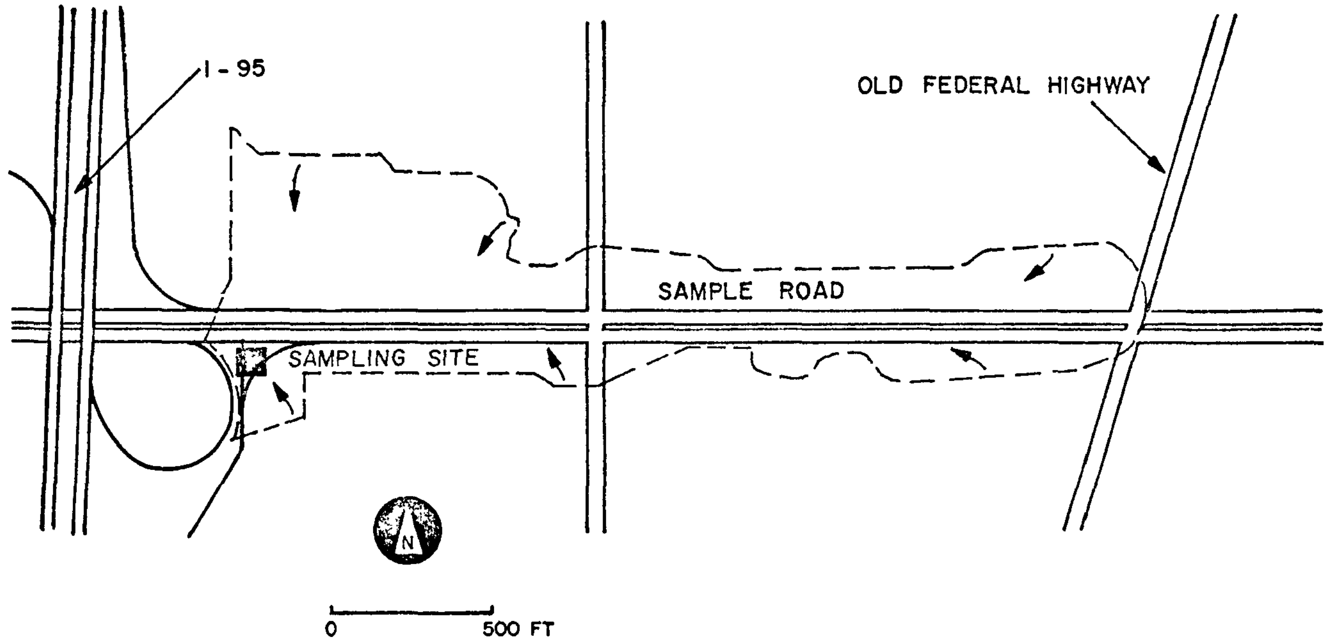


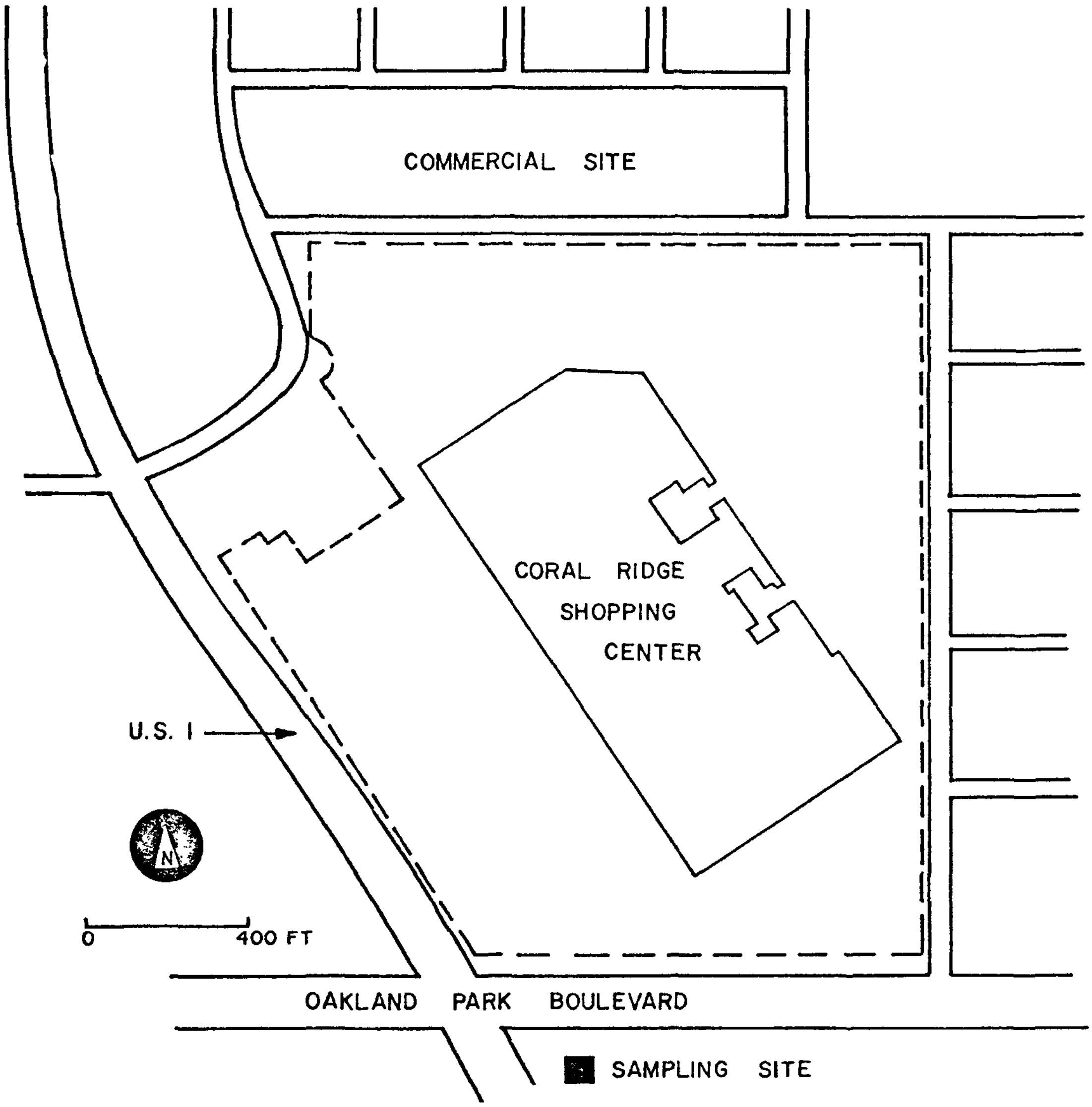
Figure VII-1 Broward County, Florida, Residential Catchment, 47.5 ac (19.2 ha)



BROWARD COUNTY , FLORIDA

TRANSPORTATION CATCHMENT (FL I 2)

Figure VII-2 Broward County, Florida, Transportation Catchment, 39.0 ac (15.8 ha). Scale is approximate.



BROWARD COUNTY, FLORIDA
COMMERCIAL CATCHMENT (FL 1 3)

Figure VII-3 Broward County, Florida, Commercial Catchment, 28.4 ac (11.5 ha). Scale is approximate.

DURHAM, NORTH CAROLINA

The 1069 ac (433 ha) Third Fork Basin in Durham has been monitored for rainfall-runoff data by the USGS as reported by Tucker (42). The RRL and ILLUDAS models were tested on these data (49,50), and keypunched rainfall-runoff data for 1969 were received through the courtesy of the Illinois State Water Survey. These data have also been used for hydrograph analyses (176).

Quality sampling was performed in 1969 by Bryan (133,134) and in 1971-1973 by Colston (135). Bryan's data were in the form of composite samples and are not included in the data base. Of the several storms sampled by Colston, rainfall data are reported for four and included herein. Colston's report (135) also contains useful catchment information and examples of SWMM modeling. All data for the catchment are considered to be good due to the careful processing of rainfall-runoff data by the USGS and analysis of the quality data by Colston. However, measurements of BOD_5 were not reproducible, and it was Colston's recommendation that they not be used as an indicator of water quality. In addition, due to the fact that the quality samples were taken from the bottom, suspended solids measurements may not be representative of the entire vertical solids profile.

State and City Code: NC 02

Table VII-5. Catchments - Durham

No.	Name	Area ac (ha)	Sewerage	Population	Imperviousness %	Ave. land Slope, %	Land Use Percentages
1	Third Fork	1069 (433)	Storm (open channels)	6400	29[a]	7.6	Res. 24, com. and ind. 19, public and institutional 12, open 10.

[a]Paved 20%, rooftops 9, unpaved streets 3, vegetation 68.

Table VII-6. Quantity Data - Durham

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Third Fork	f_1	5	1	-	r_1	5	15	6/69-2/70
								4	6/72-10/72

f_1 - Continuous stage measurement at V-notch weir, connected to digital tape punch recorder. USGS station no. 02097243.

r_1 - Float-type rain gage with punched record.

Time synchronization: Good since rain gage and stage gage use same clock.

Table VII-7. Quality Sampling - Durham

No.	Catchment	Sampling Method	Sampling Interval min.	Sampling Location	No. Storms	Period
1	Third Fork	s_1	12 - 30	Basin outlet at USGS weir	4	6/72-10/72

s_1 - Pumped to Serco Model NW-3 automatic sampler, modified slightly as described by Colston (135). Sample volume was 0.35 l. Inlet pump was anchored near stream bed immediately below weir.

Time synchronization , flow-quality: Good since USGS and quality sampling clocks were housed in same facility and could be cross checked.

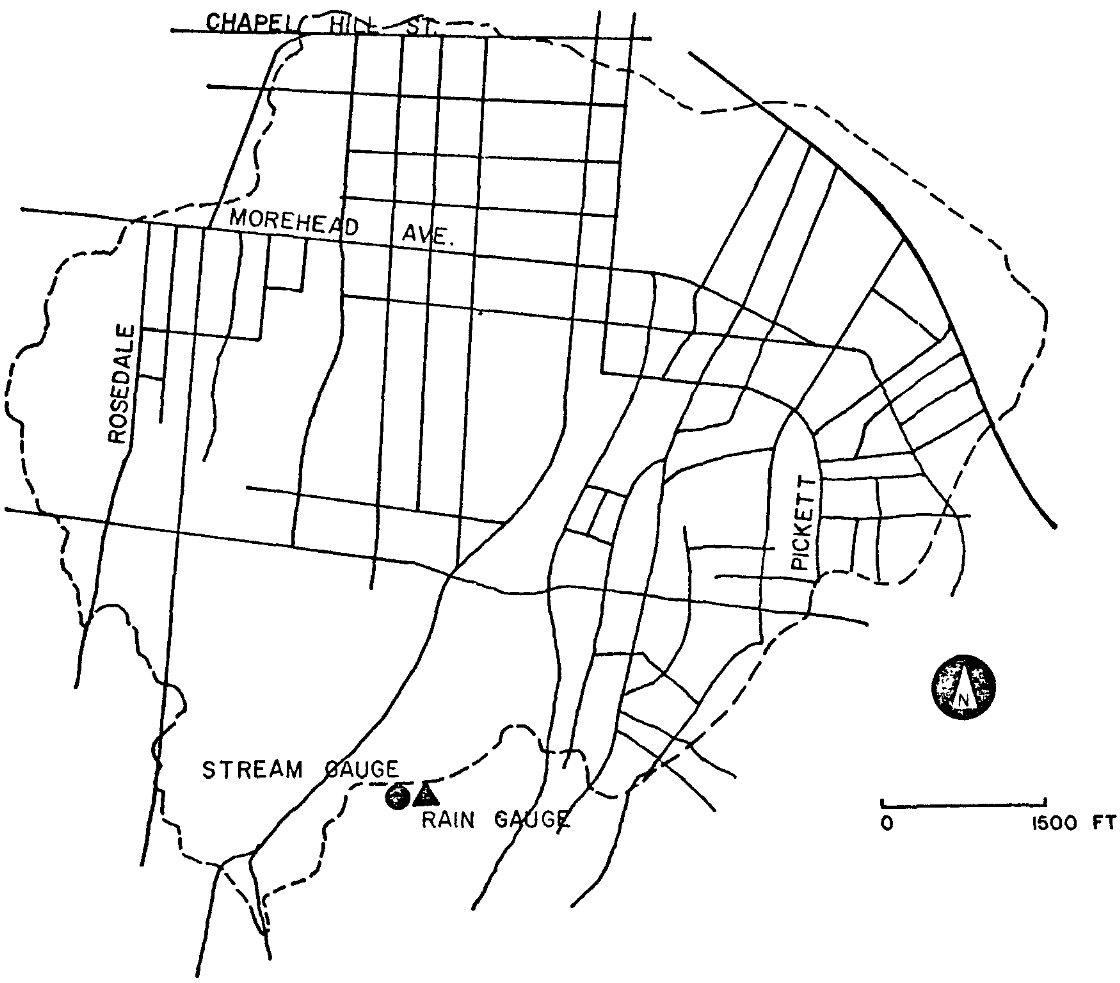
Table VII-8. Quality Parameters - Durham

Not all parameters are given for all storms.

Parameter	STORET Code	Units
BOD_5	310	mg/l
COD	340	mg/l
Dis. COD	341	mg/l
pH	400	mg/l
Tot. Alaklinity	410	mg/l as $CaCO_3$
Tot. Solids	500	mg/l
Tot. Vol. Solids	505	mg/l
Suspended Solids	530	mg/l
Vol. Susp. Solids	535	mg/l
TKN	625	mg/l - N
Tot. P	665	mg/l - P
Tot. Organic C	680	mg/l - C
Ca	916	mg/l
Mg	927	mg/l
Cr	1034	µg/l
Cu	1042	µg/l
Fe	1045	µg/l
Pb	1051	µg/l
Mn	1055	µg/l
Al	1107	µg/l
Fec. Coliform	31616	MPN/100ml[a]

[a]On data tape, coliforms reported as 100 x $\log_{10}$ (MPN/100ml).

Cobalt, nickel and strontium were also measured but all values were less than the detection level of 100 µg/l.



DURHAM , N. C.

THIRD FORK CATCHMENT

(NC 2 1)

Figure VII-4 Durham, N.C., Third Fork Catchment, 1069 ac (433 ha).

LANCASTER, PENNSYLVANIA

Data were taken from the 134 acre (54.2 ha) Stevens Avenue catchment as part of the Swirl Regulator Demonstration Project (EPA Grant S802219, formerly 11023 GSC) being undertaken at that location. In preparation for construction of a swirl regulator/concentrator at the Stevens Avenue outfall to Connestoga Creek, monitoring was performed in 1973-74 by the City of Lancaster and Meridian Engineering of Philadelphia. As a participant in the project, the University of Florida received data on a routine basis and has used the combined-sewered Stevens Avenue catchment as a study area in a previous report (106).

All data were collected and analyzed by the city; however, depth, pH, DO, conductivity and temperature were reduced directly from the original strip charts by UF. Rainfall data were similarly reduced by UF from xerox copies of the charts. Quality data are felt to be good at this location. Flow data are not as good since they were obtained using Manning's equation to convert measured depths. However, supercritical flow at the measuring point eliminates any backwater effects.

The automatic depth gage recorded values at 18 sec intervals. When the data were reduced for conversion to flows (and inclusion on the Data Base tape), these values were weighted by $AR^{2/3}$ where A is the cross sectional area and R is the hydraulic radius at the given depth, and five adjacent values were averaged to provide 1.5 min, weighted averages. Even using this procedure, computed flows are highly variable and may change by over 100 cfs (2.8 m^3/sec) in one time step, owing to the steep, "flashy" character of the catchment. Since rainfall data are available at only a 5 min interval, hydrologic model calibration with these data is difficult.

State and City Code: PA 01

Table VII-9. Catchments - Lancaster

Name	Area ac (ha)	Population	Drainage System	DWF cfs (1/sec)	Ave Runoff Coef	Land Use
1. Stevens Avenue	134 (54.2)	3900	Combined	0.6-0.9 (17-25)	0.59	Single-family res., 90% Multi-family res., 10%

Table VII-10. Quantity Data - Lancaster

	Flow		Rain					
			Gages Used					
Catchment	Type of Flow Meas	Sampling Interval min	No. in Catchment	No. near Catchment	Type	Sampling Interval min	No. Storms	Period
Stevens Avenue	f_1	1.5	1	0	r_1	5	6	9/73 - 1/74

f_1 - Depth measurement in 60 in. (152 cm) RCP sewer by Controlotron Corp 290-1 sonic water level sensor. Continuous strip chart records at depth were converted to flow by UF using Manning equation, n = 0.013, slope = 0.035 (note that flow is supercritical). Measured depths are also given in data tabulation.

r_1 = Weighing bucket raingage at Hand JHS. 24-hour strip charts.

Time synchronization, rain-flow: possible errors due to separate clocks.

Table VII-11. Quality Sampling - Lancaster

Catchment	Sampling Method	Sampling Interval min	Sampling Location	No. Storms	Period
Stevens Avenue	s_1	1.5-60	Diversion Structure	6	9/73 - 1/74

s_1 - pH, conductivity, DO, temperature by Ohmart Corp Model 1-1000-D probe sensor. Recorded on Westronic multiple-pen strip chart along with depth measurment. Other parameters by Sonford Model HG-4 automatic sampler (connected to Ohmart sampler pumps) into 2 liter (0.53 gal) bottles.

Time synchronization, flow-quality: good because data recorded on same strip chart.

Table VII-12. Quality Parameters - Lancaster

Not all parameters are given for all storms.

Parameter	STORET Code	Units
Conductivity (probe)	94	μ mhos
Dis. Oxygen (probe)	299	mg/1
pH (probe)	400	
Temperature (probe)	11	°F
Sus. Solids (SS)	530	mg/1
Fixed SS	540	mg/1
Vol. SS	535	mg/1
Dis. Solids	515	mg/1
Tot. Solids	500	mg/1
BOD_5	310	mg/1
BOD_{20}	324	mg/1
COD	340	mg/1
TOC	680	mg/1
Tot. Cd	1027	μg/1
Tot. Cr	1034	μg/1
Tot. Cu	1042	μg/1
Tot. Pb	1051	μg/1
Tot. Zn	1092	μg/1
Chloride	940	mg/1
Tot. Org. N	605	mg/1-N
NH_3-N	610	mg/1-N
NO_3-N	620	mg/1-N
NO_2-N	615	mg/1-N
OPO_4-P	70507	mg/1-P
Tot. P	665	mg/1-P
Hydroliz. P	669	mg/1-P
Depth[a]	50055	in.
Flow[a]	61	cfs
Rain	90050	in./hr

Grease/oil, total coliforms and fecal coliforms were listed as part of the sampling program, but no data were given for the storms used.

[a]Depths and flows are averages of 5 values over a 1.5 min interval, reported at the center of the interval. Depths are weighted by $AR^{2/3}$ as described in the text.

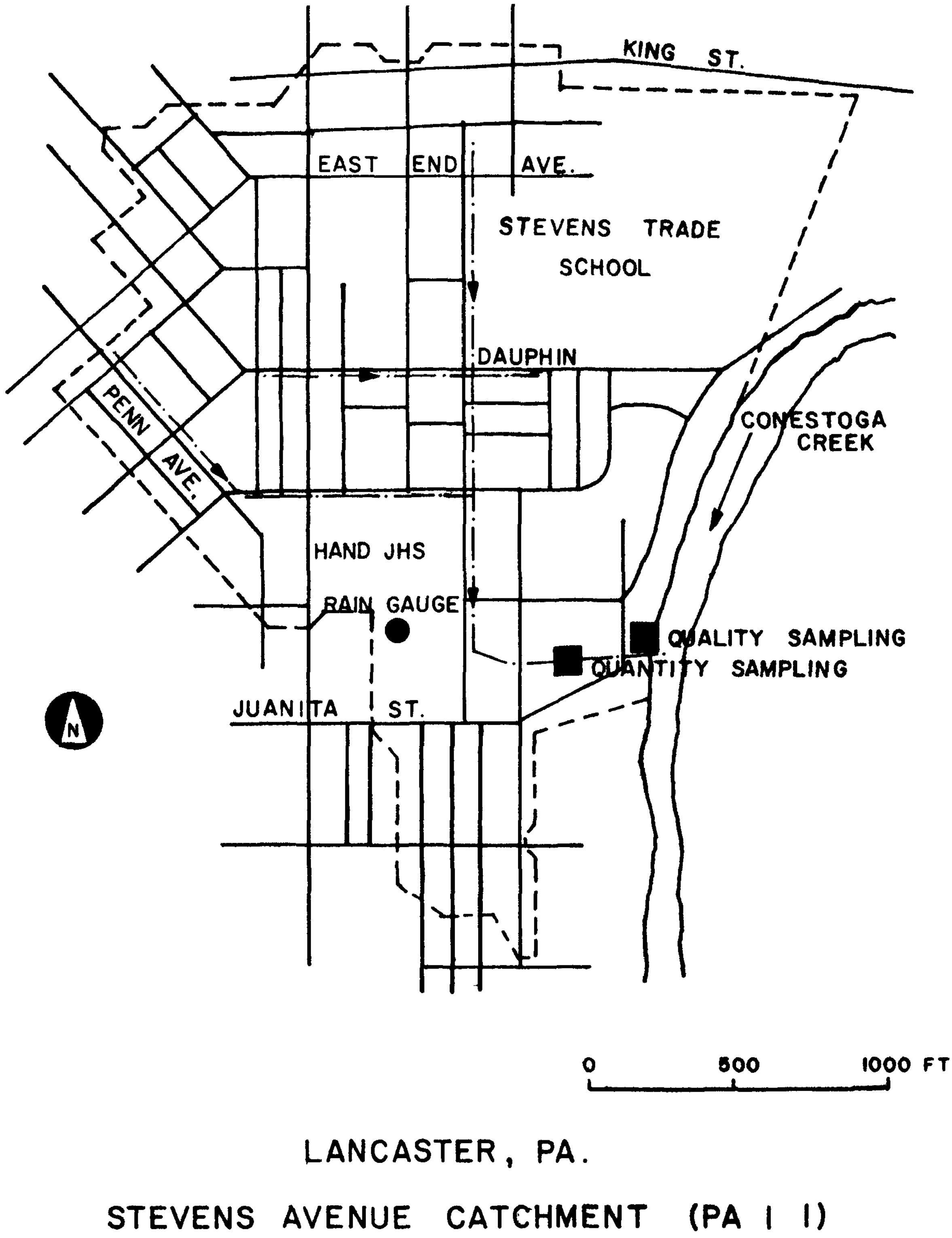


Figure VII-5 Lancaster, Pennsylvania, Stevens Ave. Catchment, 134 ac (54.2 ha).

LINCOLN, NEBRASKA

Quantity and quality data were gathered for the three residential catchments as part of OWRT-sponsored research conducted by the University of Nebraska. The period of study was April 1972 to May 1974.

Data were taken from a thesis (107) and completion report (56) and reduced prior to receipt by UF. Additional information on rainfall was received from R. Sallach (personal communications, 1975, 1976). These data are considered to be of good quality, on the basis of discussions with University of Nebraska personnel.

State and City Code: NB 01

Table VII-13. Catchments - Lincoln

No.	Name	Area ac (ha)	Sewerage	Population	Imperviousness (%)	Length of Streets mi (km)	Land Use
1	39th & Holdrege	79 (32)	Storm[c]	822[a]	30		Residential
2	63rd & Holdrege	85 (39.4)	Storm[c]	391[b]	36-40	4.3 (6.9)	Residential
3	78th & A St.	357 (145)	Storm[c]		25		Developing residential, open, farm

[a]1952 population. Estimated 1975 population density = 11.3 persons/ac (27.9 persons/ha).

[b]1952 population. Estimated 1975 population density = 7.9 persons/ac (19.5 persons/ha).

[c]Open channels.

Table VII-14. Quantity Data - Lincoln

	Flow		Rain					
			Gages Used					
Catchment	Type of Flow Meas	Sampling Interval min	No. in Catchment	No. near Catchment	Type	Sampling Interval min	No. Storms	Period
39th & Holdrege	f_1	10-15	1	0	r_1	15-90	20	4/72 - 5/74
63rd & Holdrege	f_2	10-15	0	1	r_1	15-90	15	4/72 - 5/74
78th & A St.	f_3	10-15	1	0	r_1	15-90	14	4/72 - 7/73

f_1 - Visual head measurement on sharp-crested rectangular weir in open channel 20 ft (6.1 m) downstream of 48 in. (1220mm) concrete sewer.

f_2 - Visual readings of depth markings on wall of 48 in. (1220mm) sewer. Converted to flow using Manning's equation.

f_3 - Visual readings of markings on wall of 5 x 10 ft(1.5x3.6m) concrete box culvert in open drainage ditch. Velocity measurements used to develop stage-discharge relationship.

r_1 - Standard USGS recording rain gages with seven day clock.

Time synchronization: Rain-flow dependent upon different clocks. Possibility of occasional time shift between flow and rainfall measurements.

Comment: Time sequence of rainfall is poorly defined for many storms due to reduction of data over long time periods (e.g., rainfall totals reported at 90 min intervals for some storms).

Table VII-15. Quality Sampling - Lincoln

No.	Catchment	Sampling Method	Sampling Interval min	Sampling Location	No. Storms	Period
1	39th & Holdrege	s_1	10-15	At weir downstream of 48 in. (1220 mm) sewer	20	4/72 - 5/74
2	63rd & Holdrege	s_1	10-15	At outlet of 48 in. (1220mm) sewer	15	4/72 - 5/74
3	78th & A St.	s_1	10-15	In box culvert in open drainage ditch	14	4/72 - 5/74

s_1 - Manual grab samples.

Time synchronization, flow-quality: good since both kinds of data recorded simultaneously at same point.

Table VII-16. Quality Parameters - Lincoln

Not all parameters were recorded for all storms at all locations.

Parameter	Catchment No.	STORET Code	Units
BOD_5	All	310	mg/1
COD	All	340	mg/1
VSS	All	535	mg/1
TS	All	500	mg/1
TVS	All	505	mg/1
SS	All	530	mg/1
NO_3-N	All	620	mg/1-N
Org-N	All	605	mg/1-N
OPO_4-P (Soluble)	All	671	mg/1-P
Spec. Conductivity	All	95	μ mho
Turbidity	All	70	JTU
Tot. Colif.	All	31503	MPN/100 ml[a]
Salinity	All	480	ppt

[a]Note: On data tape, coliforms are given as 100 x $\log_{10}$ (MPN/100 ml)

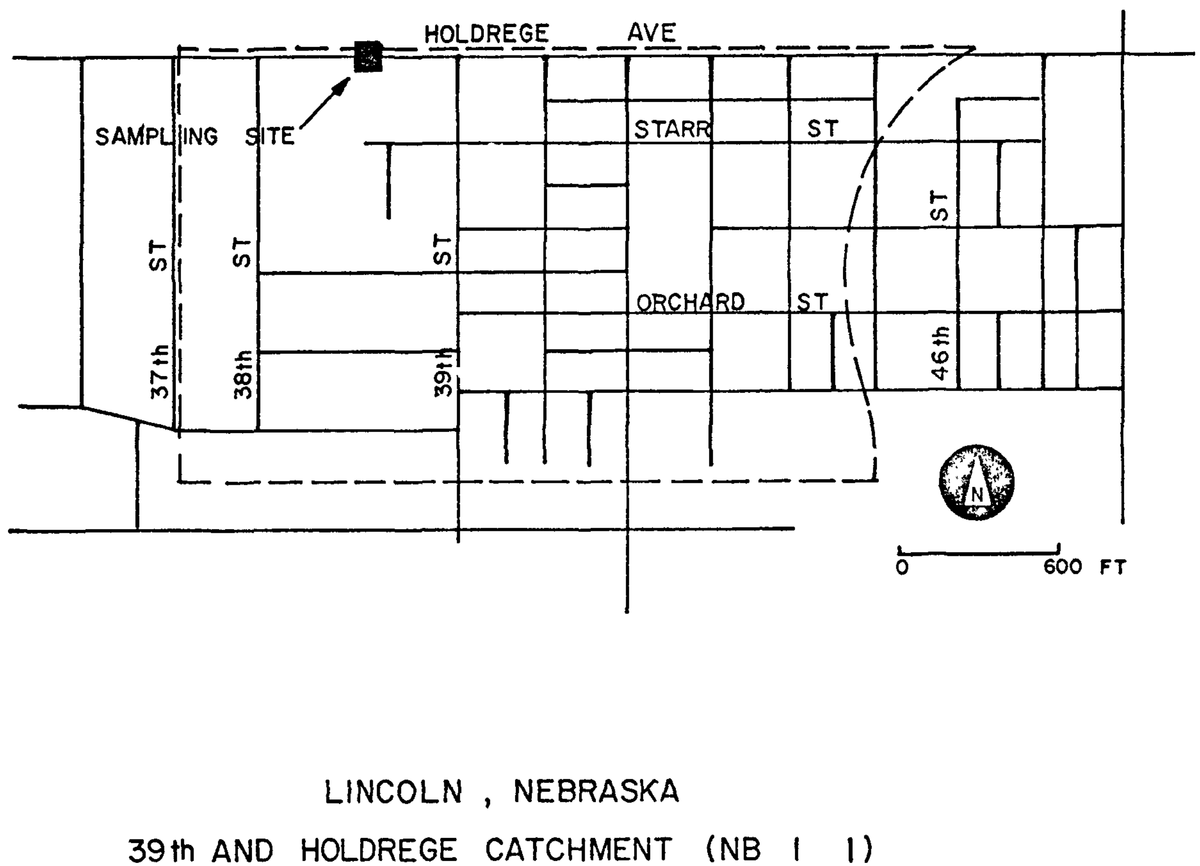


Figure VII-6 Lincoln, Nebraska, 39th and Holdrege Catchment, 79 ac (32 ha). Scale is approximate.

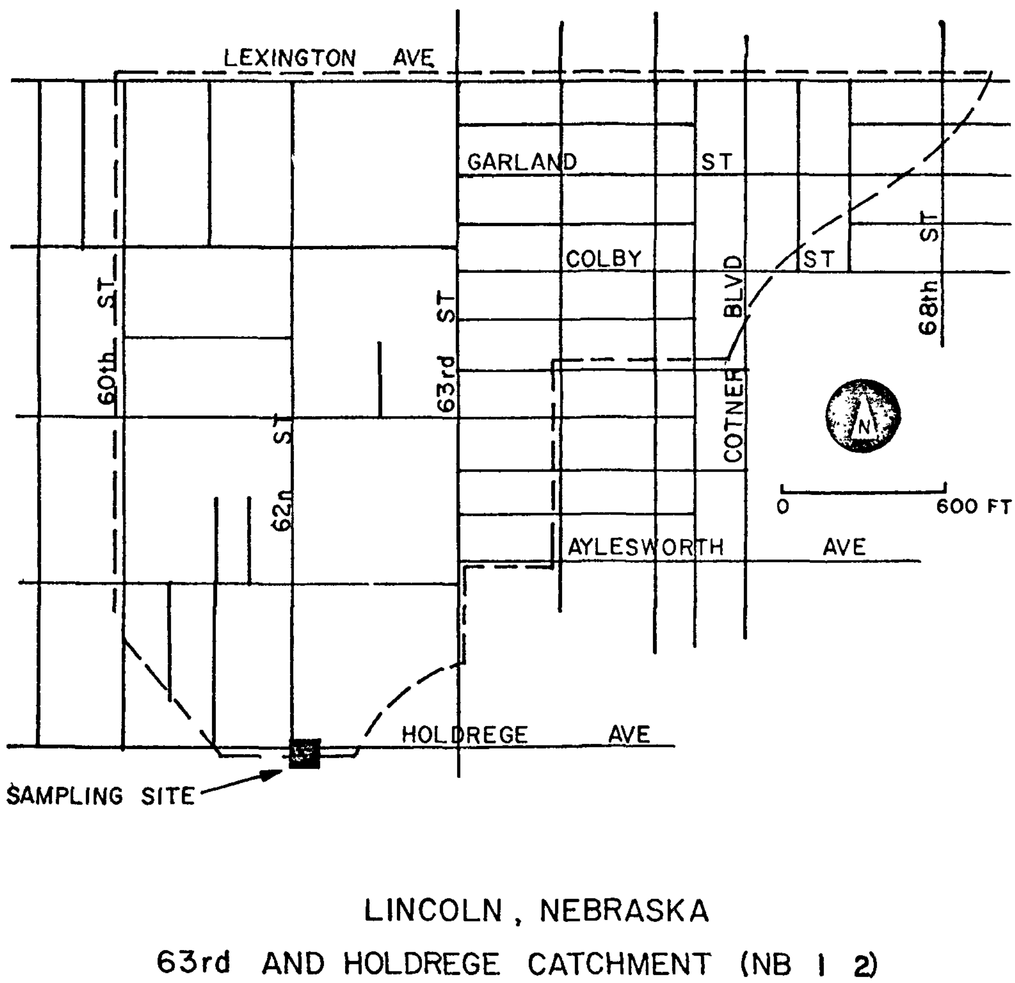


Figure VII-7 Lincoln, Nebraska, 63rd and Holdrege Catchment, 85 ac (39.4 ha). Scale is approximate.

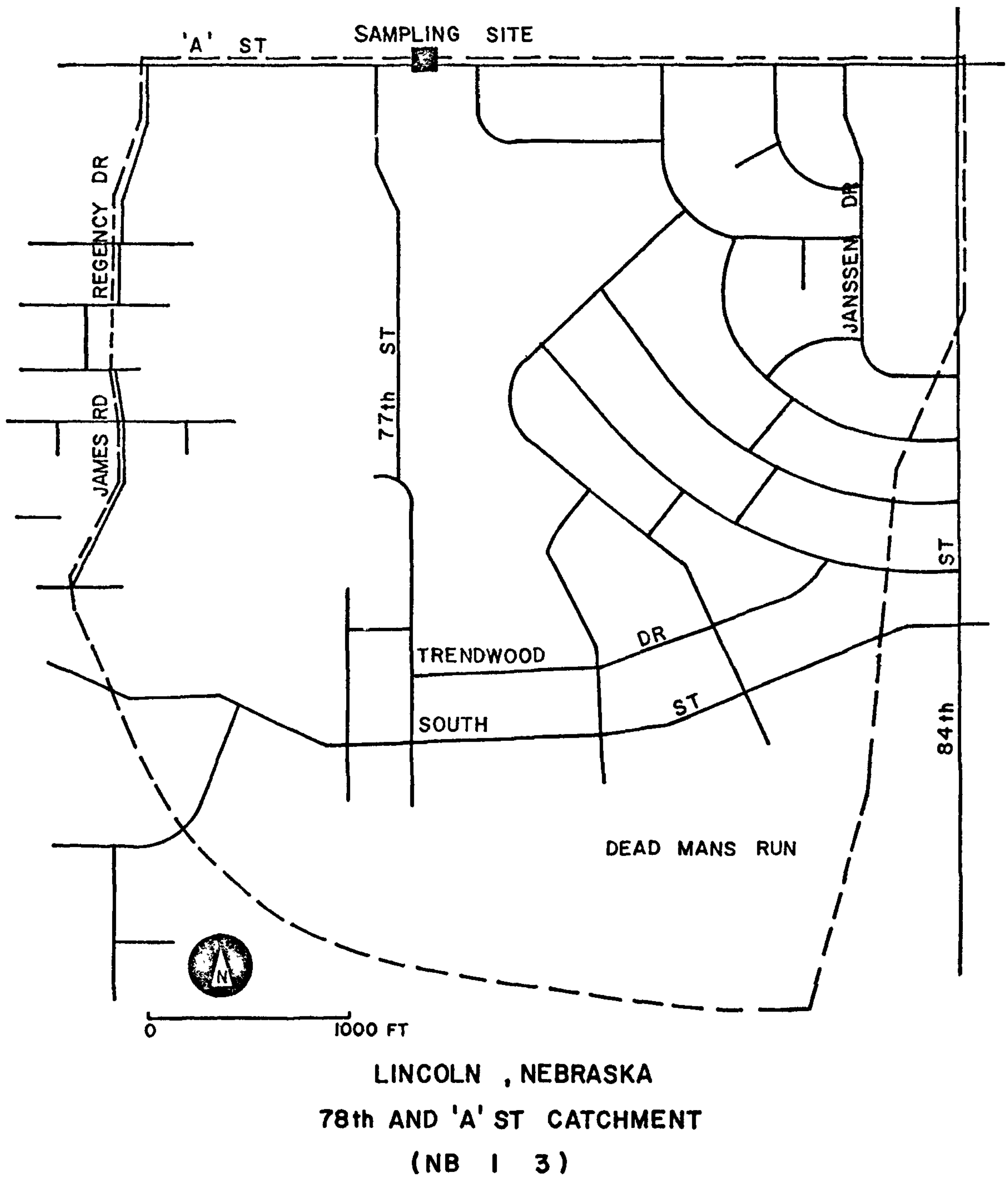


Figure VII-8 Lincoln, Nebraska, 78th and 'A' St. Catchment, 357 ac (195 ha). Scale is approximate.

RACINE, WISCONSIN

Data were taken from a draft report (108) of a detailed study performed by Envirex, Inc. involving an extended monitoring program. The flow data are somewhat difficult to interpret since runoff from the catchment is split between two outlets, Site I and Site II, and difficulties were experienced in flow measurements at Site II. Thus, proper interpretation of the Site I runoff data must rely upon accurate analysis of upstream diversion structures. It is understood that this information will be contained in the final version of the report. All data are taken from the draft report and were reduced prior to to receipt by UF. Additional quality parameters beyond the three included herein were also monitored and will be included in the data base at a future date.

State and City Code: WI 01

Table VII-17. Catchments - Racine

No.	Name	Area ac (ha)	Population	Sewerage	Land Use Percentages
1	Site I	829.3 (335.8)	9847[a]	Combined	Single Fam. Res. 63, Multi-Fam. Res. 10, Com. 12, Ind. 9, Park 6

[a]Population of residential land use only.

Table VII-18. Quantity Data - Racine

	Flow		Rain					
			Gages Used					
Catchment	Type of Flow Meas	Sampling Interval min	No. in Catchment	No. near Catchment	Type	Sampling Interval min	No. Storms	Period
Site I	f_1	10	2	1	r_1	5	9	7/73 - 8/74

f_1 - At Site I, total flow is sum of pumped flow to treatment plant, measured by Parshall flume, plus weir overflow, determined by bubbler tube measurement of stage at diversion structure. Stage measurements in Parshall flume were variable, hence results are given in terms of a range (minimum and maximum) at each time step.

r_1 - Bendix, weighing bucket recording gages. Value reported is from the one out of three sites selected for modeling of the particular storm.

Time synchronization: flow-rain, dependent upon separate clocks on rain and stage gages. Possibility of time shifts between two sets of data. No problems reported.

Comment: In the reference report flow was recorded at two sites in the catchment. Data in this report is only for Site I since there were many problems with the accuracy of Site II. When comparing with modeling results, characteristics of flow dividers upstream from Sites I and II must be considered since total runoff from catchment is split between Sites I and II.

Table VII-19. Quality Sampling - Racine

No.	Catchment	Sampling Method	Sampling Interval min	Sampling Location	No. Storms	Period
1	Site I	s_1	10-30	Wet well at lift station to treatment plant	7	11/73 - 8/74

s_1 - grab samples.

Time synchronization: flow-quality, good since data gathered simultaneously at same location.

Table VII-20. Quality Parameters - Racine

Not all parameters are available at all times for all storms.

Parameter	STORET Code	Units
BOD_5	310	mg/1
SS	530	mg/1
Tot. Colif.	31501	MPN/100 ml[a]

[a]On data tape, coliforms are given as 100 x $\log_{10}$ (MPN/100 ml).

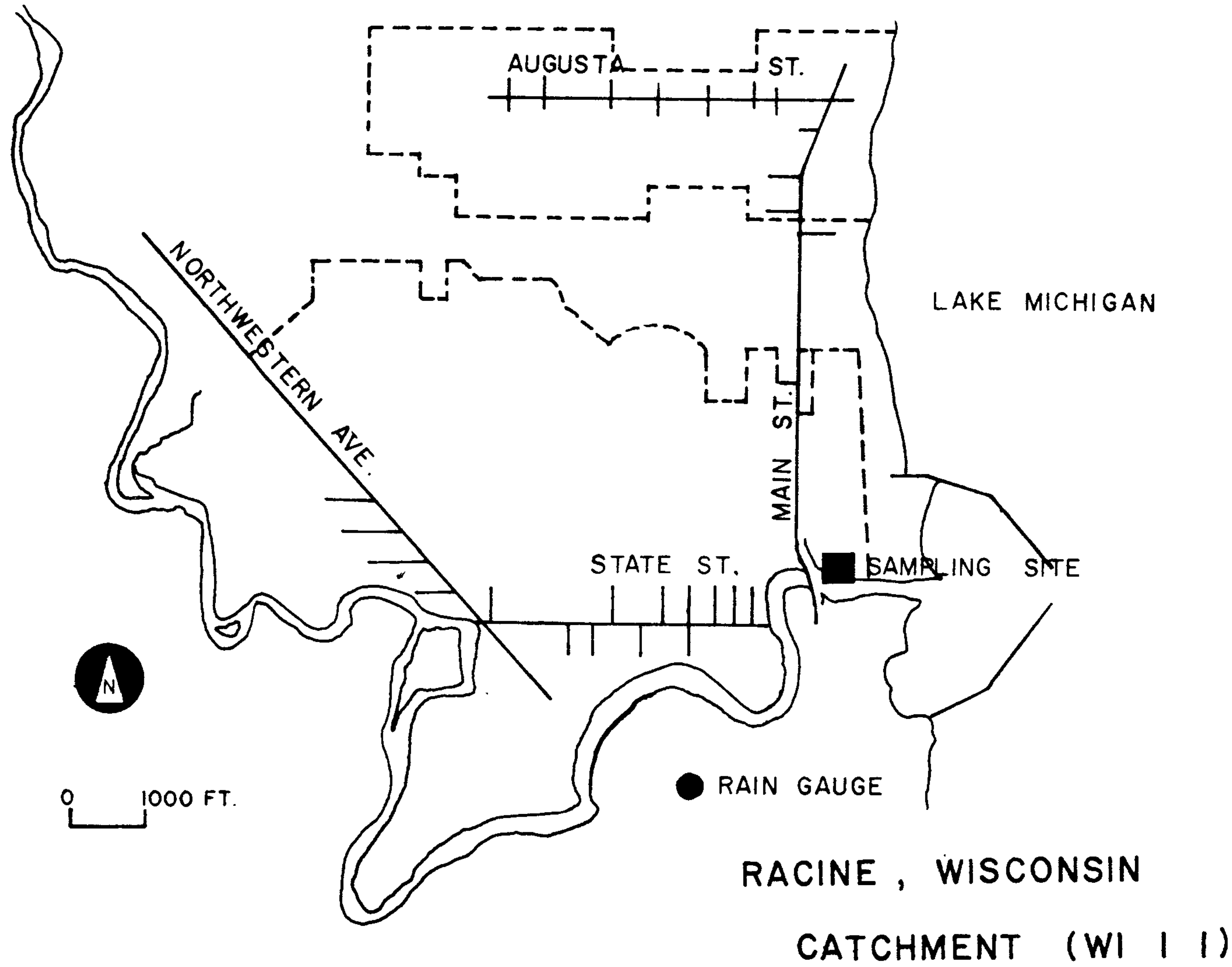


Figure VII-9 Racine, Wisconsin, Site I Catchment, 829 ac (336 ha).

SAN FRANCISCO, CALIFORNIA

Flow and quality data included in the report were collected by Engineering Science, Inc., for the City of San Francisco during 1966-70(34,35,175). Six catchments were monitored in the study, five mainly residential and one mainly industrial. Although the volume of data (i.e., number of storms sampled) is small, the data themselves are considered good and represent one of the earlier efforts in monitoring overflow points for later model calibration.

All data were acquired and reduced by the staff of Engineering Science and are taken directly from their reports. They have been used previously for model verification (102,143-145,178). All rainfall values included on the data tape were read from graphs since no tabulation was provided.

The City of San Francisco instituted in 1972 an extensive network of tipping-bucket rain gages and bubbler stage measurements throughout the City. These data are stored on several hundred magnetic tapes by the City but have not been reduced to a convenient form for modeling to date.

State and City Code: CA 01

Table VII-21. Catchments - San Francisco

No.	Name	Area ac (ha)	Sewerage	Population	No. Catchbasins	Streets, mi (km)	Land Use Percentages
1	Baker St.	168 (68)	Combined	13,200	140	8.75 (14.0)	Res 80, Com 8, Vac 12
2	Mariposa St.	223 (90)	Combined	4,500	145	8.45 (13.5)	Res 29, Ind 36, Vac 14, Other 21
3	Brotherhood Way	180 (73)	Combined	5,100	114	11.6 (19.6)	Res 77, Com 6 Govt 11, Other 6
4	Vicente St., North	16 (6.5)	Storm	400[a]	12[a]	1.32 (2.1)	Res 100
5	Vicente St., South	21 (8.5)	Storm	500[a]	15[a]	1.64 (2.6)	Res 80, Com 15, Other 5
6	Selby St.	3400 (1380)	Combined	81,000	2300	136 (217)	Res 77, Com 2, Ind 6, Vac 15
7	Laguna St.	375 (152)	Combined	25,300	250	17.2 (27.5)	Res 62, Com 16, Ind 6, Other 16

[a]Estimated

Table VII-22. Quantity Data - San Francisco

No.	Catchment	Flow: Type of Flow Meas	Flow: Sampling Interval min	Rain: Gages Used No. in Catchment	Rain: Gages Used No. near Catchment	Rain: Type	Rain: Sampling Interval min	No. Storms	Period
1	Baker St.	f_1	5-10	1	Fed Bldg	r_1	10	3	4/69 - 11/69
2	Mariposa St.	f_1	5-10	1	Fed Bldg	r_1	10	3	2/69 - 4/69
3	Brotherhood Way	f_1	5-10	1	Fed Bldg	r_1	10	3	1/70
4	Vicente St., N	f_1	5-10	1		r_1	10	1	2/70
5	Vicente St., S	f_1	5-10	1		r_1	10	1	2/70
6	Selby St.	f_2	5-10	1	Fed Bldg	r_1	10	8	11/69 - 3/67
7	Laguna St.	f_3	5-10	1		r_2	5-10	2	3/67

f_1 - Dye dilution, using pumped dye inflow 500-700 ft (150-210 m) upstream from diversion structure. Reported flows corrected for assumed flow into interceptor.

f_2 - Depth measurement at outfall structure. Stage-discharge calibration over weir. Interceptor blocked during storms, so reported flows are overflows over weir. A volume of approximately 5.3×10^5 ft^3 (1.5×10^4 m^3) in overflow structure and trunk sewer must be filled at beginning of storm prior to overflow.

f_3 - Depth measurement in sewer outfall, converted to flow by Manning equation. Flows apparently uncorrected for "small" amount diverted to interceptor during storms.

r_1 - Unspecified recording raingage. Rainfall measured at Federal Building by US Weather Service occasionally used, but not indicated as to which storms.

r_2 - Homemade gage using graduated cylinder, read at fixed time intervals.

Time synchronization: dependent on different clocks in different gages. Possibility of occasional time shift between flow and rainfall measurements.

Table VII-23. Quality Sampling - San Francisco

No.	Catchment	Sampling Method	Sampling Interval min	Sampling Location	No. Storms	Period
1	Baker St.	s_1	≥ 10	Above diversion structure	3	4/69 - 11/69
2	Mariposa St.	s_1	≥ 10	Diversion structure	3	2/69 - 4/69
3	Brotherhood Way	s_1	≥ 10	Above diversion structure	3	1/70
4	Vicente St., North	s_1	≥ 10	Diversion structure	1	2/70
5	Vicente St., South	s_1	≥ 10	Diversion structure	1	2/70
6	Selby St.	s_2	≥ 10	Diversion structure	8	11/66 - 3/67
7	Laguna St.	s_3	≥ 10	Outfall below diversion structure	2	3/67

s_1 - Pumped to sample bottle from intake on bottom of sewer. About 10 sec required to fill bottle.

s_2 - Mechanical sampler traverses flow from top to bottom over about a two minute interval. Provides depth integrated sample. Final sample composited from three samplers at outfall.

s_3 - Manual grab samples taken in sewer outfall.

Time synchronization: quality-flow good at all locations since both measurements made simultaneously at same point.

Table VII-24. Quality Parameters - San Francisco

Not all parameters are given for all storms at all catchments

Parameter	Catchment No.	STORET Code	Units
COD	All	340	mg/l
BOD_5	All	310	mg/l
Floatables	All	90055	mg/l
Grease (Hex Extract)	All	70351	mg/l
Set. Solids	1-5	545	ml/l
Set. Solids @ 30 min	6,7	90060	ml/l
Sus. Solids (SS)	All	530	mg/l
Vol. SS	All	535	mg/l
Particle Size Dist.			
% Retained on:			
74 μ filter	1-5	90065	%
14 μ filter	1-5	90066	%
5 μ filter	1-5	90067	%
0.45 μ filter	1-5	90068	%
Tot. N	1-5	600	mg/l-N
NH_3-N	All	610	mg/l-N
TKN	6,7	625	mg/l-N
OPO_4-P	1-5	70507	mg/l-P
TPO_4-PO_4	6,7	650	mg/l-PO_4
Tot. Colif.	1-5	31505	MPN/100 ml[a]
Fec. Colif.	All	31615	MPN/100 ml[a]
Spec. Conductivity	All	95	μ mho
Alkalinity	All	410	mg/l as $CaCO_3$
pH	1-5	400	
Bioassay	1-5	90069	% survival at 96 hrs
SO_4	6,7	945	mg/l-SO_4
Cl	6,7	940	mg/l
Na	6,7	929	mg/l
K	6,7	937	mg/l
Ca	6,7	916	mg/l
Mg	6,7	927	mg/l
Settled BOD	6	90064	mg/l
Vol. Set. Solids	6	544	mg/l
Settled COD	6	90063	mg/l
Toxicity	1-5	90070	% survival at 96 hrs
Flow	All	61	cfs
Rainfall	All	90050	in./hr

[a]On data tape, coliforms are given as 100 x $\log_{10}$ (MPN/100 ml).

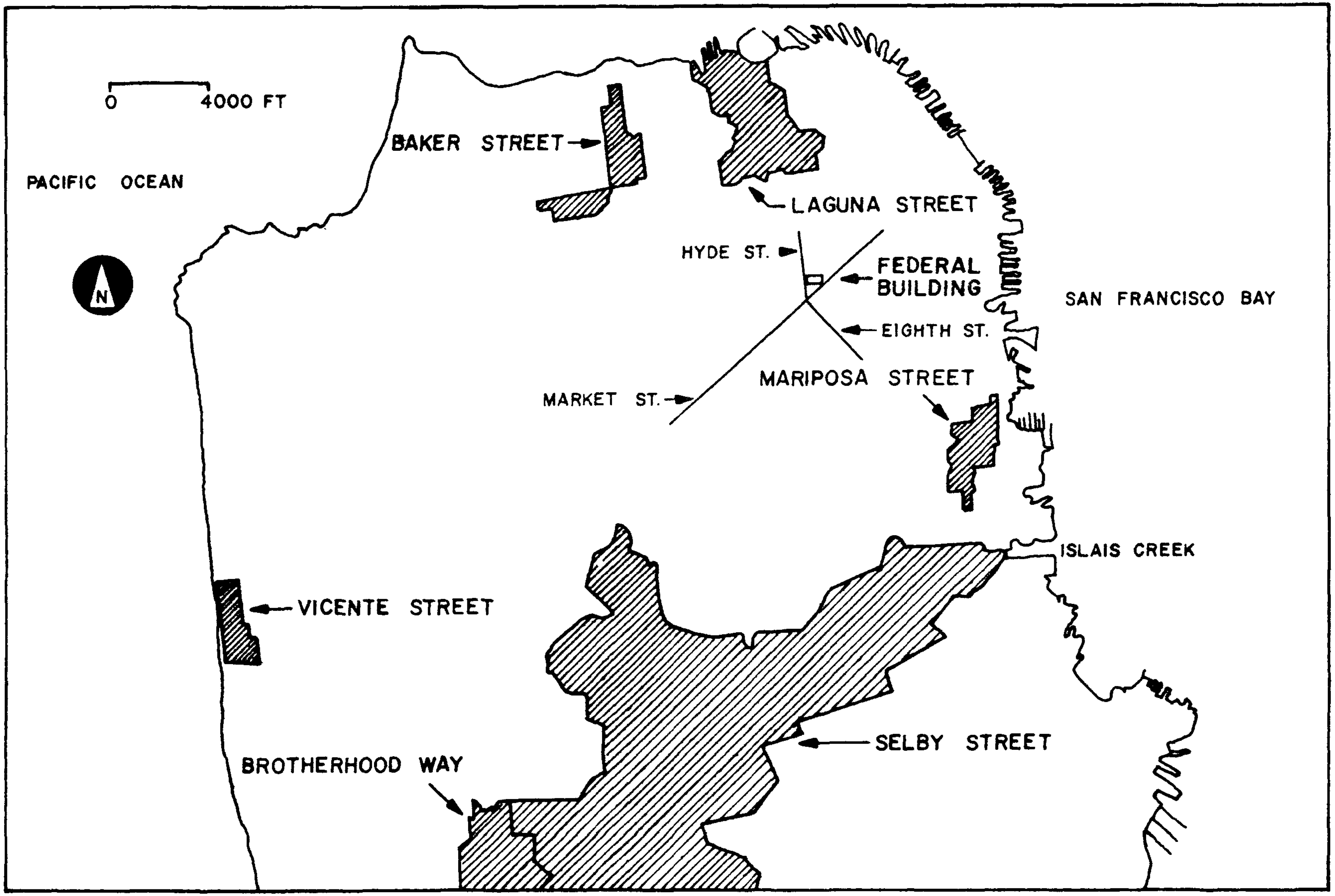


Figure VII-10 Location map for San Francisco catchments.

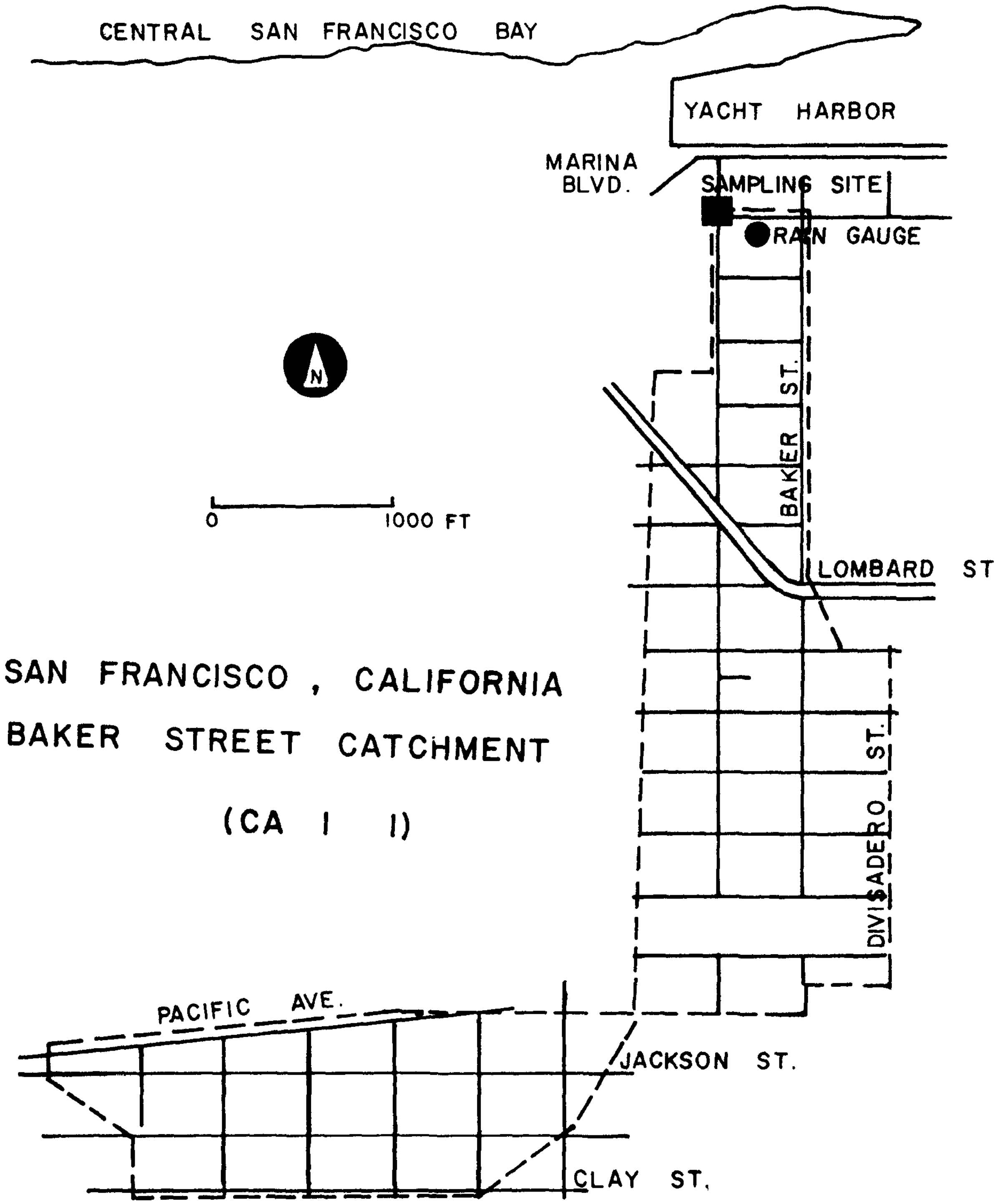
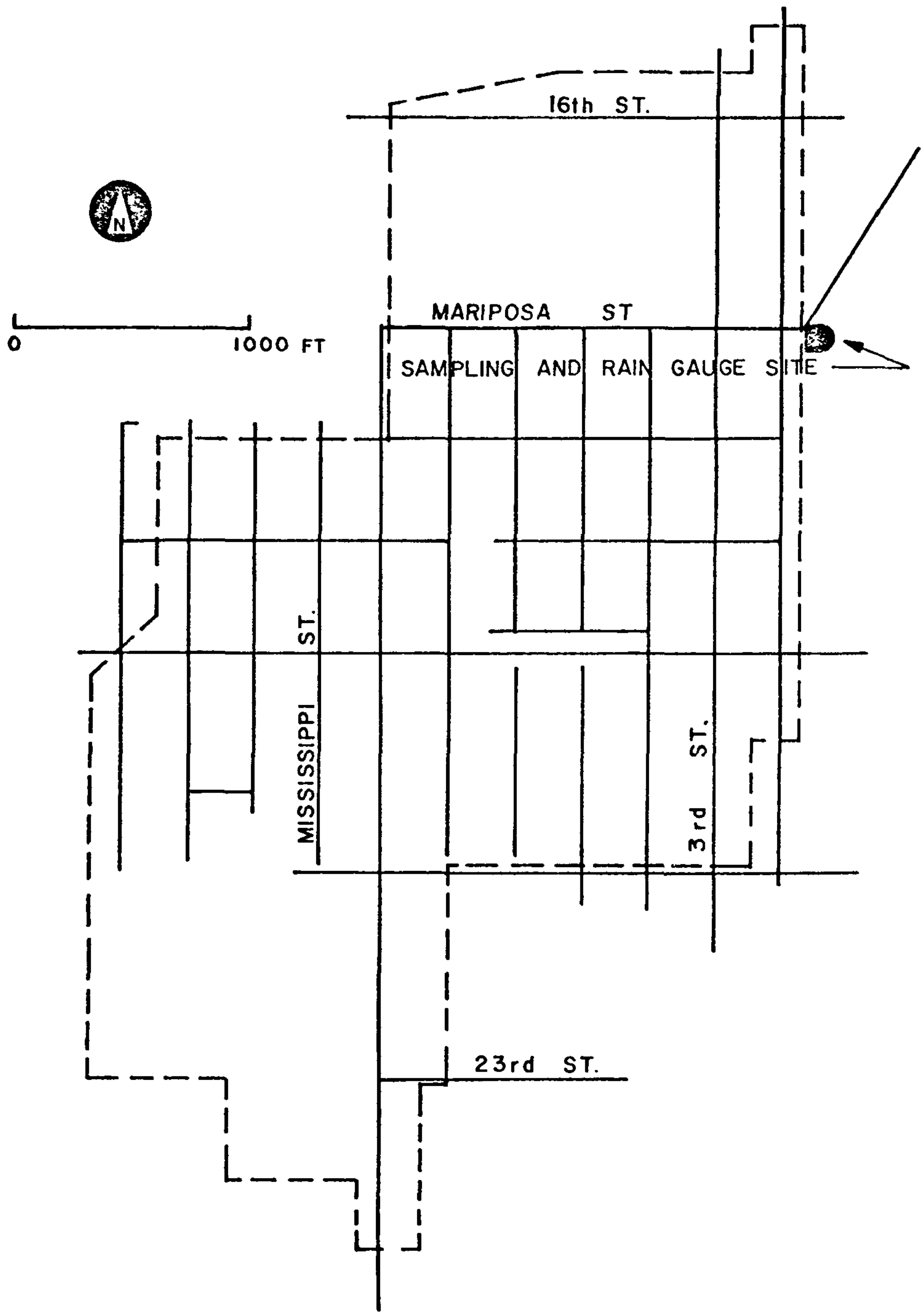
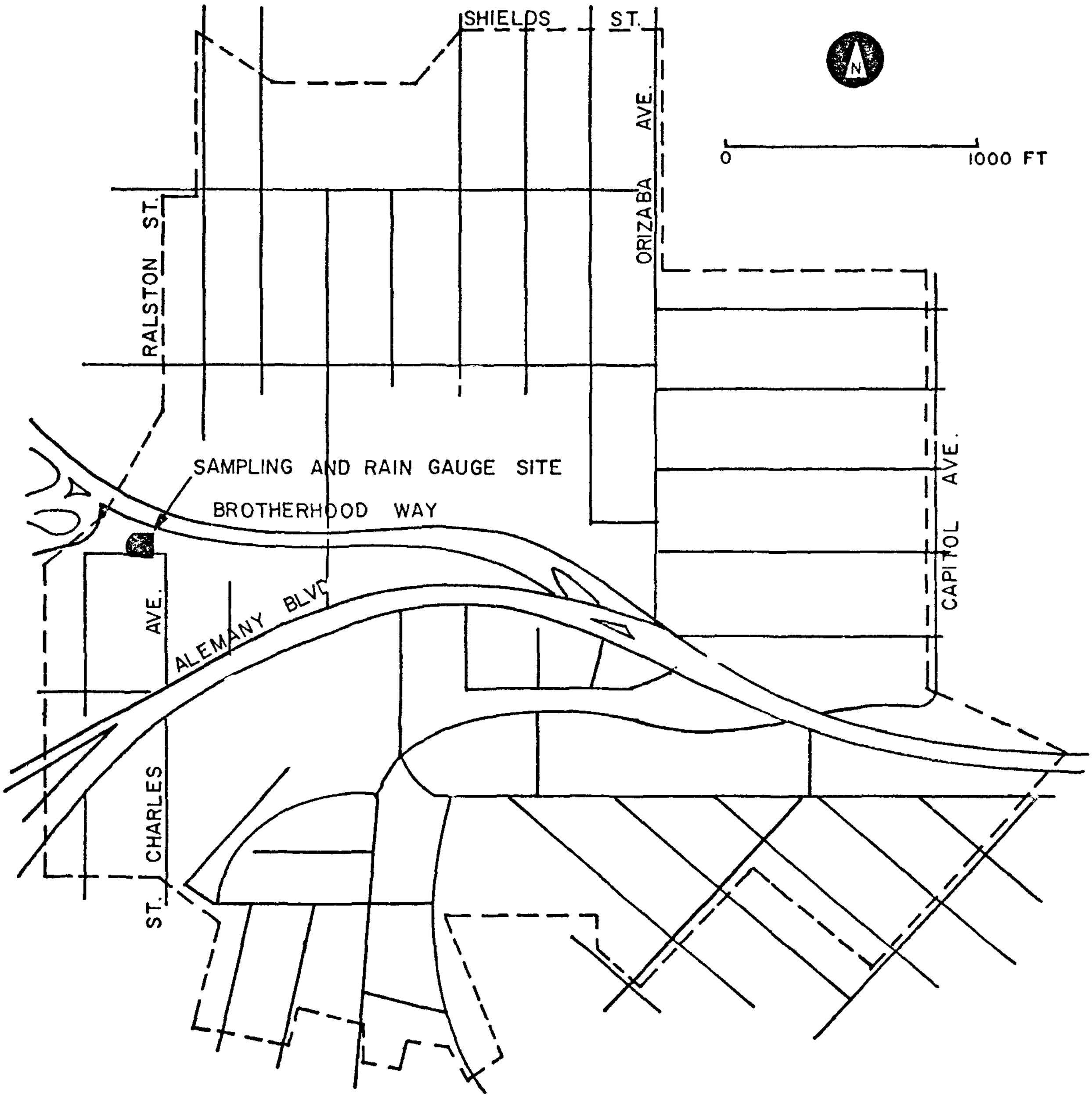


Figure VII-11 San Francisco, California, Baker St. Catchment 168 ac (68 ha)



SAN FRANCISCO , CALIFORNIA
MARIPOSA STREET CATCHMENT (CA I 2)

Figure VII-12 San Francisco, California, Mariposa St. Catchment, 223 ac (90 ha).



SAN FRANCISCO, CALIFORNIA

BROTHERHOOD WAY CATCHMENT (CA I 3)

Figure VII-13 San Francisco, California, Brotherhood Way Catchment, 180 ac (73 ha).

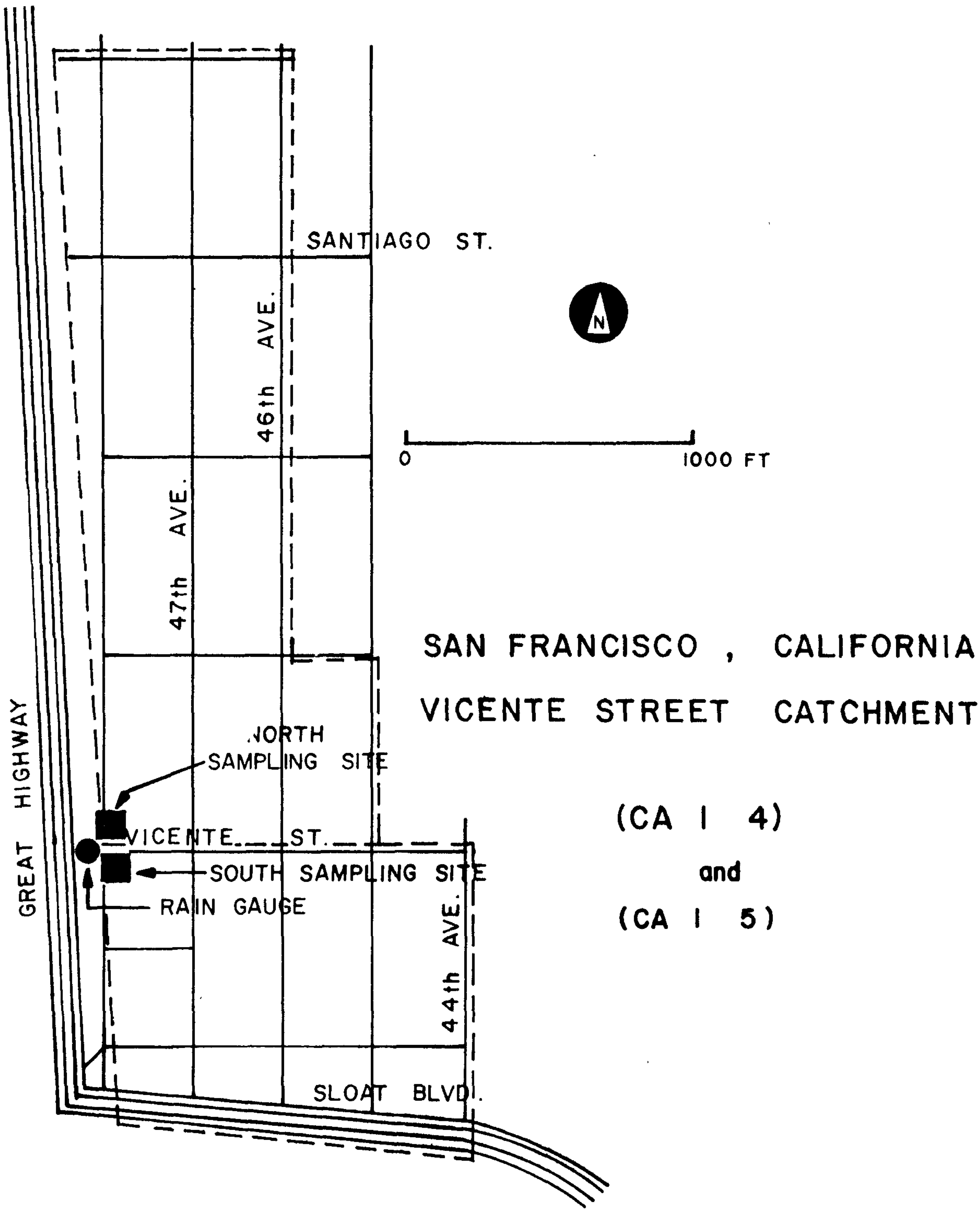


Figure VII-14 San Francisco, California, Vicente St. North Catchment, 16 ac (6.5 ha) and Vicente St. South Catchment, 21 ac (8.5 ha).

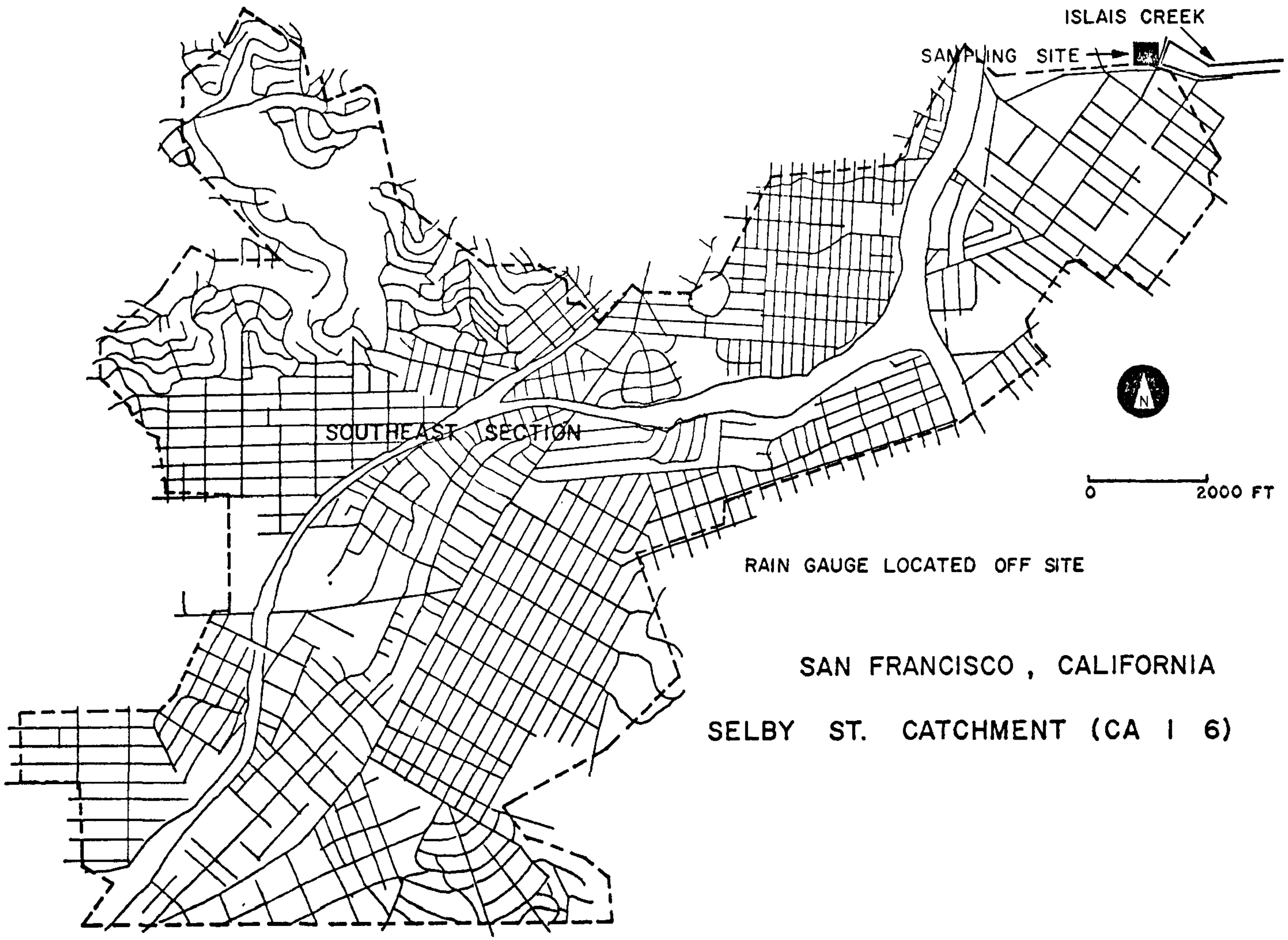


Figure VII-15 San Francisco, California, Selby St. Catchment, 3400 ac (1380 ha).

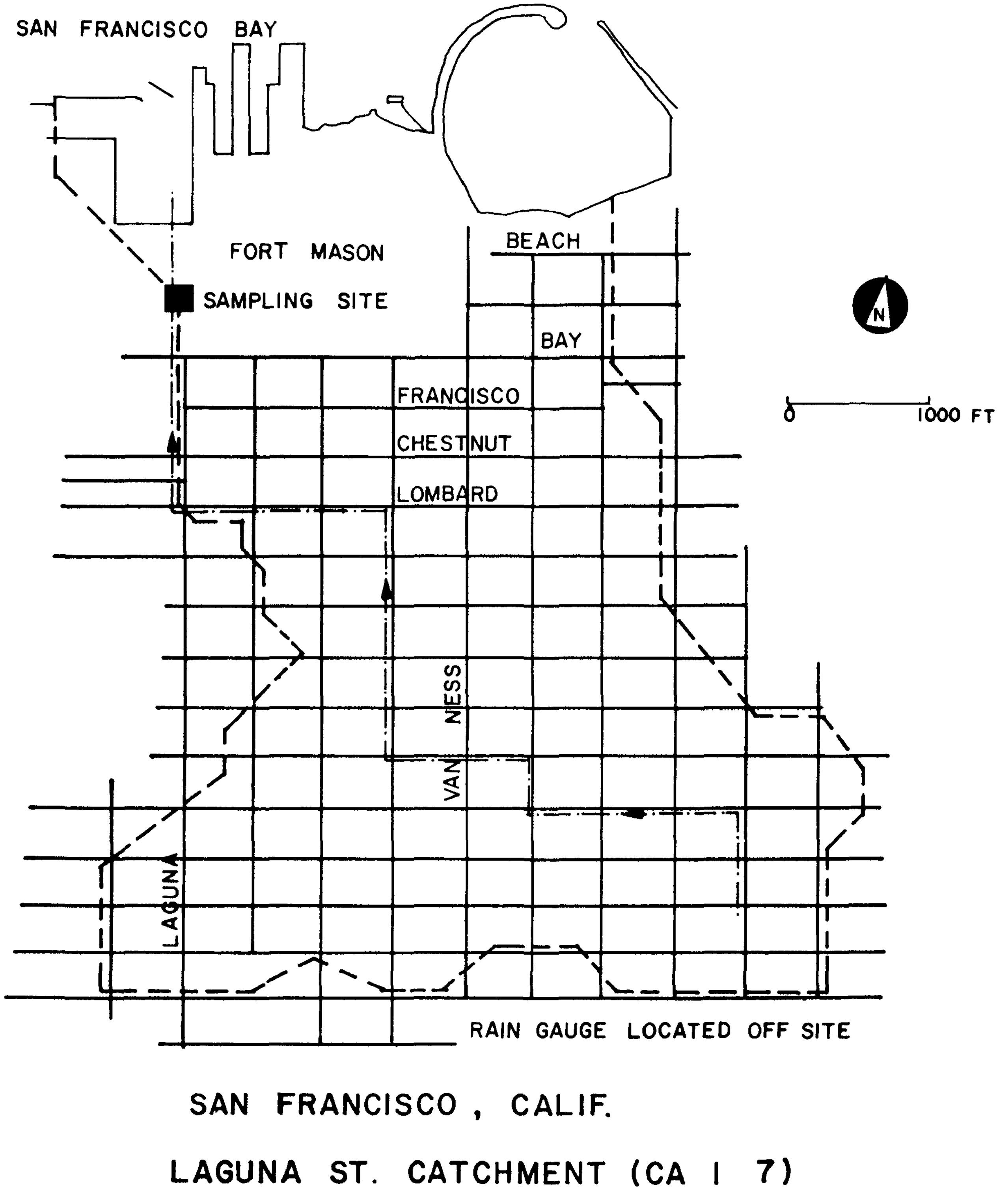


Figure VII-16 San Francisco, California, Laguna St. Catchment, 375 ac (152 ha).

SEATTLE, WASHINGTON

The data included in this report were made available by the Municipality of Metropolitan Seattle (METRO) through the River Basin Coordinating Committee, plus later data through a continuing sampling program by METRO. The data are part of an integrated study of water and wastewater management of the Cedar and Green River Basins (33, 146).

Seven catchments were sampled representing residential, commercial, and industrial land use. Data for all seven were gathered during 1973 under a cooperative arrangement between METRO and the Seattle District Corps of Engineers. Intensive sampling at three catchments has continued into 1974-75. All data, with the exception of some limited 74-75 rainfall data, were reduced by the agency prior to receipt by UF.

All Seattle data are considered excellent, both in terms of sampling procedures and volume. METRO personnel are performing extensive in-house analyses of the data to determine loading rates, statistical parameters, etc. When published, their reports should provide a valuable addition to the data themselves. Some additional information on the catchments is available in modeling studies performed for the city (109, 143).

State and City Code: WA 01

Table VII-25. Catchments - Seattle

No.	Name	Area ac (ha)	Sewerage	Land Use
1	View Ridge 1 (VR1)[a]	630 (255)	Storm	High dens., older single family residential
2	View Ridge 2 (VR2)	105 (43)	Storm	Single fam. res. 50%, multiple fam. res. 40%, com. and hosp. 10%
3	South Seattle (SS3)	27.5 (11.1)	Storm	Industrial
4	Southcenter (SC4)	24 (9.8)	Storm	New shopping center (com.)
5	Lake Hills (LH5)	150 (61)	Storm	Medium dens., newer single family residential
6	Highlands (HL6)	85 (34)	Storm	Low density, wooded, single family residential
7	Central Bus. Dist. (CBD7)	27.8 (11.3)	Combined	Older business district (com.)

[a]Notation used in Seattle documentation.

Table VII-26. Quantity Data - Seattle

No.	Catchment	Flow: Type of Flow Meas[a]	Flow: Sampling Interval[b] min	Rain: Gages Used No. in Catchment	Rain: Gages Used No. near Catchment	Rain: Type	Rain: Sampling Interval min	No. Storms	Period
1	View Ridge 1	f_1	5-15	0	3	r_1	5-60	5 25	2/73- 9/73 10/74-12/75
2	View Ridge 2	f_3	5-15	1	2	r_1	5-15	5	2/73- 9/73
3	South Seattle	f_3	5-15	0	2	r_1	5-60	5 26	3/73- 9/73 10/74-12/75
4	Southcenter	f_1	5-15	1	0	r_1	5-60	6 25	2/73- 9/73 10/74-12/75
5	Lake Hills	f_2	5-15	1	1	r_1	5-15	5 2	3/73- 9/73 4/75- 6/75
6	Highlands	f_3	5-15	0	1	r_1	5-15	4	3/73- 9/73
7	Central Bus. Dist.	f_3	5-15	0	1	r_1	5-15	5	3/73- 9/73

[a]All flows computed from stage-discharge relationship from Manning equation, with some calibration using velocity measurements. Stage measured by Arkon Model 63 TN Nitrogen Gas Bubbler Tube.

f_1 - Recorder at hole in conduit. f_2 - Recorder at catchbasin. f_3 - Recorder at manhole.

[b]Flows were calculated every 15 min from strip chart records with linear interpolation for values reported at shorter intervals.

r_1 - Stevens tipping bucket gage and event recorder. Reported data are for gage in catchment, if working, or else nearest gage in direction of approaching storm.

Time synchronization, rain-flow: dependent upon separate clocks in rain and stage gages. No problems reported.

Comment: Early problems in flow measurements developed at Southcenter, Lake Hills and Highlands due to unusually high velocities creating a venturi effect as water rushed past the bubbler tube. Weirs were installed on April 23-24, 1973 to reduce velocities, and calibrations changed accordingly. Flow data are considered very good, in general.

Table VII-27. Quality Sampling - Seattle

No.	Catchment	Sampling Method	Sampling Interval min	Sampling Location	No. Storms	Period
1	View Ridge 1	s_1	15	Flow-measuring site	5 25	2/73- 9/73 10/74-12/75
2	View Ridge 2	s_2	15	Flow-measuring site	5	3/73- 9/73
3	South Seattle	s_1	15	Flow-measuring site	5 26	3/73- 9/73 10/74-12/75
4	Southcenter	s_1	15	Flow-measuring site	5 25	2/73- 9/73 10/74-12/75
5	Lake Hills	s_2	15	Flow-measuring site	5 2[a]	3/73- 9/73 4/75- 6/75
6	Highlands	s_2	15	Flow-measuring site	4	3/73- 9/73
7	Central Bus. Dist.	s_2	15	Flow-measuring site	5	3/73- 9/73

[a]Only quality data are a few measurements of total P.

s_1 - Manual grab samples in 2 gal (7.6 l) bottles (1973 storms). Most 1974-75 storms used Serco automatic samplers.

s_2 - Manual grab samples in 2 gal (7.6 l) bottles.

Time synchronization, flow-quality: good since flow measured at same location as quality sampling.

Table VII-28. Quality Parameters - Seattle

Not all parameters are given for all storms at all catchments.

Parameter	Catchment No.	STORET Code	Units
DO	All	300	mg/l
pH	All	400	
Temperature	All	10	°C
Susp. Solids (SS)	All[a]	530	mg/l
BOD_5	All	310	mg/l
COD	All	340	mg/l
Cd	All[a]	1027	μg/l
Cr	All	1034	μg/l
Cu	All	1042	μg/l
Pb	All[a]	1051	μg/l
Zn	All[a]	1092	μg/l
Cl	All	940	mg/l
NH_3-N	All[a]	610	mg/l-N
NO_2-N	All	615	mg/l-N
NO_2-N + NO_3-N	All[a]	630	mg/l-N
TKN	All	625	mg/l-N
Organic-N	1,3,4[a]	605	mg/l-N
Fec. Colif.	All	31616	MPN/100 ml[b]
Tot. Colif.	All	31501	MPN/100 ml[b]
Tot. Hydroliz. P	All	669	mg/l-P
Tot. P	1,3,4[a]	665	mg/l-P
OPO_4-P	All[a]	70507	mg/l-P
Conductivity	All[a]	94	μ mho/cm
Turbidity	All[a]	70	JTU
Grease (Hex Extract)	All	70351	mg/l
Tot. Dis. Solids	All	515	mg/l
Set. Solids (at 1 hr)	All	546	mg/l
SO_4	All	945	mg/l
Fe	All	1045	μg/l
Hg	All	71900	μg/l
As	All	1002	μg/l
Flow	All[a]	61	cfs
Rain	All[a]	90050	in./hr
Dry Days Preceding Storm[c]	1,3,4	90100	days
Catchment Area[c]	1,3,4	53	acres
Storm Rainfall[c]	1,3,4	45	in.

[a]Only parameters measured when using automatic samplers during 1974-75 storms

[b]On data tape, coliforms are given as 100 x $\log_{10}$ (MPN/100 ml).

[c]Also provided on data tape for 1974-75 storms.

Table VII-29. Background Levels at Three Catchments - Seattle

Limited samples were taken in 1976 to determine background levels of parameters during periods of no rain. These may be used as initial conditions at the initiation of storms. They also are subject to refinement at a future date.

Parameter	STORET Code	Concentration at Catchments 1 (VR1)	3 (SS3)	4 (SC4)	Units
Tot. P	665	0.15	0.11	0.22	mg/1-P
OPO_4-P	70507	0.09	0.1	0.14	mg/1-P
Organic-N	605	0.44	0.40	0.80	mg/1-N
NH_3-N	610	0.06	0.08	0.16	mg/1-N
NO_2 + NO_3-N	630	2.3	0.1	0.35	mg/1-N
Susp. Solids (SS)	530	6.0	24.0	14.0	mg/1
Turbidity	70	120	220	110	JTU
Conductivity	94	290	180	420	μ mho/cm
Cd	1027	4[a]	4[a]	4[a]	μg/1
Pb	1051	100	100	100	μg/1
Zn	1092	10	190	150	μg/1
Flow	61	0.24	0.01	0.01	cfs

[a] Lowest measureable.

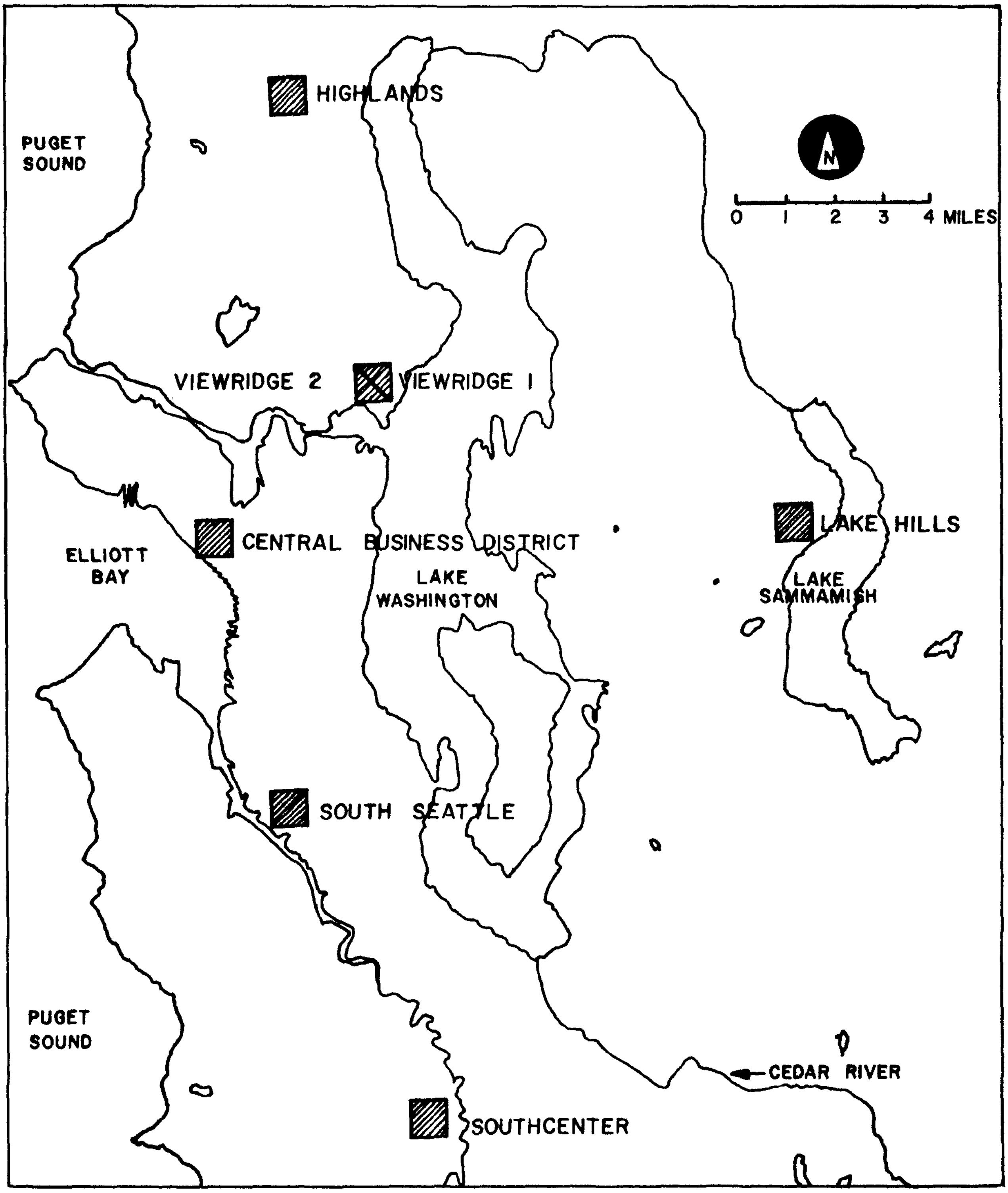


Figure VII-17 Location map for Seattle catchments.

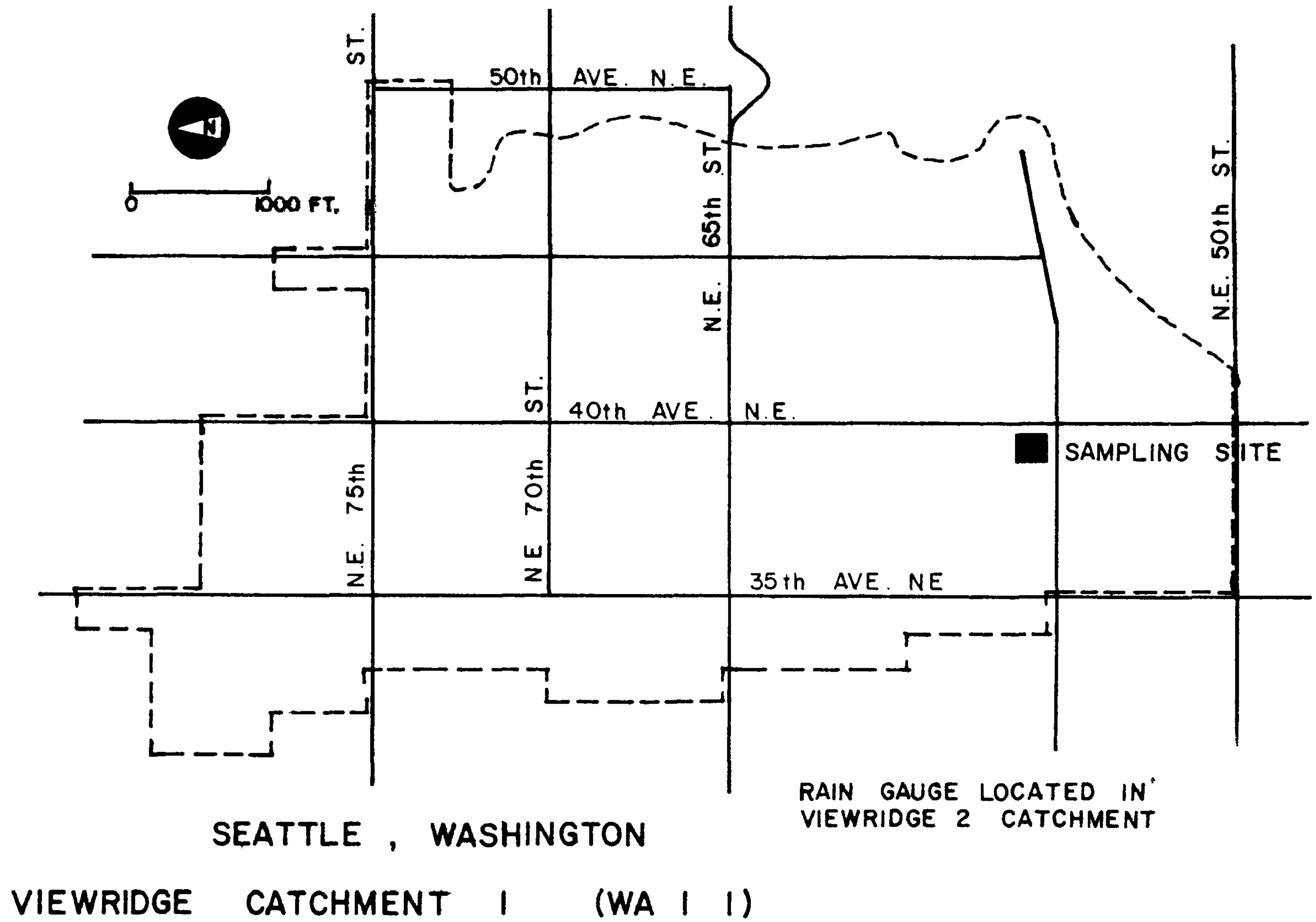


Figure VII-18 Seattle, Washington, Viewridge 1 Catchment, 630 ac (255 ha).

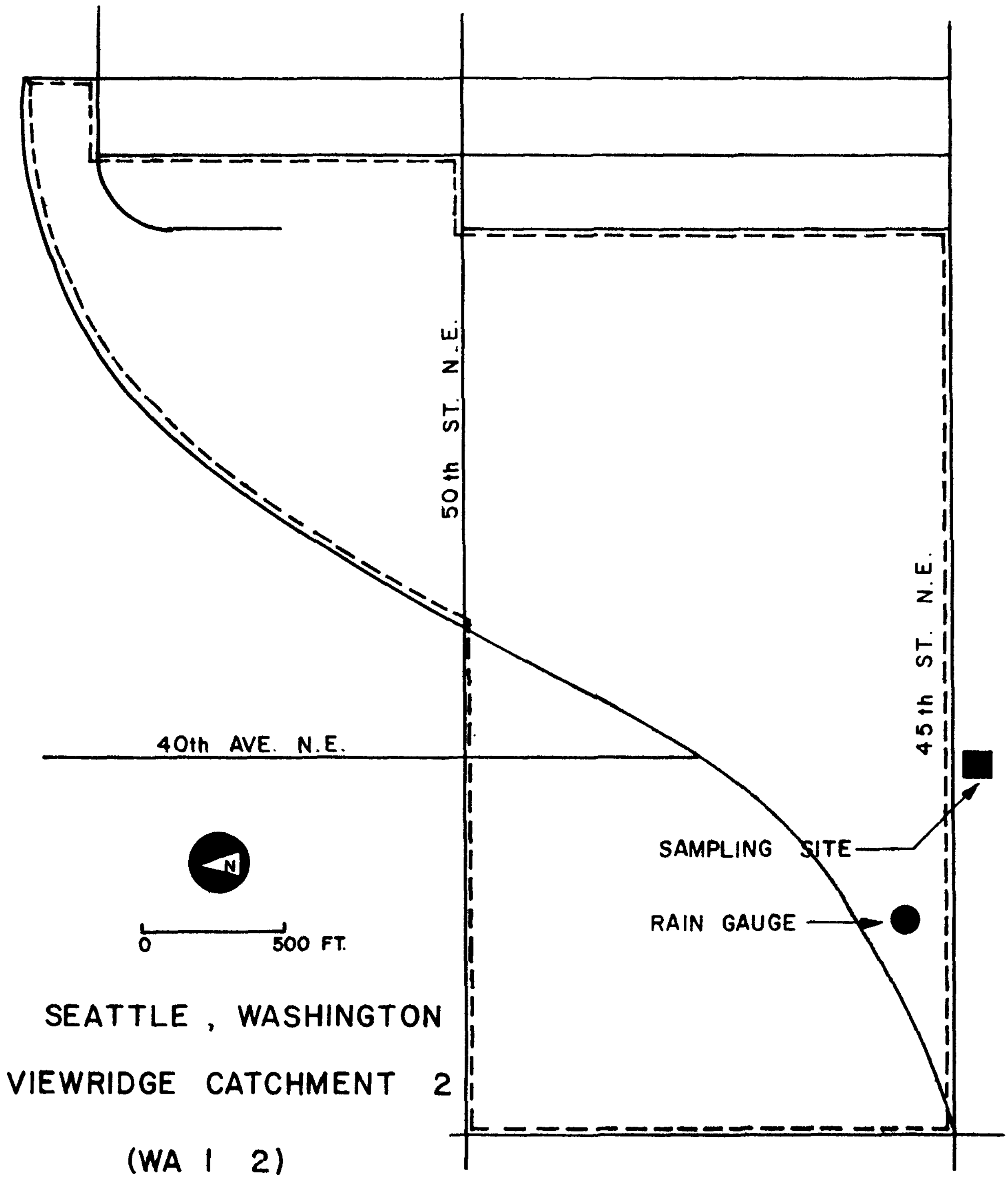


Figure VII-19 Seattle, Washington, Viewridge 2 Catchment, 105 ac (43 ha). Scale is approximate.

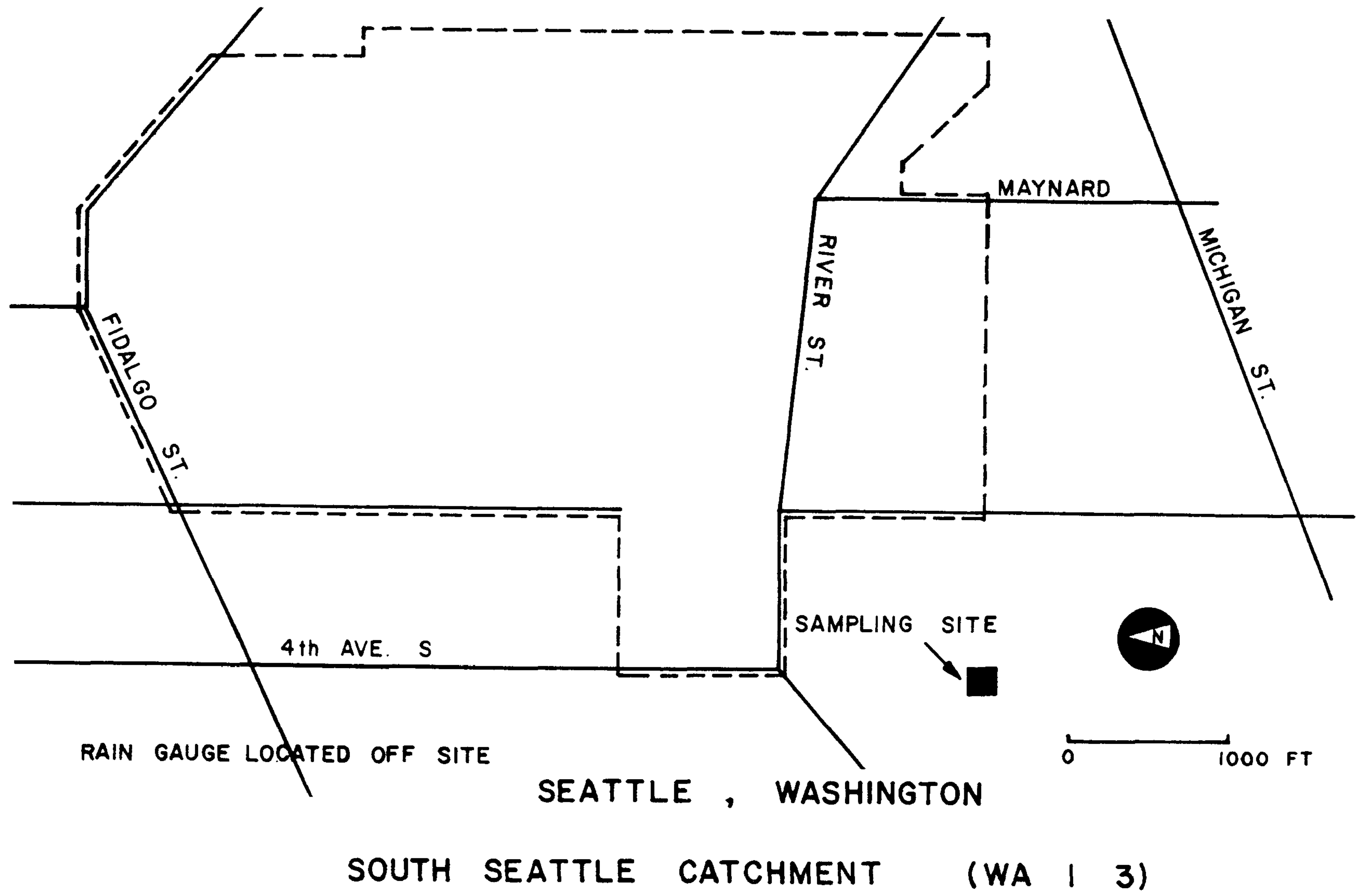
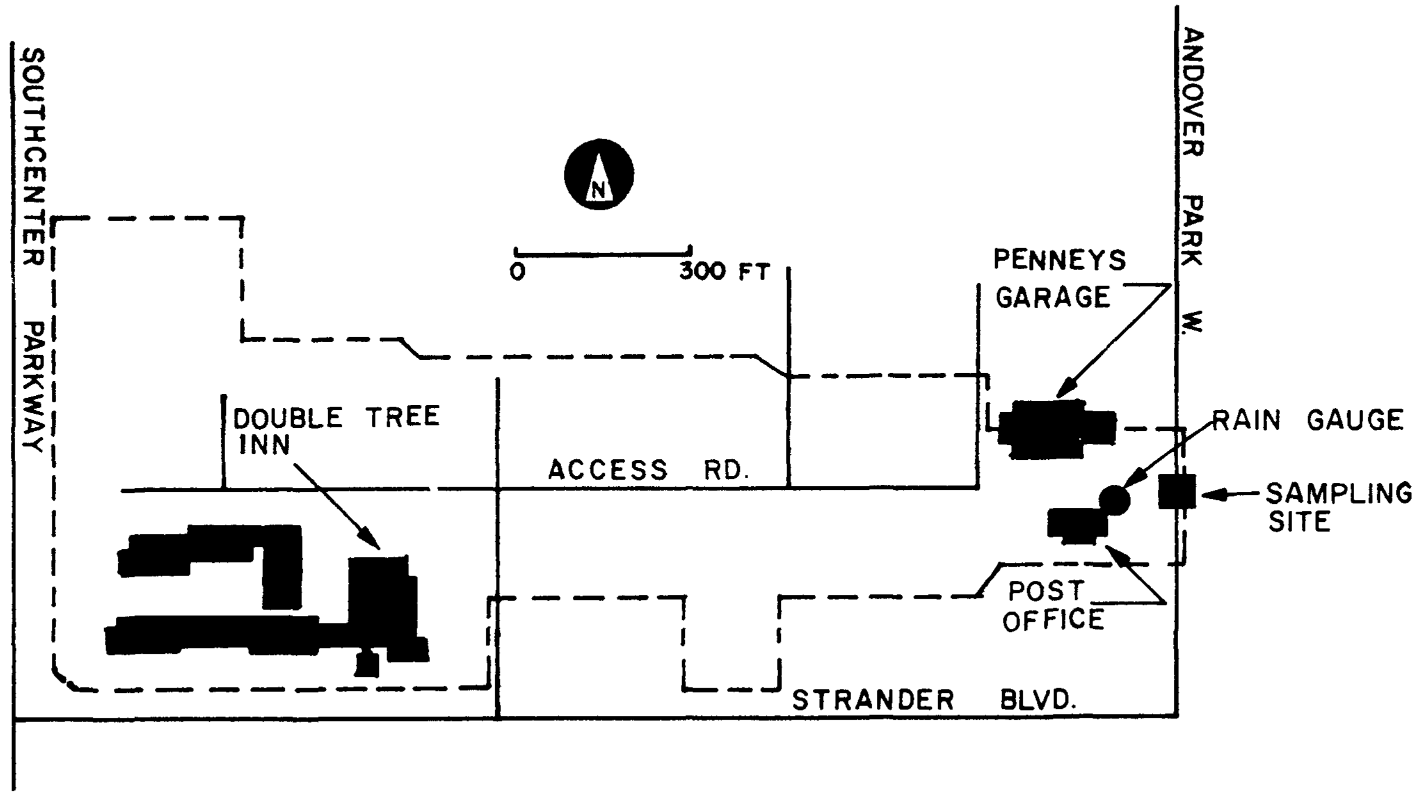


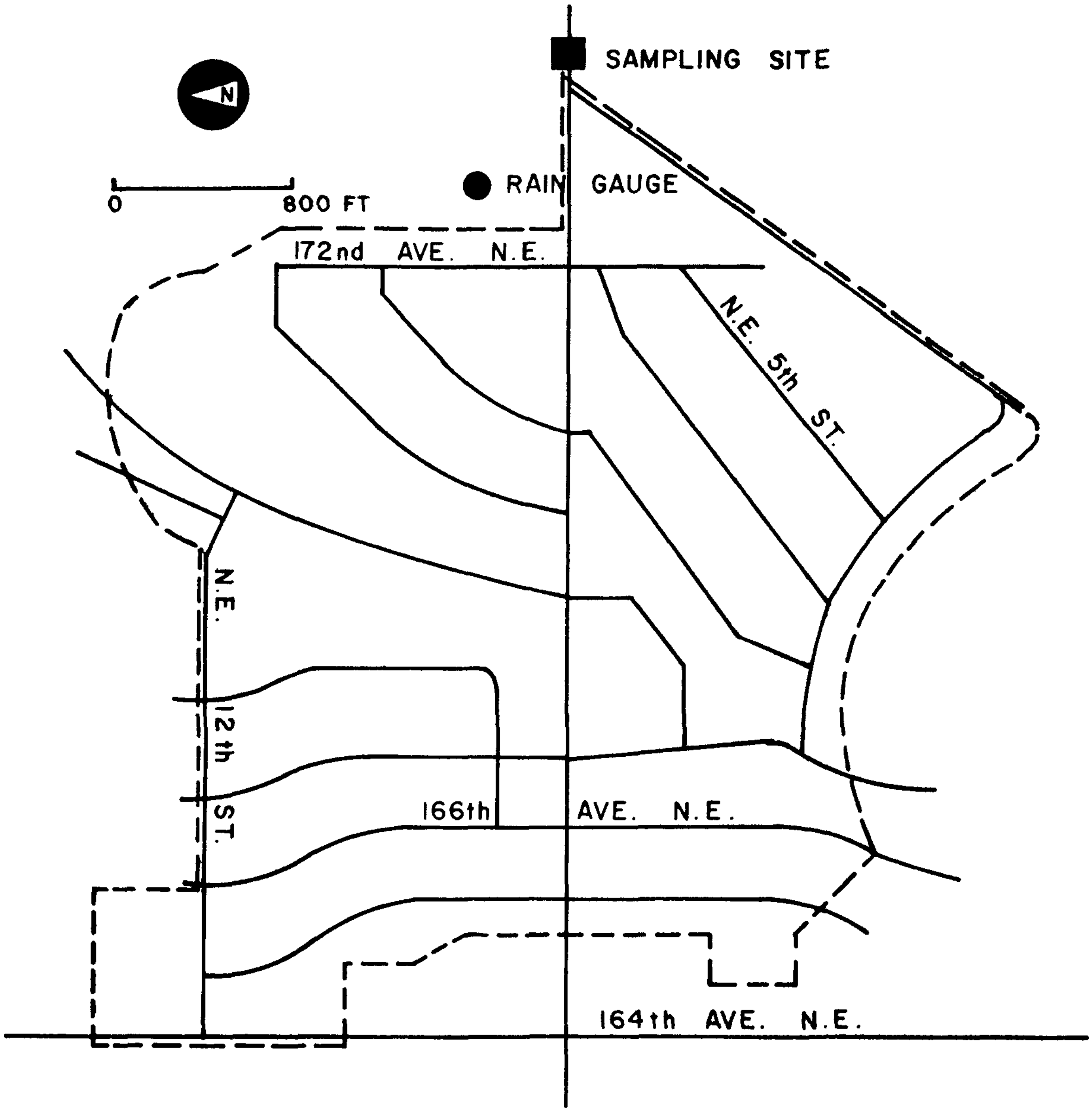
Figure VII-20 Seattle, Washington, South Seattle Catchment, 27.5 ac (11.1 ha).



SEATTLE , WASHINGTON

SOUTHCENTER CATCHMENT (WA I 4)

Figure VII-21 Seattle, Washington, Southcenter Catchment, 24 ac (9.8 ha).



SEATTLE, WASHINGTON

LAKE HILLS CATCHMENT (WA I 5)

Figure VII-22 Seattle, Washington, Lake Hills Catchment, 150 ac (61 ha).

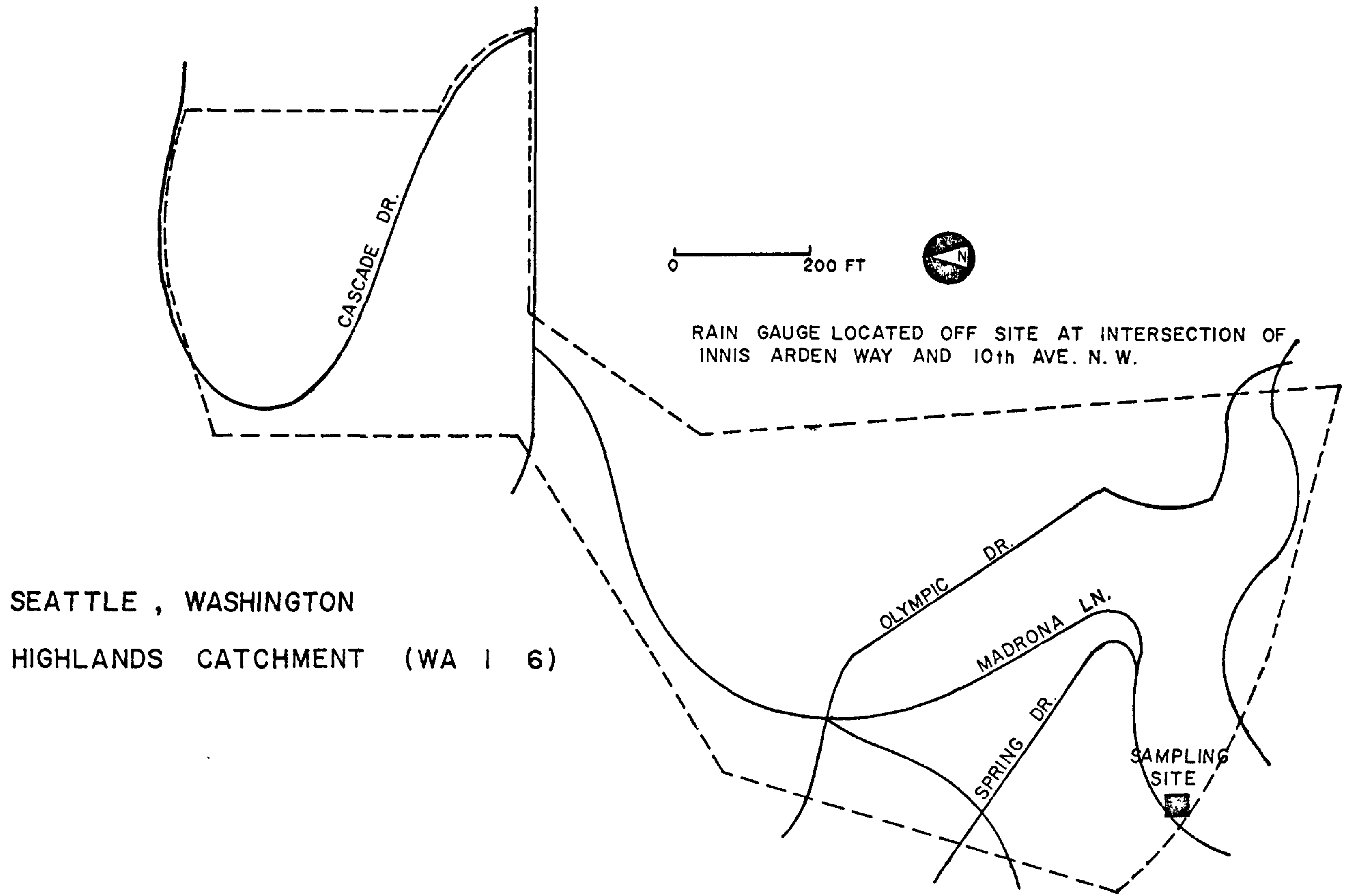


Figure VII-23 Seattle, Washington, Highlands Catchment, 85 ac (34 ha).

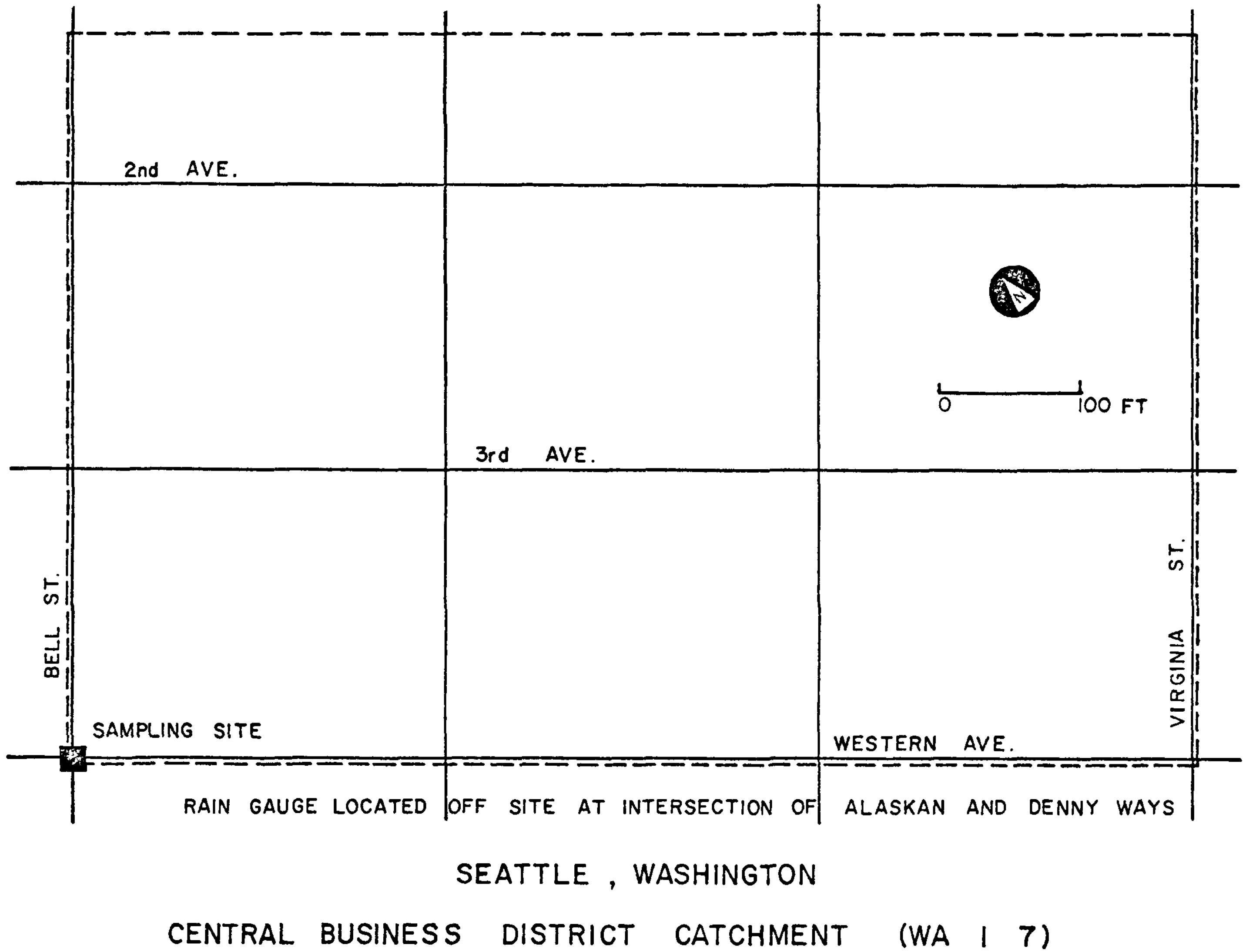


Figure VII-24 Seattle, Washington, Central Business District Catchment, 27.8 ac (11.3 ha).

WINDSOR, ONTARIO

Data were taken from the thesis of Droste (110) of the University of Windsor from one residential catchment for the period September 1972 to August 1973. Sampling and all data reduction were performed by the University of Windsor. Additional information about a nearby catchment is provided in an earlier study by Singh, but his data are not included because of construction activities underway during his sampling activities (111).

The data included herein were taken for a large number of storms, 22, but suffer from a large sampling interval of one hour. This will limit their usefulness somewhat for modeling purposes.

Province and City Code: ON 01

Table VII-30. Catchment - Windsor

No.	Name	Area ac (ha)	Sewerage	Population	Land Use
1	Labadie Road	29.5 (11.9)	Storm	590	Single family Residential

Table VII-31. Quantity Data - Windsor

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of Flow Meas	Sampling Interval min	No. in Catchment	No. near Catchment	Type	Sampling Interval min	No. Storms	Period
1	Labadie Road	f_1	60		3	r_1	60	22	9/72 - 8/73

f_1 - Stage measured by Arkon Model 63 TN Nitrogen Gas Bubbler Tube in 21 in. (53 cm) sewer at manhole. Flow computed using calibrated stage-discharge relationship.

r_1 - Not reported, but 0.01 in. (0.254 mm) accuracy.

Flow-rain synchronization: dependent upon separate clocks on rain and stage gages. No problems reported.

Comment: A weighted average of two or three rain gages is reported leading to some smoothing of data. Gages are operated by Department of Geography at University of Windsor. Storms of January 23-24, March 16-17, 1973 and November 25-26, 1972 contain significant snowfall.

Table VII-32. Quality Sampling - Windsor

Catchment	Sampling Method	Sampling Interval min	Sampling Location	No. Storms	Period
Labadie Road	s_1	60	Manhole	22	9/72 - 8/73

s_1 - Automatic grab sampler by Testing Machines International. Sampling head anchored to bottom of sewer. Samples not taken when flow < 0.01 cfs (0.28 l/sec).

Time synchronization: Quality-flow good because measurements taken at same location.

Table VII-33. Quality Parameters - Windsor

Not all parameters were sampled for all storms

Parameter	STORET Code	Units
BOD_5	310	mg/l
Tot. Colif.	31504	MPN/100 ml[a]
Fec. Colif.	31616	MPN/100 ml[a]
Tot. Susp. Solids (SS)	530	mg/l
Vol. SS	535	mg/l
NH_3-N	610	mg/l-N
NO_3-N	620	mg/l-N
NO_2-N	615	mg/l-N
OPO_4-PO_4	660	mg/l as PO_4
Cl	940	mg/l
SO_4	945	mg/l
Alkalinity	410	mg/l as $CaCO_3$
Ca. hardness	901	mg/l as $CaCO_3$
Total hardness	900	mg/l as $CaCO_3$
pH	400	
Color	80	PTU
Turbidity	70	JTU
Spec. Conductivity	95	μ mho

Some additional data were taken in composite samples during storms.

[a]On data tape, coliforms are given as 100 x $\log_{10}$ (MPN/100 ml).

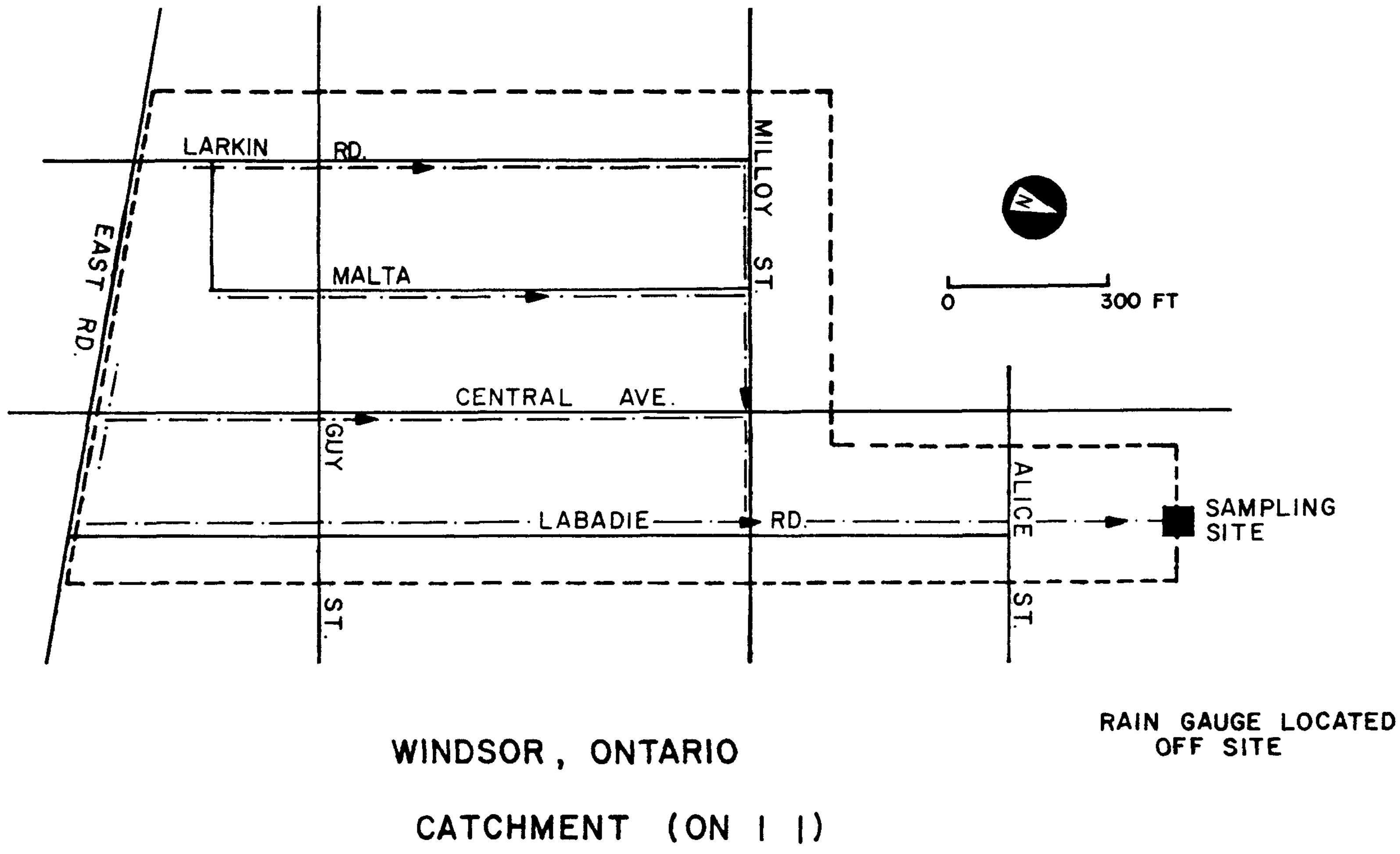


Figure VII-25 Windsor, Ontario, Labadie Road Catchment, 29.5 ac (11.9 ha).

WEST LAFAYETTE, INDIANA

Quantity and quality data were gathered for an urban and a semi-urban/rural watershed as part of OWRT-sponsored research conducted by Purdue University (Grant No. 14-31-001-3712).

The period of study was from October 1972 to May 1975. However, because of missing rainfall data, only 38 percent of the urban events and none of the semi-urban/rural ones are included here.

Data were taken from a completion report (161) and reduced prior to receipt by UF. Included data are considered to be of good quality.

Tucker (42) and Sarma et al. (182) also refer to these watersheds, as do Stall and Terstriep (49) in the evaluation of the RRL Method. The latter authors indicate that the catchment boundary can be variable because of the possibility of additional inflows during large storms that would ordinarily be intercepted by an adjacent combined sewer.

State and City Code: IN 01

Table VII-34

Catchments - West Lafayette

No.	Name	Area ac (ha)	Sewerage	Population	Imperviousness %	Land Use Percentages
1	Ross-Ade upper watershed	29 (11.7)	Storm	252[a]	38[b]	Single family residential

a - 72 single-family dwellings, 3-5 persons per dwelling, or 8.7 persons per acre.

b - Rooftops 17%, streets and driveways 21%.

Table VII-35 Quantity Data - West Lafayette

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Ross-Ade upper watershed	f_1	30	1	0	r_1	30	10	6/74-11/74
								2	8/67

f_1 - Columbus-type deep notch weir with a crest length of six feet, downstream of a 6ft (1.83m) deep by 6ft (1.83m) wide concrete flume which runs underneath the gaging station, which is a 15ft deep (4.6m) concrete pit, established by USGS in 1964. A stilling well, located to one side of the instrument pit, is connected to a Leupold-Stevens A-35 continuous stage recorder through a pulley arrangement.

r_1 - The rain gage has a 16 in. (40.6cm) diameter rainfall receiver, and a temperature sensor is located 8 ft (2.4m) above ground level. The Leupold-Stevens A-35 continuous stage recorder is also used to record cumulative rainfall and air temperature. The recorder has a 20 in. (50.8cm) chart and is driven at a rate of 144 in./day (366cm/day) so readings can easily be made for 1 minute intervals.

Time Synchronization: Very good since the same recorder is used for rainfall and runoff recordings.

Table VII-36 Quality Sampling - West Lafayette

No.	Catchment	Sampling Method	Sampling Interval, min.	Sampling Location	No. of Storms	Period
1	Ross-Ade upper watershed	s_1	30	L_1	10	6/74-11/74

s_1 - Sentry Sequential Composite Sampler, Charles F. Warrick Floatless Liquid Level Control, Sears Model 28-7108 3-amp 12-volt battery charger, and an isolation transformer. Samples consisted of six 4-minute aliquots. Samples are not refrigerated.

L_1 - Sampler was on the floor of the pit, about 8 ft (2.4 m) above the liquid level in the sewer. The samples were collected from the sewer through "Tygon" tubing and distributed in the polyethylene gallon containers placed under the sampler.

Table VII-37 Quality Parameters - West Lafayette

Parameter	STORET Code	Units
BOD_5	310	mg/1
Tot Susp. Solids	530	mg/1

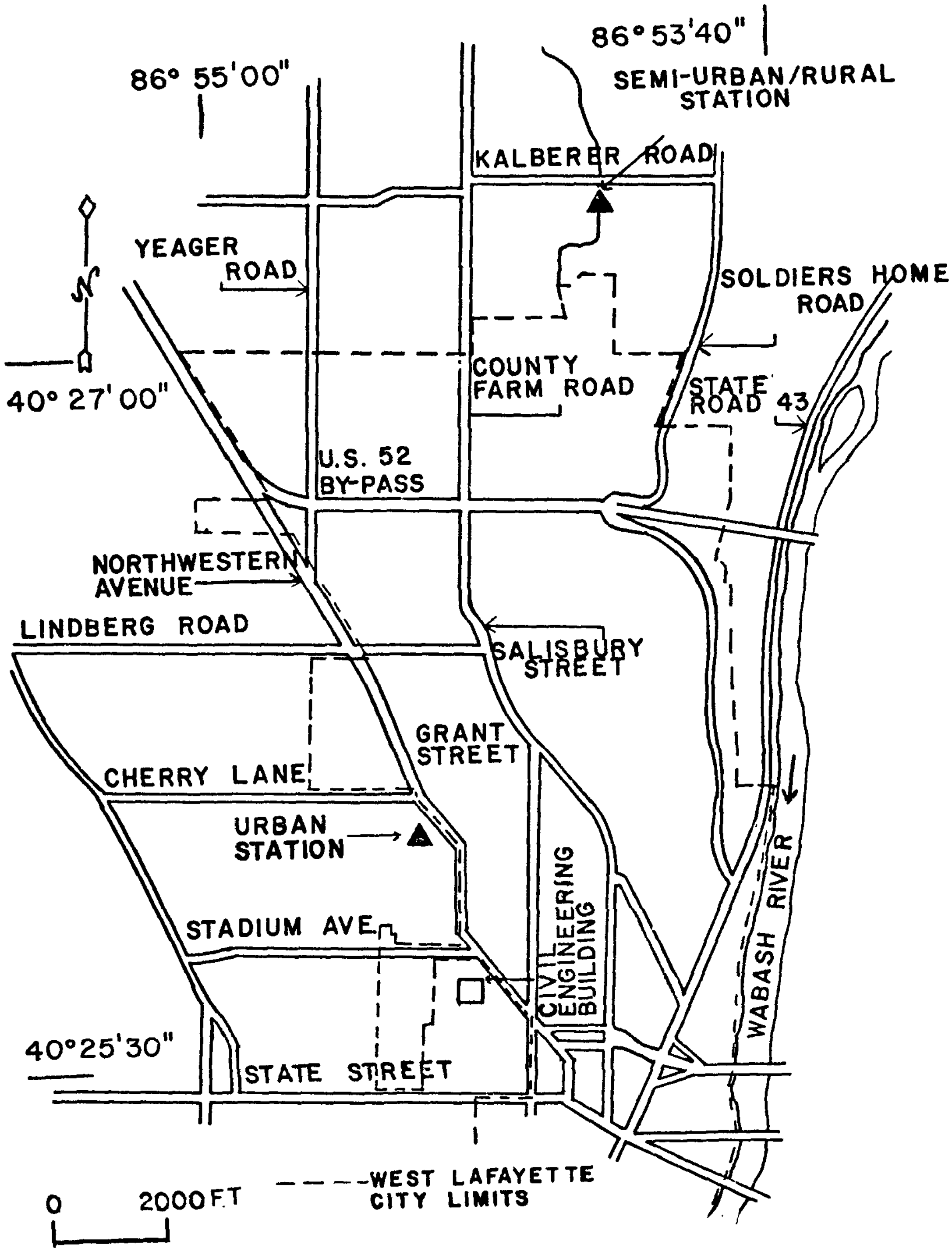


Figure VII-26. Location map for the urban station, Ross-Ade drain (upper basin)in West Lafayette, Indiana. The semi-urban/rural station is discussed in the Purdue University report (161) but not included in the data base because of a lack of rainfall data. Some rainfall-runoff data are available for the entire Ross-Ade basin (not shown), draining through the Purdue campus to the southwest of the city.

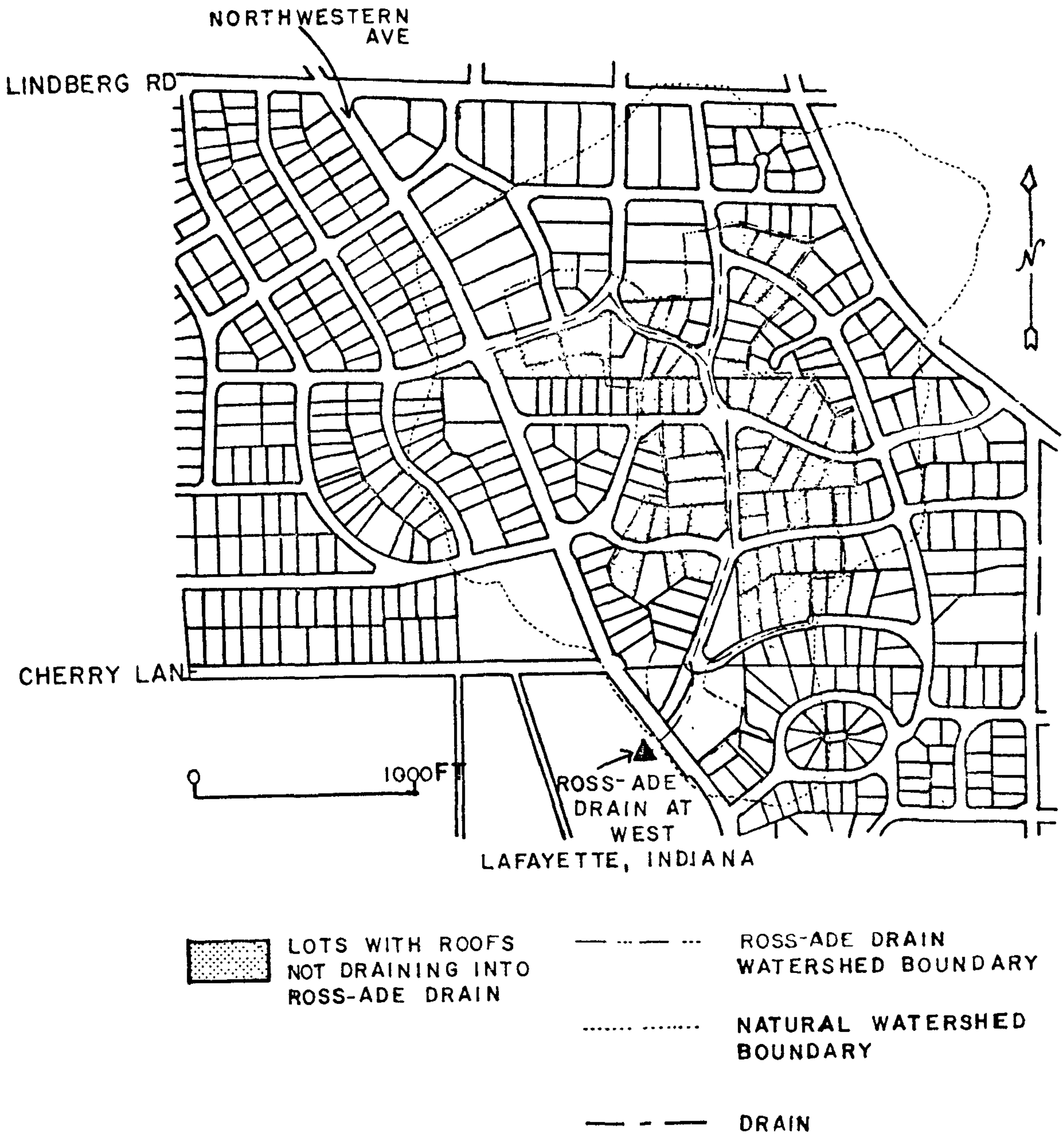


Figure VII-27 West Lafayette, Indiana, Ross-Ade (Upper) Catchment(IN0101), 29 ac (11.7 ha). The larger, surrounding basin does not contribute to the Ross-Ade drain. Most roofs not contributing to the drain are assumed to discharge to a combined sewer.

GREENFIELD, MASSACHUSETTS

Data were collected by the University of Massachusetts for an urban basin covering most of the city. The period of study is from June 1976 to May 1977. The data are considered to be of very good quality. Portions of the study were supported by the following grants: University of Massachusetts Water Resources Research Center WR-A095 and WR-B059, Massachusetts Division of Water Pollution Control 76-10-2, and EPA R-803069.

Data were sent to UF by the University of Massachusetts and were reduced prior to their receipt. Unfortunately, from the 8 storm events received, 3 were deleted due to missing rainfall values.

Information on the basin, sampling program and SWMM calibration runs is given by Nunno (183) and Nunno et al. (184). Further information is given in other University of Massachusetts publications on SWMM modeling (74,143, 185,186) and SWMM input and output (187). Additional background information on the area and associated sampling in the Green River is given by DiGiano et al. (188).

State and City Code: MA 01

Table VII-38 Catchments - Greenfield

No.	Name	Area ac (ha)	Sewerage	Population	Imperviousness %	Avg. Land Slope %	Land Use Percentages	Street Cleaning Interval (days)
1	Maple Brook Basin	1014 (410)	Storm	14,800[a]	15.1	5.4	Single family residential, 64; multi-family residential, 5; commercial, 15; industrial, 3; open/park land, 13.	60

[a]14,800 = 18,500 x 0.80 (18,500 = total population of Greenfield).

Table VII-39 Quantity Data - Greenfield

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Maple Brook Basin	f_1	2 - 15	1	0	r_1	2 - 15	5	6/76-4/77

f_1 - Sharp crested suppressed rectangular weir in 7 x 7ft (2.13x2.13m) concrete culvert. Head was continuously monitored with a Manning "Dipper" transmitter coupled with a Rustrak strip chart recorder.

r_1 - Weathermeasure P501 tipping bucket raingage, calibrated to 0.01 in. (0.25mm) of rainfall, coupled with a Rustrak strip chart recorder. Raingage located near centroid of basin.

Time synchronization: Rain-flow dependent on different clocks however , regular time checks were made to insure synchronization.

Table VII-40 Quality Sampling - Greenfield

No.	Catchment	Sampling Method	Sampling Interval, min.	Sampling Location	No. of Storms	Period
1	Maple Brook Basin	s_1	2 - 15	L_1	5	6/76-4/77

s_1 - Manning - S4000 automatic sampler used to take discrete samples.

L_1 - Intake was located 20 ft (6.1m) upstream of a 3.0ft high by 7.0ft wide (0.9m x 2.1m) sharp crested weir. The sampler was activated at a preselected water height by the stage recorder. Time of sampling was indicated on the stage strip chart.

Table VII-41 Quality Parameters - Greenfield

Not all parameters are given for all storms

Parameter	STORET Code	Units
BOD_5	310	mg/l
COD	340	mg/l
pH	400	
Tot. Susp. Solids	530	mg/l
Volatile Susp. Solids	535	mg/l
Ortho - PO_4	660	mg/l
Total P	665	mg/l
TOC	680	mg/l
Chloride	940	mg/l
Tot. Lead	1051	µg/l
Tot. Zinc	1092	µg/l

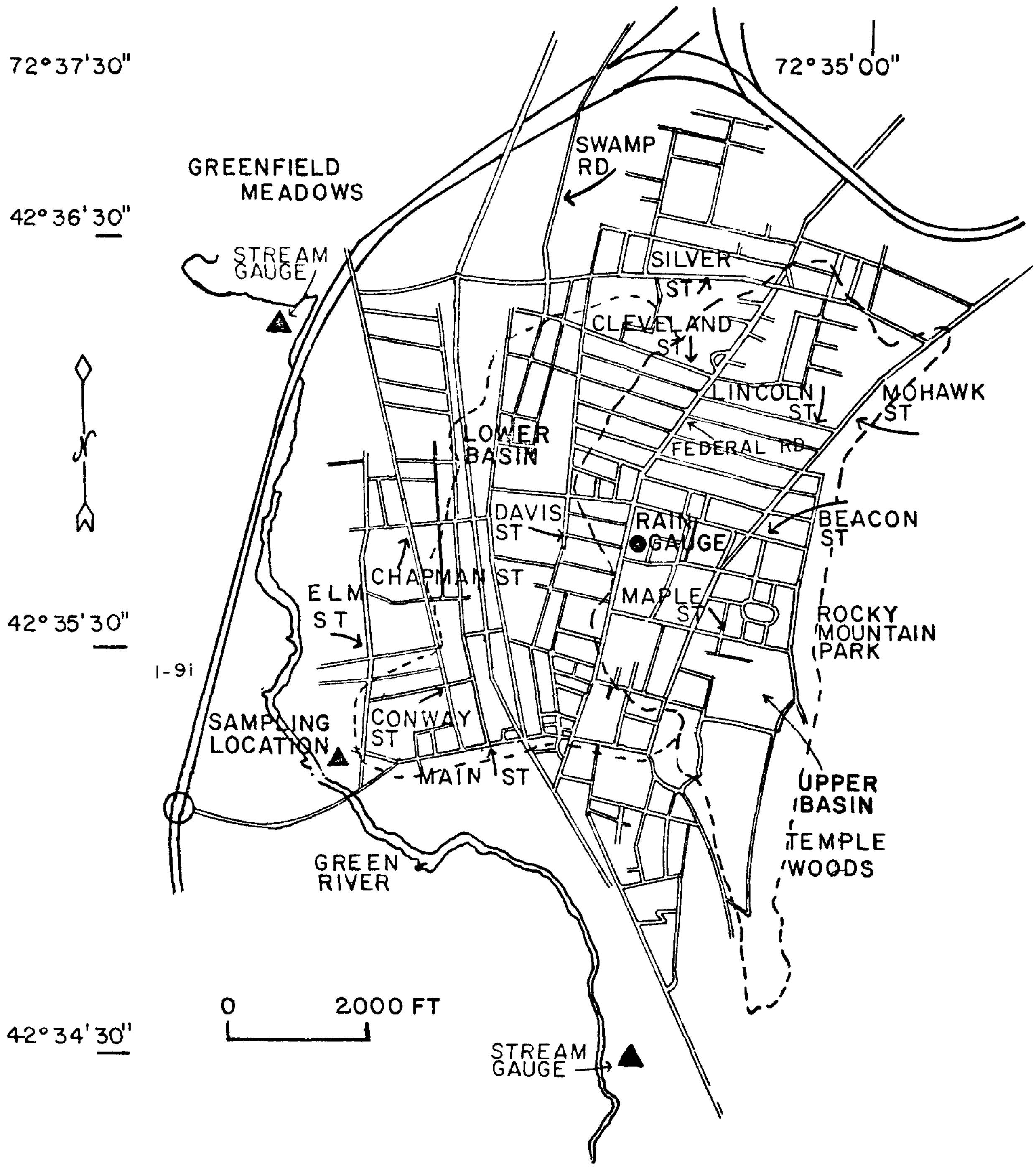


Figure VII-28 Greenfield, Massachusetts, Maple Brook Catchment (MA0101), 1014 ac (410 ha). The catchment covers most of the city and has been divided into an upper and lower basin during modeling studies by the University of Massachusetts.

NORTHAMPTON, MASSACHUSETTS

Quantity and quality data for a 380 ac (154 ha) urban sub-basin were collected during June and July 1977 by the University of Massachusetts under joint sponsorship of the OWRT (Grants WR-A095 and WR-B059), Massachusetts Division of Water Pollution Control (Grant 76-10-2), and the EPA (Grant R-803069). Details of the sampling program and subsequent SWMM modeling are given by Nunno et al. (184) and McAloon (189). The data for the six storm events were reduced prior to receipt by UF and are considered to be of good quality.

State and City Code: MA 02

Table VII-42 Catchments - Northampton

No.	Name	Area ac (ha)	Sewerage	Population	Imperviousness %	Avg. Land Slope %	Land Use Percentages	Street Cleaning Interval (days)
1	Market Street Brook Sewer Sub-basin I	380 (154)	Storm	a	24.2	2.86	Single family residential, 21; multi-family residential, 25; commercial, 26; industrial, 7; open/park land, 21.	b

a - Northampton's total population is 32,500 on 22,400 acres. This basin encompasses most of the commercial and industrial development.

b - The central business district (2.9% of catchment) is swept daily. Remaining catchment areas are swept at an average interval of 119 days.

Table VII-43 Quantity Data - Northampton

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Market Street Brook Sewer Sub-basin I	f_1	1 - 15	1	0	r_1	1 - 15	6	6/77-7/77

f_1 - Broad crested weir of wood construction in a 130 year old brick arch (1.52m base 1.62m height) sewer. Head was continuously monitored and recorded by Instrumentation Specialties Company companion units ISCO 1700 Flow Meter (bubbler principle) and ISCO 1720 Strip Chart Recorder.

r_1 - Weathermeasure P501 tipping bucket raingage calibrated to 0.25mm of rainfall, coupled with a Texas Electronics Model R2-1014P Recorder. The single raingage was located near the mouth of the catchment.

Time synchronization: Rain-flow records were dependent upon two different clocks; however, regular time checks were made to insure synchronization.

Table VII-44 Quality Sampling - Northampton

No.	Catchment	Sampling Method	Sampling Interval, min.	Sampling Location	No. of Storms	Period
1	Market Street Brook Sewer Sub-basin I	s_1	4 - 36	L_1	6	6/77-7/77

s_1 - Samples were manually taken from street level with rope and bucket; they were stored in ice throughout transport to lab, then were chemically preserved and analyzed according to Standard Methods.

L_1 - The sampling point was downstream from the weir which provided extensive turbulence in stream and therefore a well-mixed sample.

Table VII-45 Quality Parameters - Northampton

Not all parameters are given for all storms

Parameter	STORET Code	Units
BOD_5	310	mg/l
COD	340	mg/l
pH	400	
Tot. Susp. Solids	530	mg/l
Volatile Susp. Solids	535	mg/l
Ortho-PO_4	660	mg/l
Total P	665	mg/l
TOC	680	mg/l
Chloride	940	mg/l
Tot. Lead	1051	μg/l
Tot. Zinc	1092	μg/l
Antecedent Dry Days[a]	90100	days

[a] Antecedent dry days defined for this catchment as number of days before storm in which cumulative rainfall $\leq$ 1 in. (2.54 cm.)

Figure VII-29 Northampton, Massachusetts, Market Street Brook Catchment (MA0201), 380 ac (154 ha). The catchment consists of sub-basin I of the University of Massachusetts study (189). The smaller sub-basin II (not shown) was modeled but not monitored.

SECTION VIII

DESCRIPTION OF RAINFALL-RUNOFF DATA BASE SOURCES

INTRODUCTION

The following subsections describe locations for which rainfall and runoff data have been obtained and placed in the data base. No quality data (or only unsuitable data) are available, although current studies at some sites are likely to provide such data in the future.

Again, sources included in this section were chosen primarily on the basis of quality of the data, availability and documentation. Remarks made at the introduction to Section VII apply here also. In particular, documentation varies greatly from site to site. In a few instances, the only readily available information available to UF was that contained in the RRL and ILLUDAS studies (49,50). However, in most cases, at least some other source documentation was available. The cited references should be consulted for additional information at each location.

For quantity-only locations, a table of parameter codes is not given unless there are multiple rain gages, in which case data from each gage is given a different code number (see Table VI-3). In the absence of a table, rainfall and flow values are assigned the code numbers 90050 and 00061, respectively, as indicated in Table VI-3.

Information on modeling data should again be requested directly from UF, as indicated in Section VII.

BALTIMORE, MARYLAND

Some of the earliest and most widely used urban rainfall-runoff data were gathered in Baltimore as part of the Storm Drain Research Project at The John Hopkins Unviersity. Tucker (36,40) has published data for the Northwood and Gray Haven catchments, including necessary modeling information, and the data included herein were taken from these reports. Data from other catchments, including Swansea, Montebello No. 4 and South Parking Lot No. 1, are also available (40, 50).

The Baltimore data, especially Northwood, have been extensively used for model verification, e.g., references 50, 81, 101, 112-127, 143, 174, 176-178. Such references serve as valuable supplementary material for interpretation of data.

State and City Code: MD 01

Table VIII-1. Catchments - Baltimore

No.	Name	Area ac (ha)	Sewerage	Imperviousness, %	Average Slope,%	Land Use Percentages
1	Gray Haven	23.3 (9.4)	Storm	52	0.5	Residential
2	Northwood	47.4 (19.2)	Storm	68	3	Res. 63, Com. 37

Table VII-2. Quantity Data - Baltimore

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Gray Haven	f_1	1	1	-	r_1	1	28	6/63-10/66
2	Northwood	f_1	1	1	-	r_1	1	14	3/64-9/65

f_1 - Parshall flume located in open channel. Flow measurements estimated to be within $\pm$ 5%.

r_1 - Tipping bucket gage, 0.01 in. (0.25 mm) capacity.

Time synchronization: Excellent since data recorded on same chart.

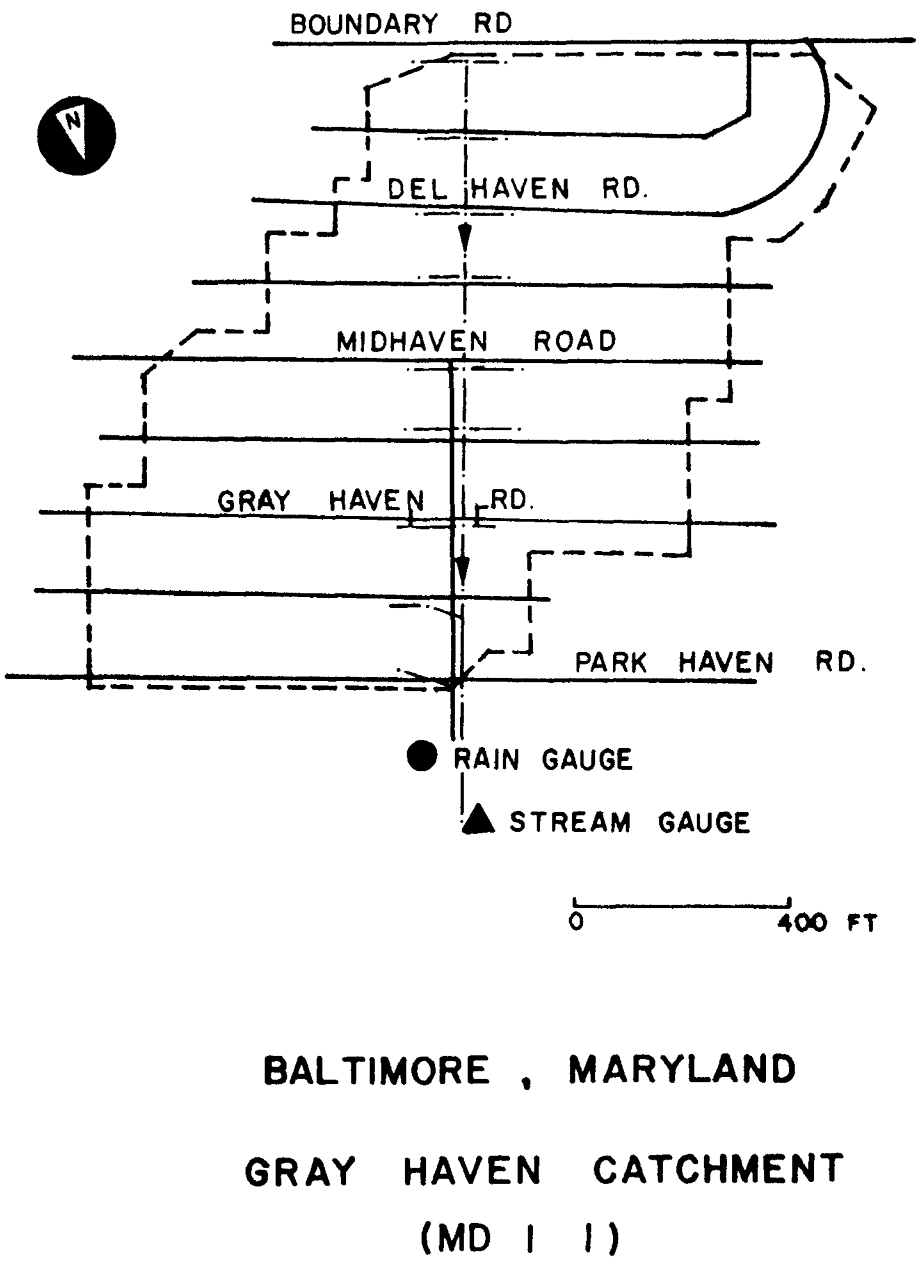
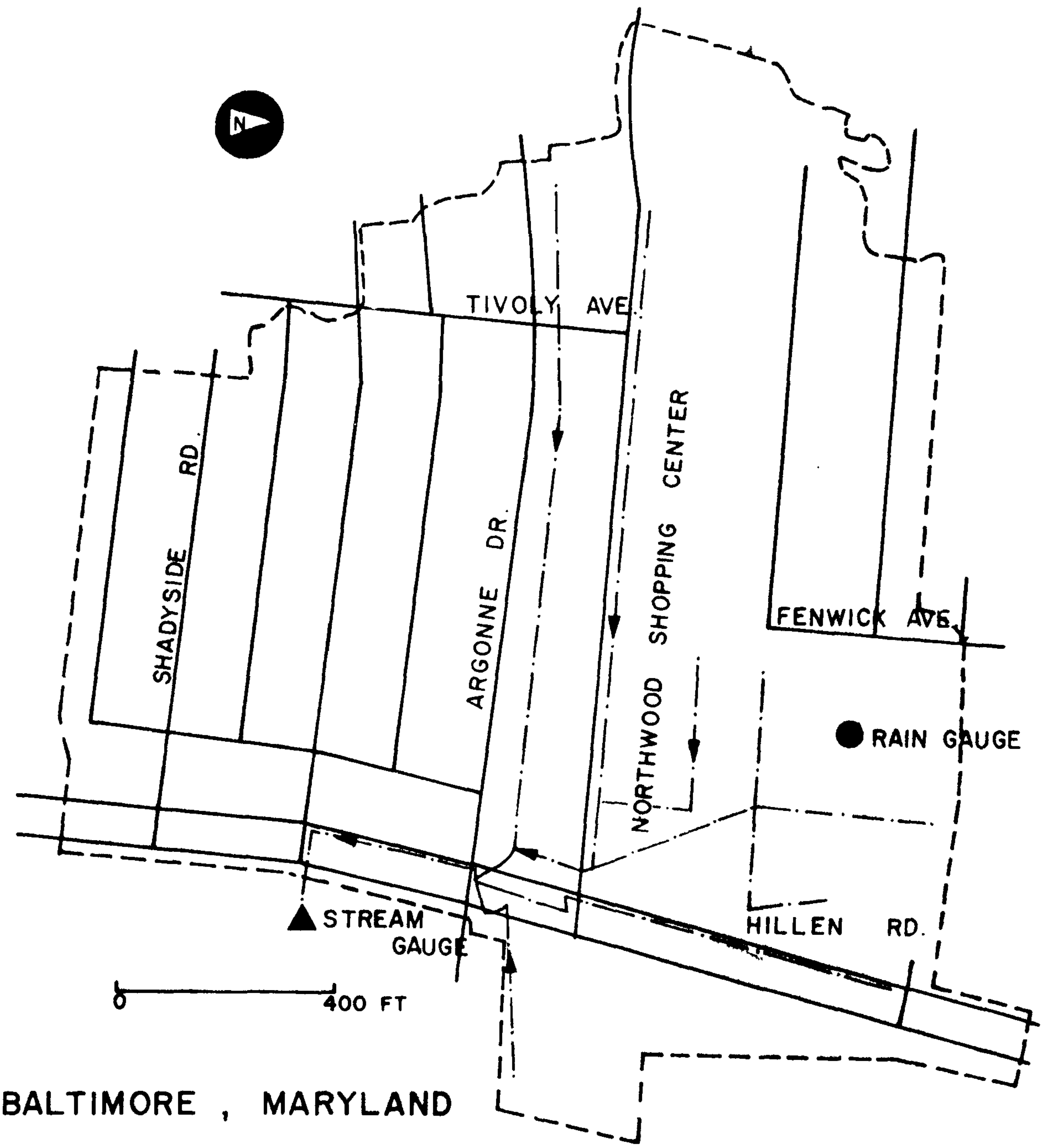


Figure VIII-1 Baltimore, Maryland, Gray Haven Catchment, 23.3 ac (9.4 ha).



BALTIMORE , MARYLAND

NORTHWOOD CATCHMENT

(MD I 2)

Figure VIII-2 Baltimore, Maryland, Northwood Catchment, 47.4 ac (19.2 ha).

CHICAGO, ILLINOIS

During the period 1959-1963, the Chicago Department of Public Works, Bureau of Engineering, collected rainfall-runoff data for the 12.9 ac (5.2 ha) Oakdale catchment, located about 6 miles (9.6 km) northwest of downtown Chicago. These data were published by Tucker (37, 40) and have been widely used for model testing, e.g., references 1, 81, 101, 112-115, 119, 125-129, 143, 174. Complete modeling data are presented by Tucker (37) to which the studies of Chow and Yen (128) and Brandstetter (1) are valuable supplements.

State and City Code: IL 01

Table VIII-3. Catchments - Chicago

No.	Name	Area ac (ha)	Sewerage	Impervious Area: Directly Connected ac(ha)	Impervious Area: Indirectly Connected ac(ha)	Pervious Area ac(ha)	No. inlet catchbasins	Land Use
1	Oakdale	12.9 (5.2)	Combined	5.15 (2.09)	0.72 (0.29)	7.05 (2.85)	30	Dense residential

Table VIII-4. Quantity Data - Chicago

No.	Catchment	Flow: Type of flow meas.	Flow: Sampling Interval, min	Rain: Gages Used: No. in Catchment	Rain: Gages Used: No. near Catchment	Rain: Type	Rain: Sampling Interval, min	No. of Storms	Period
1	Oakdale	f_1	1	-	1	r_1	1	16	5/59-9/64

f_1 - Simplex 30 in. (76cm) Type "S" parabolic flume located in vault at outlet of 30 in. (76cm) combined sewer.

r_1 - Tipping bucket gage with 0.01 in. (0.25 mm) capacity located one block north of drainage area.

Time synchronization: Good. Flow and rain data were telemetered to downtown office of Dept. of Public Works. However, time of day of start of storm is not noted, so all data are relative to start of storm.

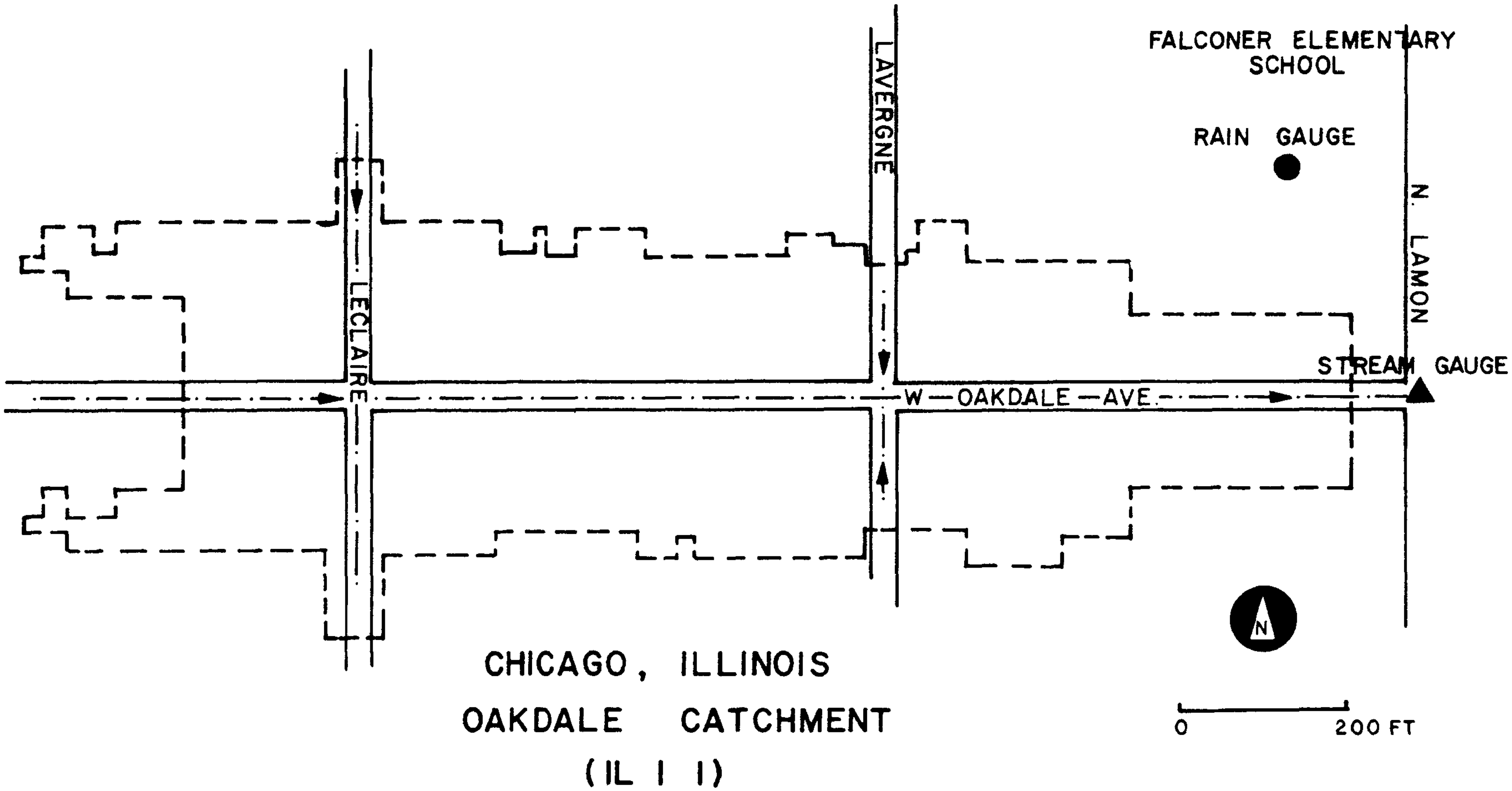


Figure VIII-3 Chicago, Illinois, Oakdale Catchment, 12.9 ac (5.2 ha).

CHAMPAIGN-URBANA, ILLINOIS

Runoff data for the Boneyard Creek catchment have been collected by the USGS since 1948. Rainfall data have been collected since 1949 by the Illinois State Water Survey in cooperation with the Department of Civil Engineering of the University of Illinois. Tucker (42) presents rainfall-stage data for 29 storms from October 1960 to August 1966. After having converted stages to flows via a rating curve and having keypunched the data, they were made available to UF through the courtesy of the Illinois State Water Survey.

The basin contains five recording gages. For 15 of the 28 storms included in the data base, a Thiessen weighted average of the five gages is given. For the remaining 13 storms, individual data for from three to five gages are given. Boneyard Creek data have been used by Stall and Terstriep for RRL and ILLUDAS model verification studies (50, 113) and by others (114, 115, 131, 142).

State and City Code: IL 02

Table VIII-5. Catchment - Champaign-Urbana

No.	Name	Area ac (ha)	Sewerage	Average Slope %	Imperviousness %	Impervious Area Land Use Percentage
1	Boneyard Creek	2290 (927)	Storm[a]	0.2	44.1	Streets 10.9, Alleys 0.9, Sidewalks 3.5, Commercial 7.0, Residential Rooftops 14.8, Campus 7.0.

[a]partially open channels.

Table VIII-6. Quantity Data - Champaign-Urbana

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Boneyard Creek	f_1	5-15	5	-	r_1	6	28	10/60-8/66

f_1 - Stage gage at concrete control. Rating curve given by Tucker (42). USGS gage ID is 3-3370.

r_1 - Weighing bucket gages with weekly charts.

Time Synchronization: Among rain gages ± 10%. Stage gage estimated to be with ± 5 min. of actual time.

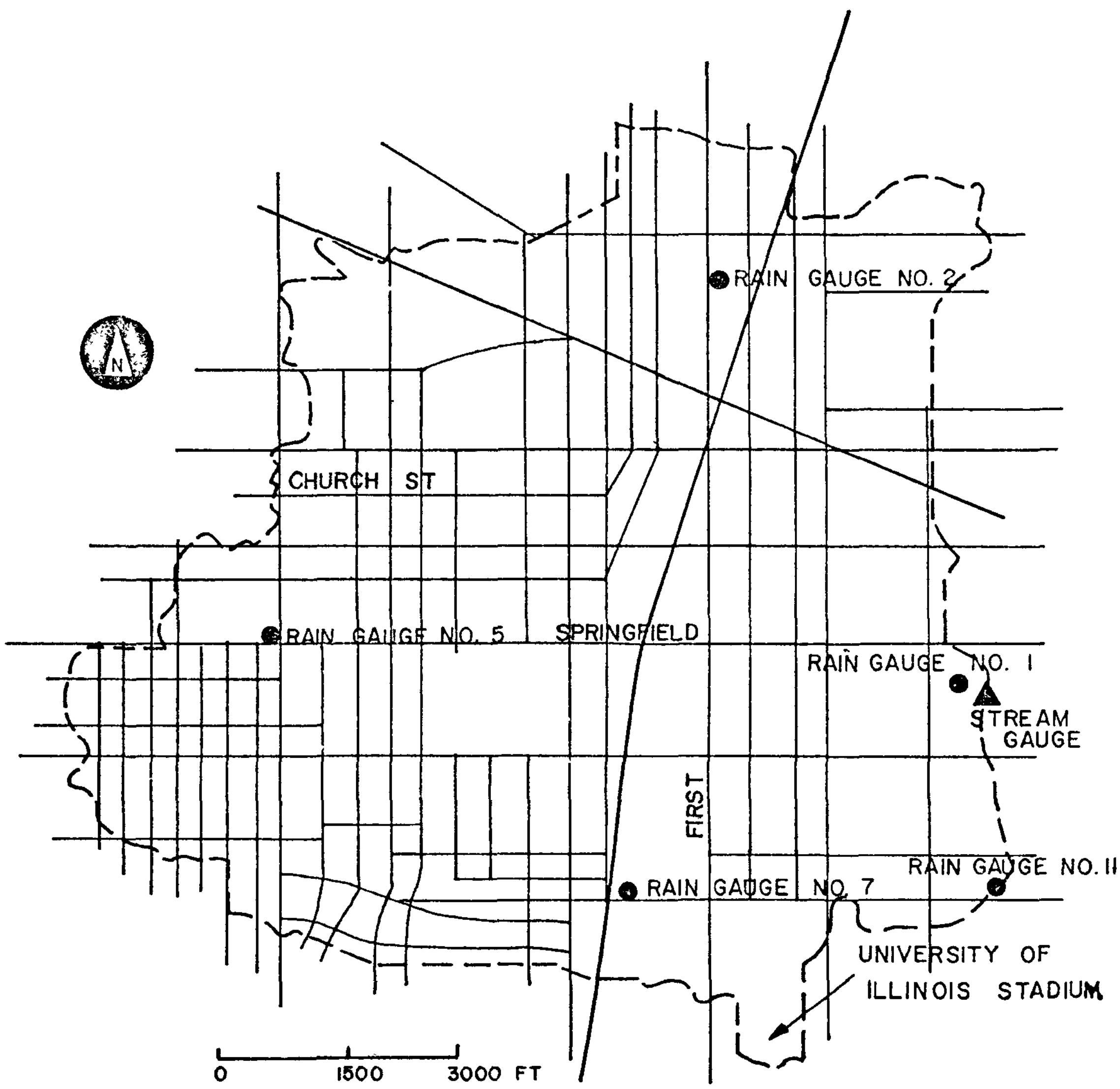
Table VIII-7. Additional Rain Gage Information - Champaign-Urbana

Gage No.	Parameter Code	Thiessen Weights		
		5 Gages	Gages 1,2,5[b]	Gages 1,2,5,11[c]
1	90049	0.15	0.40	0.20
2	90048	0.20	0.30	0.20
5	90047	0.30	0.30	0.30
7	90046	0.25		
11	90045	0.10		0.30
Average	90050[a]			

[a]Used when Thiessen average rainfall of 5 gages is given (15 storms). These data were averaged because of similar rainfall patterns.

[b]Storm of 7/13/62 has rainfall for only gages 1,2,5.

[c]Storm of 6/14/64 has rainfall for only gages 1,2,5,11.



CHAMPAIGN - URBANA , ILLINOIS
BONEYARD CREEK CATCHMENT (IL 2 1)

Figure VIII-4 Champaign-Urbana, Illinois, Boneyard Creek Catchment, 2290 ac, (927 ha).

BUCYRUS, OHIO

During 1969, Burges and Niple, Ltd. conducted combined sewer overflow studies in Bucyrus (132). Their report contains considerable information about the three sewer districts sampled, including limited quality data. Data for Sewer District No. 8 were keypunched and supplied to UF through the courtesy of the Illinois State Water Survey.

The data were used in testing the RRL and ILLUDAS models (49, 50). Terstriep and Stall (50) suggest sampling errors at high flows, i.e., high values of measured flows may be lower than their true values. In addition, the flat terrain and indeterminate drainage pattern create ponding during some storms.

State and City Code: OH 01

Table VIII-8. Catchment - Bucyrus

No.	Name	Area ac (ha)	Sewerage	Population	Average Slope, %	Imperviousness, %	Land Use Percentages
1	Sewer Dist. No.8	179 (72.5)	Combined	2020	0.85	33.7	Res. 59.6, Com. 6.3, Ind. 7.8, institutional 4.6, undev. 12.9, railroad 0.2, streets 8.6

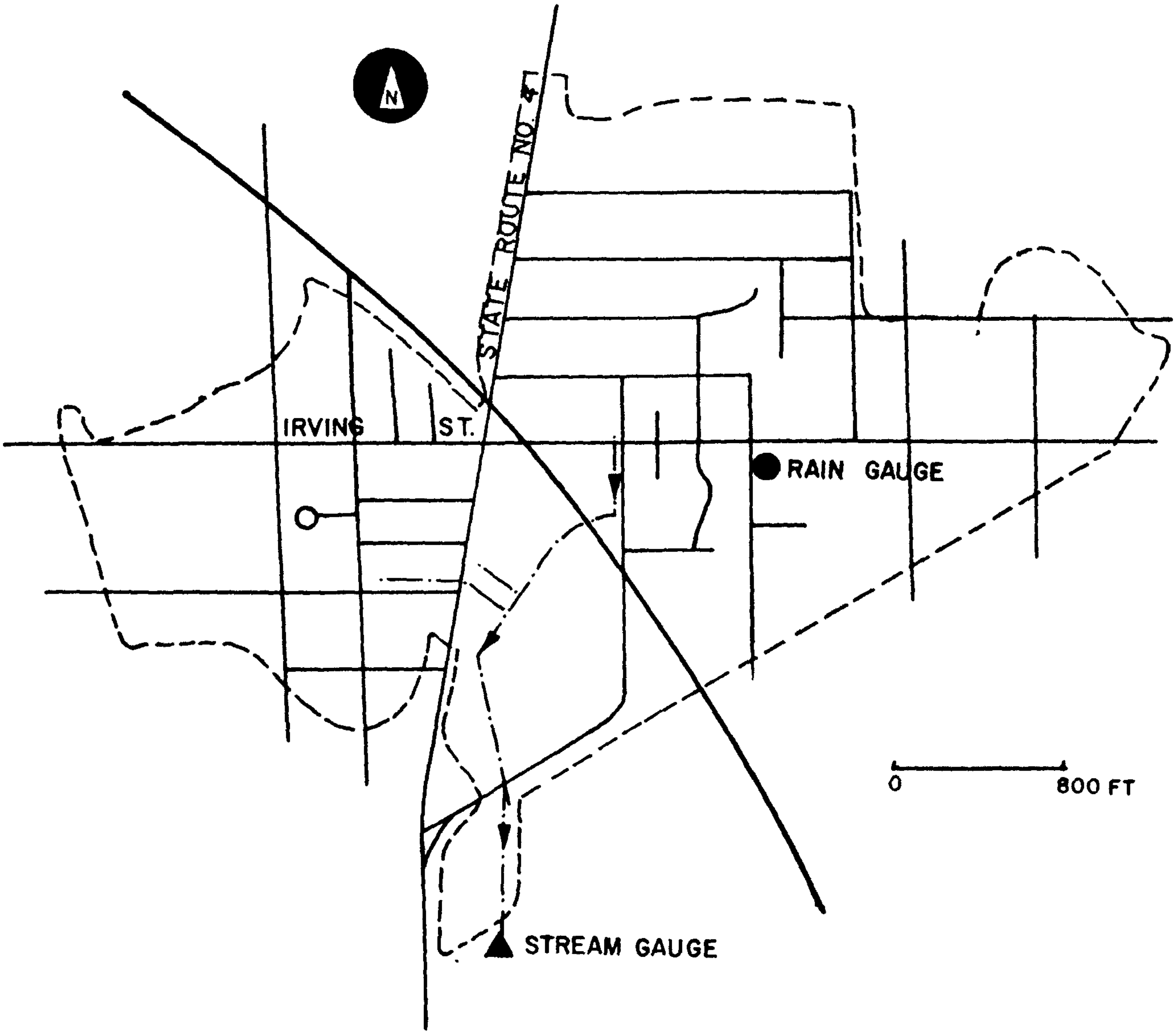
Table VIII-9. Quantity Data - Bucyrus

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Sewer District No. 8	f_1	5-15	1	-	r_1	10	10	3/69-9/69

f_1 - Stage measurements by Stevens Type-F recorder located behind 8 ft. (2.4m) rectangular weir. Readings could be made to nearest 0.01 ft. (3mm).

r_1 - Bendix weighing-bucket gage with 24 hour chart.

Time synchronization: Rain and stage gage times estimated to be within $\pm$ 2 min.



BUCYRUS, OHIO
SEWER DISTRICT NUMBER EIGHT
(OH 11)

Figure VIII-5 Bucyrus, Ohio, Sewer District Number Eight, 179 ac (72.5 ha).

FALLS CHURCH, VIRGINIA

The USGS began recording rainfall-runoff data in the residential Tripps Run Basin near Washington, D.C. in 1959. Tucker (42) reports on its characteristics and sampling program. The Illinois State Water Survey reduced original stage and rainfall records for a 326 ac (130 ha) tributary. The keypunched data were received by UF through their courtesy. A disadvantage in the data is the 0.1 in. (2.5 mm) capacity of the tipping bucket rain gage utilized. In testing the RRL and ILLUDAS models, Stall and Terstriep (49, 50) report some difficulty in obtaining good modeling information. The data have also been used in studies of the effect of urbanization on hydrographs (176, 177).

State and City Code: VA 01

Table VIII-10. Catchment - Falls Church

No.	Name	Area ac (ha)	Sewerage	Total Paved Area, %	Channel Length, mi (km)	Channel Slope	Land Use
1	Tripps Run Tributary	322 (130)	Storm	31	1.1 (1.76)	0.0193	Residential with some commercial

Table VIII-11. Quantity Data - Falls Church

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Tripps Run Tributary	f_1	5-15	1	-	r_1	10	10	3/63-10/67

f_1 - Stage measurements by a Stevens graphical recorder on a rated culvert. USGS Gage No. 1-6526.45

r_1 - Tipping bucket gage with 0.1 in. (2.5 mm) capacity.

Time synchronization: Good since rainfall and stage data recorded or same chart.

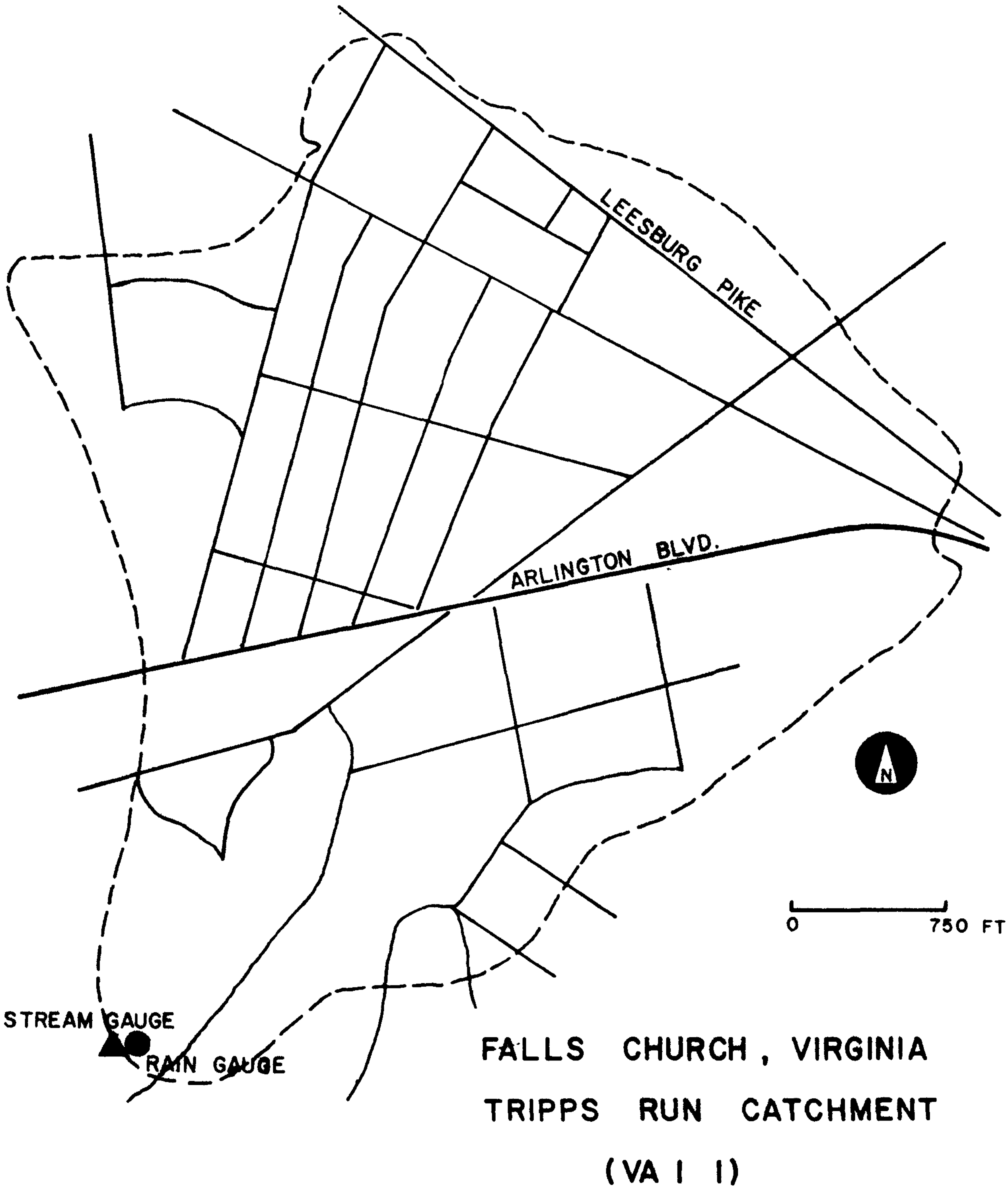


Figure VII-6 Falls Church, Virginia, Tripps Run Catchment, 322 ac (130 ha).

WINSTON-SALEM, NORTH CAROLINA

The USGS gages the 384 ac (155 ha) Tar Branch basin at Walnut Street in Winston-Salem. Keypunched rainfall-runoff data were made available to UF through the courtesy of the Illinois State Water Survey who utilized them in testing the RRL and ILLUDAS models (49, 50). The data have also been used for hydrograph analyses (171, 176). Tucker (42) provides additional information on the basin and gaging installations.

State and City Code: NC 01

Table VIII-12. Catchment - Winston-Salem

No.	Name	Area ac (ha)	Sewerage	Total Paved Area, %	Channel Length, mi (km)	Channel Slope	Land Use
1	Tar Branch	384 (155)	Storm	59	1.27 (2.03)	0.0295	Residential and business

Table VIII-13. Quantity Data - Winston-Salem

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Tar Branch	f_1	5	1	-	r_1	5	17	6/68-12/69

f_1 - Continuous stage record above a rated culvert. Fischer-Porter automatic data recorder. USGS Station no. 20115843.

r_1 - Float-type gage with punched output onto paper tape.

Time synchronization: Good since both rain and stage gage use same clock.

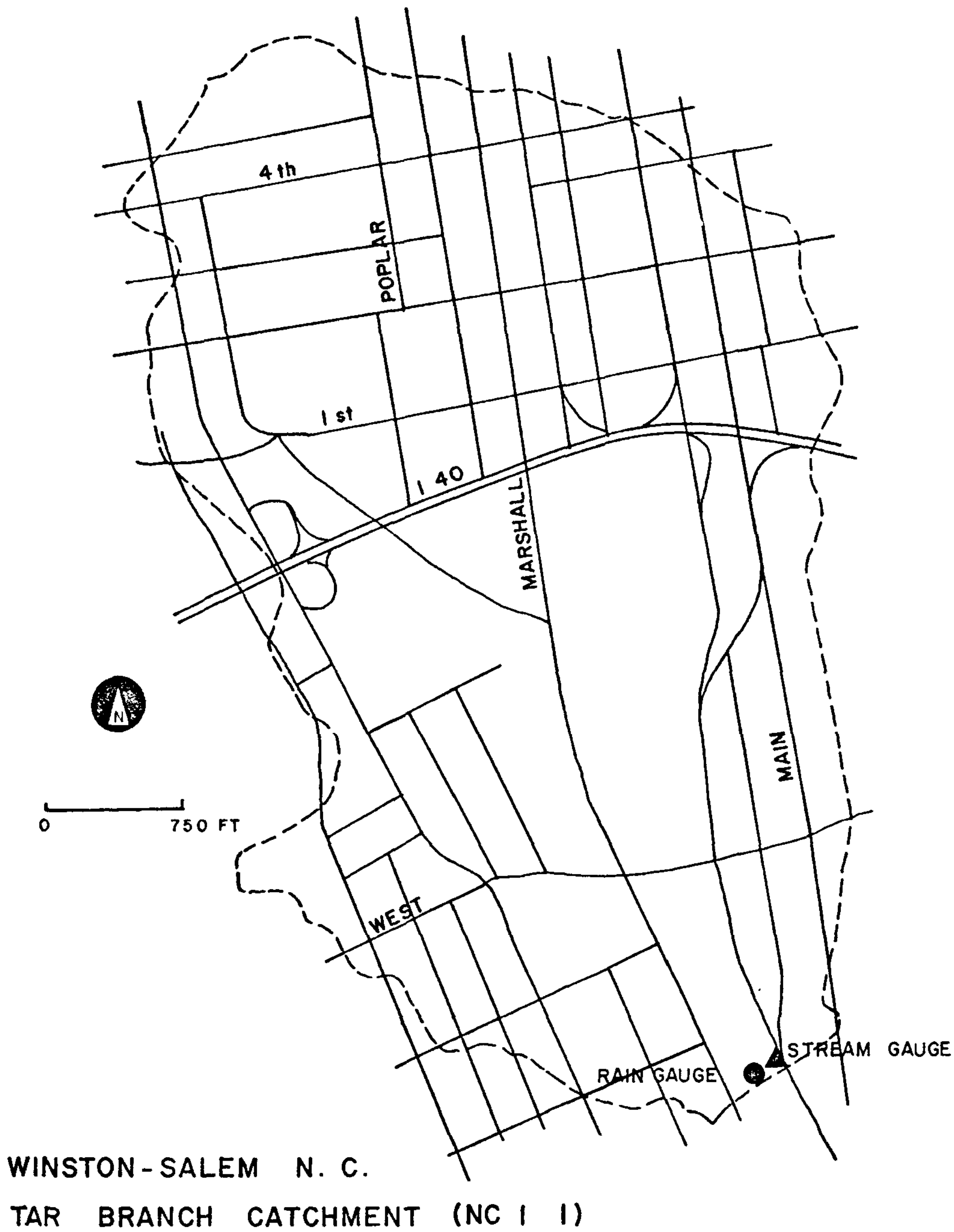


Figure VIII-7 Winston-Salem, N.C., Tar Branch Catchment, 384 ac (155 ha).

JACKSON, MISSISSIPPI

USGS data have been collected since 1965 on the residential Crane Creek basin in Jackson and utilized by the Illinois State Water Survey for RRL and ILLUDAS model verification (49, 50). Keypunched data were obtained by UF through the courtesy of the Survey. The data have also been used for unit hydrograph analyses (171) and model comparisons (172). Other information on urban runoff in Jackson is available in a USGS report by Wilson (136).

State and City Code: MS 01

Table VIII-14. Catchment - Jackson

No.	Name	Area ac (ha)	Sewerage	Total Paved Area, %	Channel Length, mi (km)	Channel Slope	Land Use
1	Crane Creek	285 (115)	Storm	24	0.8 (1.3)	0.0067	Residential

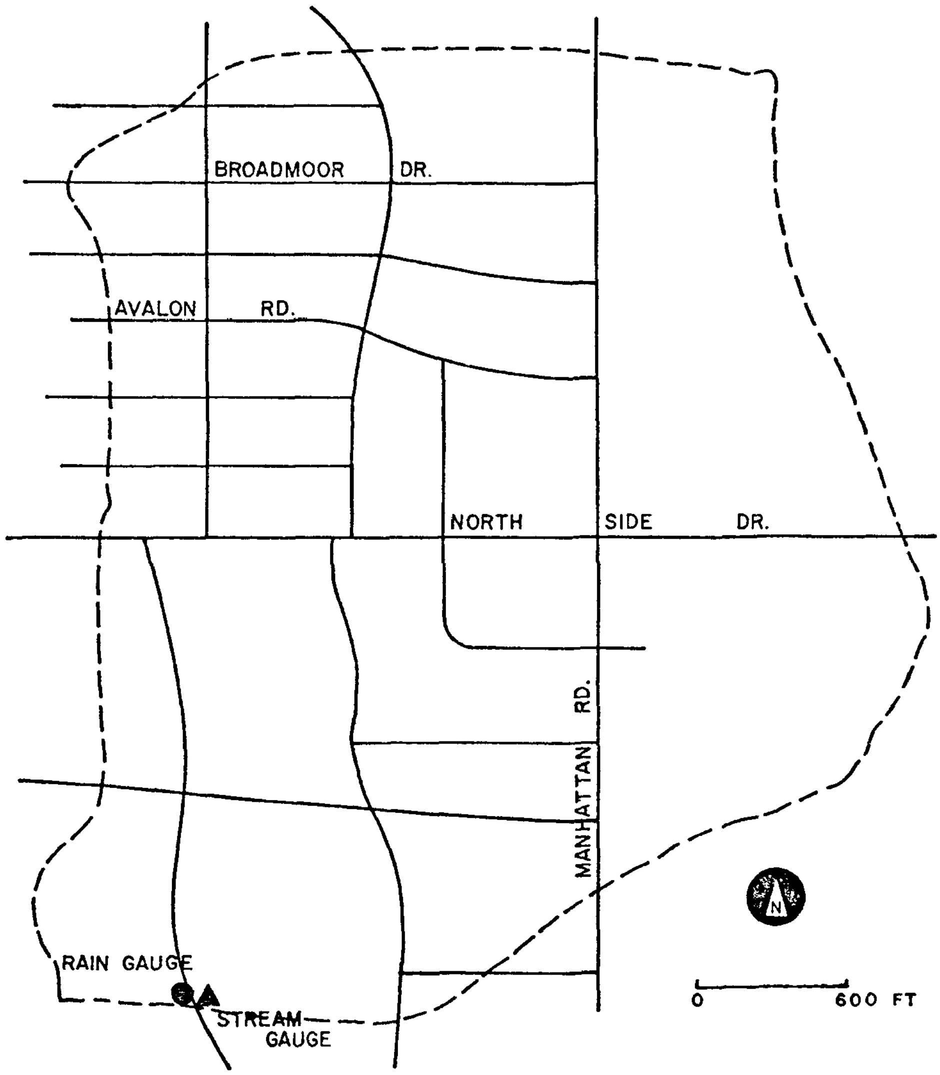
Table VIII-15. Quantity Data - Jackson

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Crane Creek	f_1	5	1	-	r_1	5	16	5/65-5/66

f_1 - Continuous stage record at a rated box culvert (Meadowbrook Dr.). Digital output on punched tape. USGS Station no. 4857.80.

r_1 - Float-type gage with punched output onto paper tape, using same clock as stage gage.

Time synchronization: Good since both rain and stage gage use same clock.



JACKSON , MISSISSIPPI
CRANE CREEK CATCHMENT
(MS I I)

Figure VIII-8 Jackson, Mississippi, Crane Creek Catchment, 285 ac (115 ha).

WICHITA, KANSAS

USGS data have been collected on the residential Dry Creek basin in Wichita and utilized by the Illinois State Water Survey for RRL and ILLUDAS model verification (49, 50). Keypunched data were obtained by UF through the courtesy of the Survey. The data have also been used for studies of hydrologic effects of urbanization in the area (179).

State and City Code: KS 01

Table VIII-16. Catchment - Wichita

No.	Name	Area ac (ha)	Sewerage	Total paved Area, %	Land Use
1	Dry Creek	1883 (762)	Storm (open channel)	31	Residential with commercial strips

Table VIII-17. Quantity Data - Wichita

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Dry Creek	f_1	5	1	-	r_1	5	8	5/64-7/65

f_1 - Continuous stage record at a rated bridge (Lincoln St.). Digital output on punched tape. USGS Gage No. 7144330.

r_1 - Float-type gage with punched output onto paper tape, using same clock as stage gage.

Time synchronization: Good since both rain and stage gage use same clock.

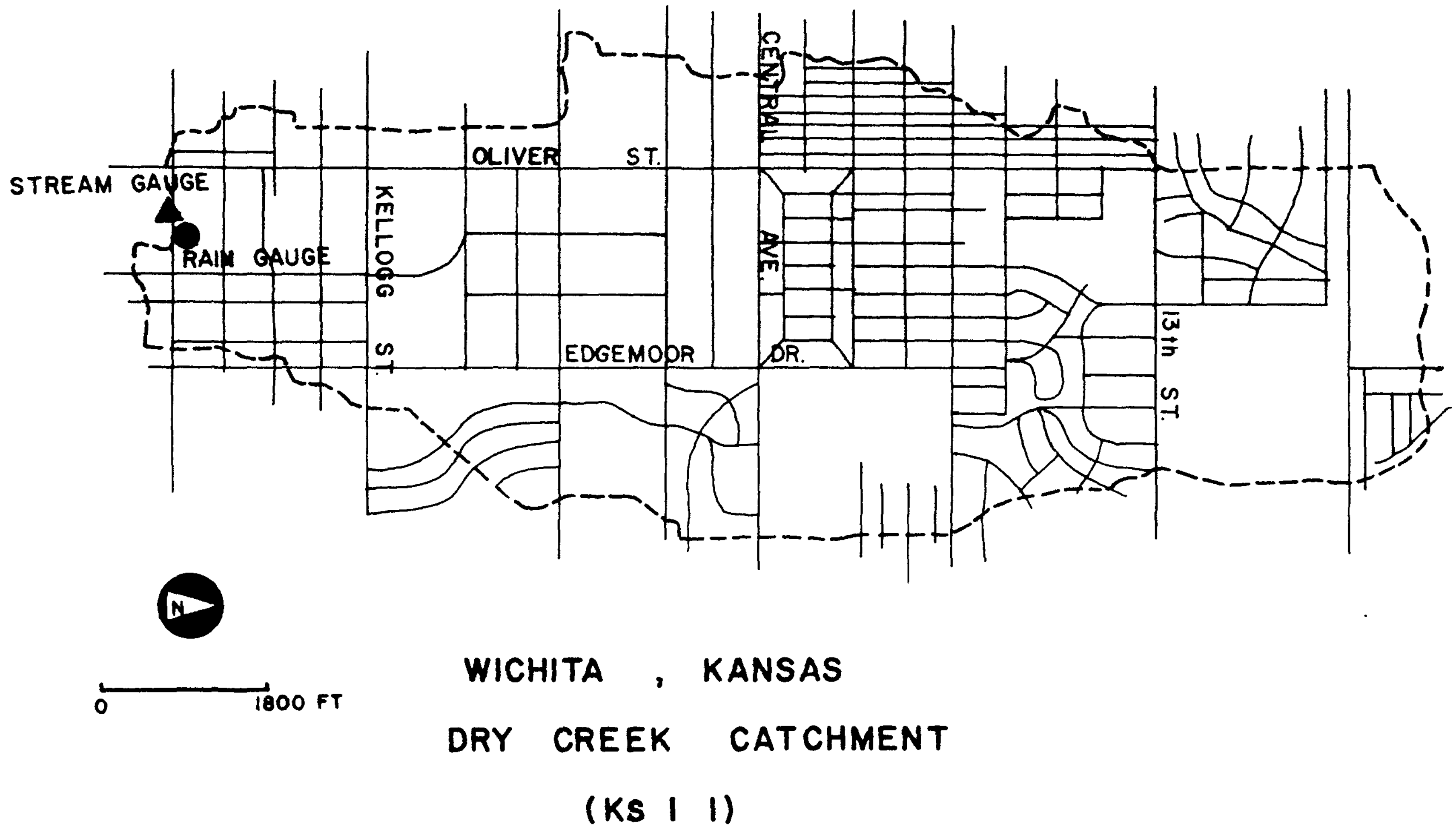


Figure VIII-9 Wichita, Kansas, Dry Creek Catchment, 1183 ac (762 ha).

WESTBURY, LONG ISLAND, NEW YORK

In connection with a larger hydrologic study in Nassau County, New York, the USGS monitored inflow from the 14.7 ac (6.0 ha) residential Woodoak Drive basin into a small recharge basin. Seaburn reports the details of the 1966-67 study (137) with further information on the flow measurement techniques (138) and related hydrology efforts in the area (139). Thus, other parameters related to the recharge basin were measured as well. The Illinois State Water Survey utilized the data for verification of the RRL and ILLUDAS models (49, 50). Keypunched data were obtained through the courtesy of the Survey.

State and City Code: NY 01

Table VIII-18. Catchment - Westbury, L.I.

No.	Name	Area ac (ha)	Sewerage	Area of Streets, %	Total[a] im-perviousness	No. Houses	Land Use
1	Woodoak	14.7 (6.0)	Storm	12	33	52	Residential

[a]Includes streets, driveways, sidewalks and roofs.

Table VIII-19. Quantity Data - Westbury, L.I.

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Woodoak	f_1	5	-	1	r_1	10	10	9/66-5/68

f_1 - Continuous stage record at a V-notch weir in 24 in. (61cm) concrete outlet pipe (only pipe in basin). Digital output on punched tape.

r_1 - Weighing bucket gage located about 900 ft. (274 m) southeast of basin.

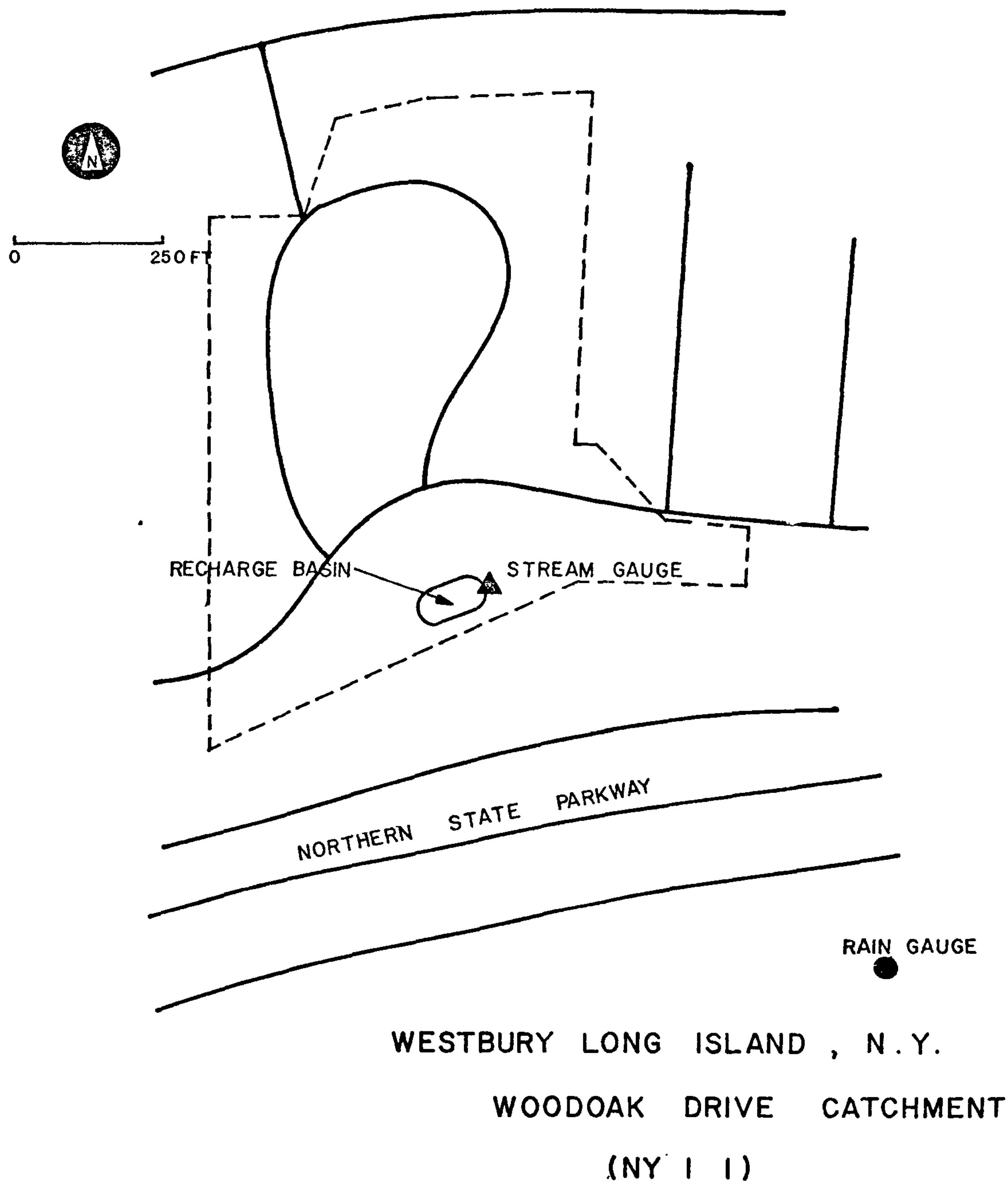


Figure VIII-10 Westbury, Long Island, New York, Woodoak Drive Catchment, 14.7 ac (6.0 ha).

PHILADELPHIA, PENNSYLVANIA

The 5326 ac (2156 ha) Wingohocking basin is Philadelphia's largest combined sewer catchment. Tucker (40) describes in detail the gaging program at Wingohocking which was initiated by the U.S. Public Health Service in 1963 and has been under the direction of the Philadelphia Water Department since 1965. Guarino, Radziul and Greene (140) discuss Wingohocking in the context of overall combined sewer problems in Philadelphia. Tucker (41) also provides additional information on the city's gaging program, plus more detailed information on the raingage network within the city (38). There are four raingages which service the Wingohocking area. Keypunched rainfall-runoff data were obtained through the courtesy of the Illinois State Water Survey who used them for RRL and ILLUDAS verification (49, 50). They indicate a possible change during 1966 in the rating curve used for flow calculations. The data have also been used for SWMM verification (102) in which some of the composited quality samples are utilized. These composited quality data are not included in the data base. SWMM input data are also given in reference 102. Additional SWMM simulations of several of the storms included in this data base have been performed by Hagarman and Dressler (141).

State and City Code: PA 02

Table VIII-20. Catchment - Philadelphia

No.	Name	Area ac (ha)	Sewerage	1960 Population	Imperviousness %	Length of Sewers, miles (km)	Land Use Percentages
1	Wingohocking	5362[a] (2171)	Combined	173,000	75	45 (72)	Single Family Res. 84.2, Multi-Family Res. 9.0, Open 6.8

[a] Reference 40. Reference 102 gives 5432 ac (2199 ha) and references 49 and 50 give 5326 ac (2156 ha).

Table VIII-21. Quantity Data - Philadelphia

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Wingohocking	f_1	15	2	3	r_1	5	12	7/67-8/68

f_1 - Depth measurements 450 ft (137 m) upstream from calibrated (physical model) broad-crested weir, which is 87 ft (27 m) upstream from 21 by 24 ft (6.4 by 7.3 m) horseshoe-shaped combined sewer outfall. Continuous depth record on strip chart from Pro-Tech model SM-205 depth recorder. Note: Given flows are overflows over weir. See Table VIII-23 for estimate of diversion into interceptor upstream of weir. Dry weather flow estimated to be about 30 cfs (0.86 m^3/sec).

r_1 - Weighing type with minimum scale divisions of 5 min. See Table VIII-22 for further information.

Time Synchronization: Rain gage network estimated to be within ± 5 min of clock time. Variation in 1 in/hr (2.5 cm/hr) speed of depth gage strip chart may lead to variations with clock time greater than 5 min.

Table VIII-22. Additional Rain Gage Information - Philadelphia
See also reference 38.

Gage No.	City Gage No.	Name	Parameter Code	Approximate Elev. ft (m)		Thiessen Weight
1	18	Roosevelt	90050	300	(91)	0.58
2	8	Heinz	90049	140	(43)	0.12
3	17	Queen Lane	90048	220	(67)	0.15
4	7	Harrow Gate	90047	80	(24)	0.15
5	20	Shawmont[a]	90046			

[a]Located to west of catchment. Data also included in data base.

Table VIII-23. Estimated Interceptor Diversions - Philadelphia

The maximum capacity of the 102 in. (259 cm) interceptor is 270 cfs (7.7 m^3/sec). It also may receive up to 150 cfs (4.3 m^3/sec) from an upstream 60 in. (152 cm) pipe. Actual diversion through interceptor will depend upon storm pattern. However, in reference 102, the following estimates are given.

Total Flow (Diversion plus Overflow) cfs	(m^3/sec)	Estimated Diversion cfs	(m^3/sec)
0 - 500	(0 - 14.2)	Up to 200	(5.7)
500 - 1000	(14.2 - 28.3)	150	(4.3)
1000 - 1500	(28.3 - 42.5)	100	(2.8)
1500	(42.5)	50	(1.4)

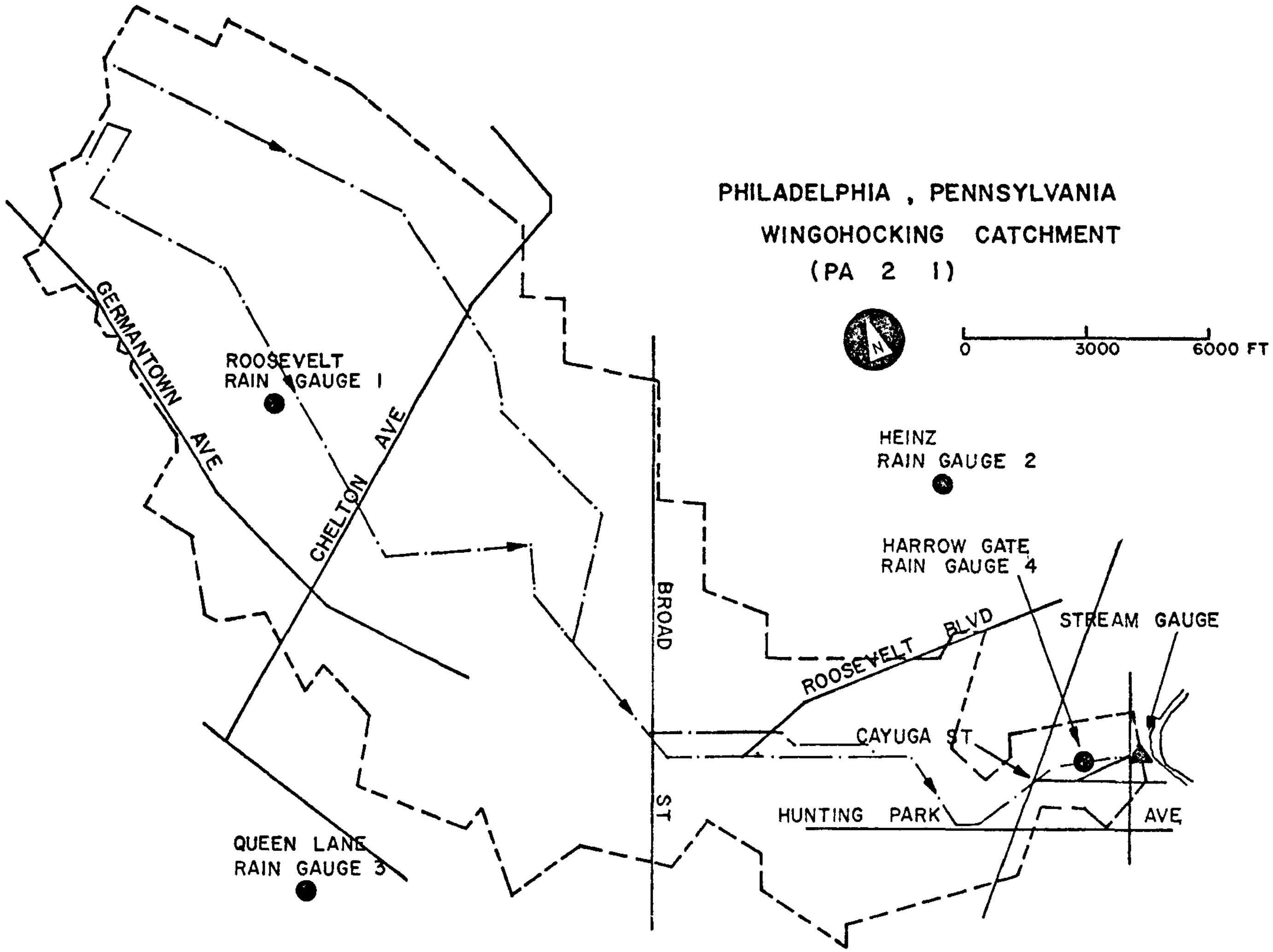


Figure VIII-11 Philadelphia, Pennsylvania, Wingohocking Catchment, 5362 ac (2171 ha).

LOS ANGELES, CALIFORNIA

The 252 ac (102 ha) Echo Park basin is a steep, residential catchment in north central Los Angeles. Copies of strip chart records of rainfall and runoff from 1954 to 1974, plus considerable catchment and other information, were received by UF directly from the City of Los Angeles, Department of Public Works, Bureau of Engineering. For purposes of the data base, reduced keypunched data were also obtained through the courtesy of the Illinois State Water Survey who used them for RRL and ILLUDAS model verification (49, 50). The HSP model has also been applied to this basin (142) during which it was estimated that measured flows could be in error by more than 20 percent due to uncertainty in the roughness and the supercritical flow velocities in the sewer. Terstriep and Stall (50) also point out that for a basin this steep, rainfall resolution at intervals less than 4 minutes would be desirable, but the 24-hour rain gage charts do not permit it.

State and City Code: CA 02

Table VIII-24. Catchment - Los Angeles

No.	Name	Area ac (ha)	Sewerage	Imperviousness, % 1956	Imperviousness, % 1970	1973 Population	Land Use
1	Echo Park	252 (102)	Storm	49.5	53.8	2850[a]	Residential with some commercial

[a]Estimate using population density of larger Echo Park District of Los Angeles.

Table VIII-25. Quantity Data - Los Angeles

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Echo Park	f_1	2 - 10	1	-	r_1	4	18	2/58-12/70

f_1 - Rating curve from Manning equation (n=0.013, slope = 0.018) in 51 in. (130 cm) concrete arch storm sewer. Stage records on Stevens Type L recorder with 24 hr chart.

r_1 - Weighing bucket gage with 24 hr chart.

Time Synchronization: Possible errors due to separate clocks on rain and stage gages.

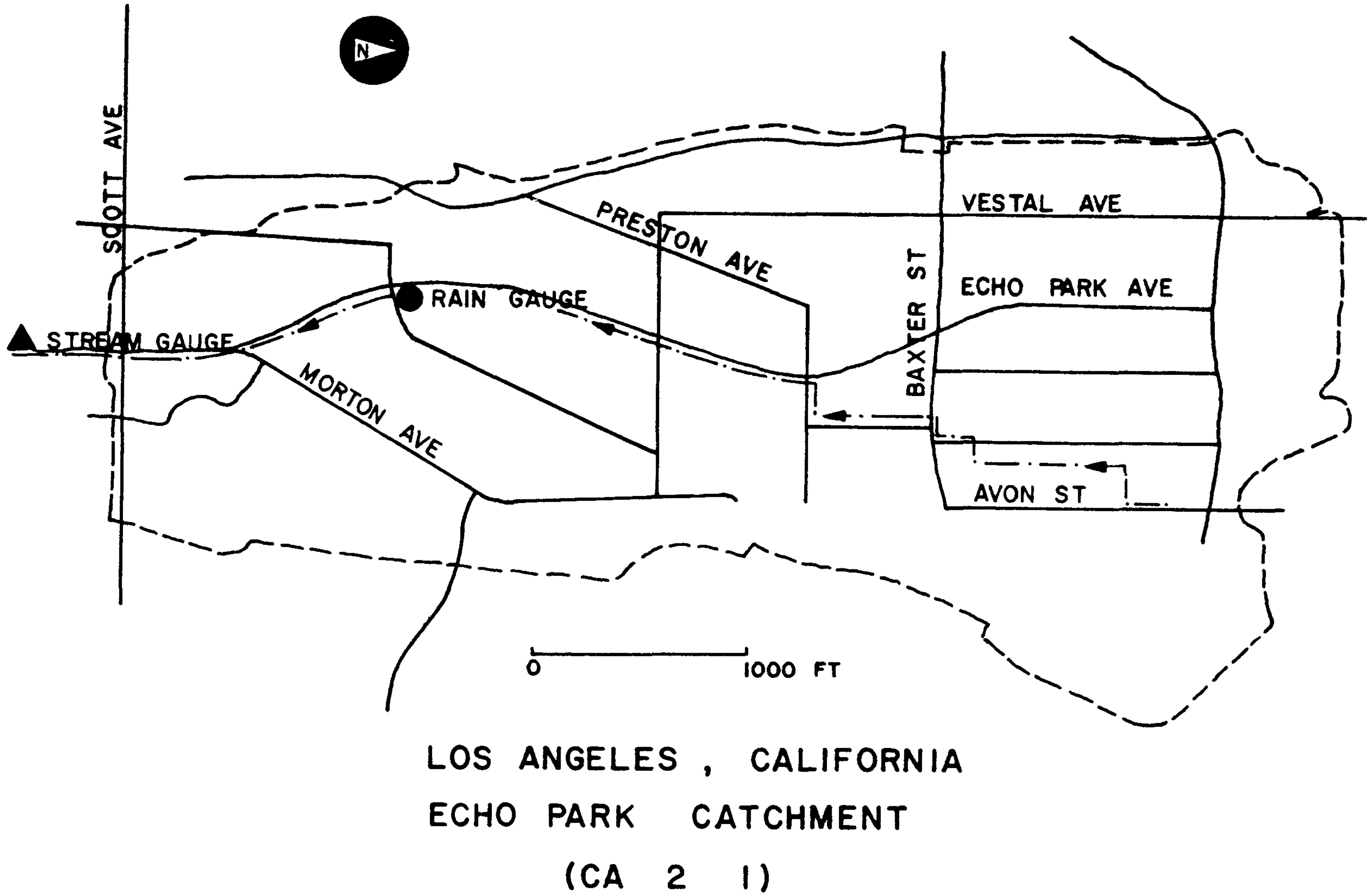


Figure VIII-12 Los Angeles, California, Echo Park Catchment, 252 ac (102 ha).

PORTLAND, OREGON

The City of Portland, Department of Public Works has collected rainfall-runoff data at the 75 ac (30 ha) residential Eastmoreland catchment since early 1975. More recently, 24 rain gages and 14 sewer monitors have been installed around the city, which are sampled at 15 second intervals and output stored on magnetic tapes. In addition, EPA Section 208 quality sampling programs have been initiated on the Eastmoreland catchment and four others. Data from these may be included in the data base at a future date.

Eastmoreland rainfall-runoff data have been used to calibrate an urban runoff model developed for the City of Portland (163). Additional information on the catchment is included therein.

State and City Code: OR 01

Table VIII-26. Catchment - Portland

No.	Name	Area ac (ha)	Sewerage	Average Slope	Population Density, persons/ac (persons/ha)	Land Use
1	Eastmoreland	75 (30)	Combined	0.04	18.2 (45)	Single family res.

Table VIII-27. Quantity Data - Portland

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Eastmoreland	f_1	0.75	0	1	r_1	0.25	24	3/75-8/75

f_1 - Brooks magnetic flow meter in 21 in. (53cm) C.S.P. (slope 0.10). Values logged on Metro data 616 Data Logger at 15 sec intervals whenever flow is greater than 1.0 cfs (0.028 m^3/sec). See Table VIII-28 for dry weather flow and infiltration information.

r_1 - Weather Measure No. P-501 tipping bucket rain gage with 0.01 in. (0.25 mm) bucket capacity. Interregated for number of tips every 15 seconds. Data base tape stores time and cummulative total (code number 90040) to avoid computing intensities over odd time intervals.

Time synchronization, rainfall-flow: Excellent since both records are recorded using same clock.

Table VIII-28. Dry Weather Flow and Infiltration Information - Portland

Average daily DWF for the Eastmoreland area has been measured at approximately 0.1 cfs (0.003 m^3/sec). This corresponds roughly to 50 gal/day per capita (0.19 m^3/day per capita). Infiltration into the system is minimal and of the same order of magnitude as the average DWF. Hourly correction factors for DWF (excluding infiltration) have been determined and are given below.

Hour	Correction Factor[a]
0	1.0
1	0.6
2	0.3
3	0.2
4	0.1
5	0.1
6	0.1
7	0.6
8	0.5
9	0.6
10	0.4
11	0.4
12	1.3
13	1.1
14	1.0
15	0.95
16	0.95
17	1.1
18	1.2
19	1.4
20	1.7
21	1.6
22	1.5
23	1.3
	24.0

[a]Multiply by average DWF to get value at each hour. These values have been adjusted slightly from data supplied by city so that they sum to 24.0.

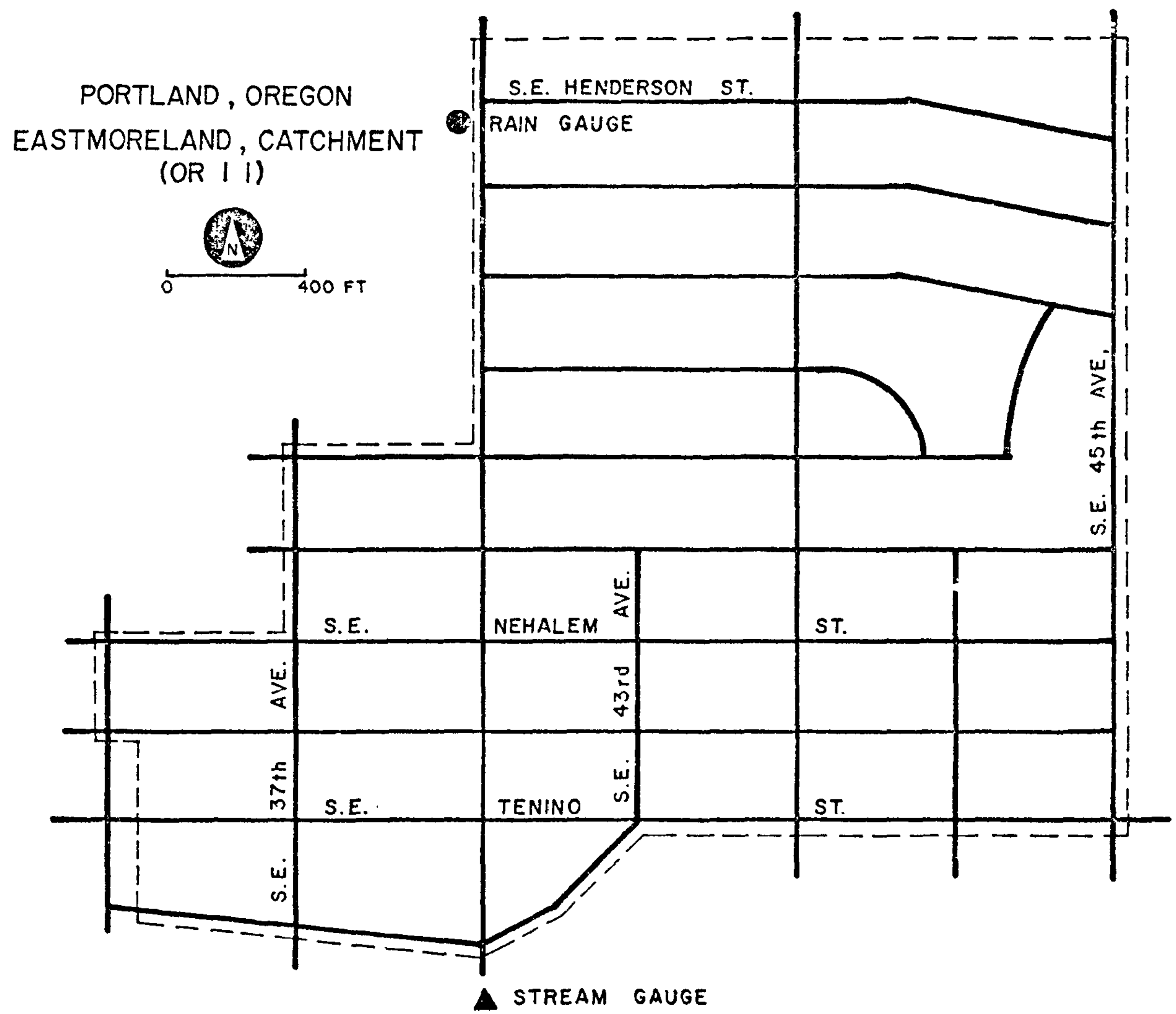


Figure VIII-13 Portland, Oregon, Eastmoreland Catchment, 75 ac (30 ha).

HOUSTON, TEXAS

In cooperation with the City of Houston, the USGS initiated collection of urban rainfall-runoff data at more than 20 sites in 1964. Annual reports have been published (e.g., 164, 165) containing catchment information and detailed results (i.e., hyetographs and hydrographs) from several storm events at several sites. Unfortunately, all but the latest reports are out of print and available only for short-term loan from the Houston offices of the USGS.

The data have been used in studies of the effect of urbanization in the Houston area (e.g., 166, 167). Data from Hunting Bayou have been used for ILLUDAS model calibration (50). Data from several Houston catchments along with many others were used by Brater and Sherrill (168) to develop unit hydrograph parameters. Keypunched data for the four catchments included herein were obtained from this latter study. Similar studies in urban hydrology are underway in Austin and Dallas.

The quality of these data are good. The measurements are carefully conducted, and the annual reports (164, 165) give a detailed time history of each storm. Quality sampling at several locations is now underway as a part of EPA 208 studies.

It is anticipated that quality data from the Woodlands project (80, 169) north of Houston will be included in addenda to the data base. Extensive quality data have been gathered; they await complete computerization before they can be transmitted to UF.

State and City Code: TX 01

Table VIII-29. Catchments - Houston

No.	Name	Area, ac (ha)	Sewerage	1960 Population Density, persons/ac (persons/ha)	Imperviousness,[e] %		Storm Sewered Area, %	Main Channel Slope	Drainage[g] Density mi/mi^2 (km/km^2)	Land Uses
1	Hunting Bayou at Cavalcade St. (USGS Gage 80757.5)	768[a] (311)	Storm[d]	12.9 (31.6)	27	29				Res. approx. 50%, plus com., ind., hwy.
2	Hunting Bayou at Falls St. (USGS Gage 80757.6)	2509[b] (1016)	Storm[d]	10.5 (26.0)	20	21	14	0.00167	2.61 (1.63)	Res. approx. 70%, plus com., ind., hwy.
3	Bering Ditch at Woodway Dr. (USGS Gage 80738.0)	1894[c] (767)	Storm[d]	6.9 (17.1)	17	27[f]	68	0.00066	3.20 (2.00)	Res. approx. 70%, plus com., ind.
4	Berry Creek at Galveston Rd. (USGS Gage 80757.0)	3110 (1259)	Storm[d]	2.9 (6.0)	8	9	18	0.00114	2.11 (1.32)	Res., com., open

[a]Tributary to (basin contained in) Hunting Bayou at Falls St. Area prior to June 1, 1970, 659 ac (267 ha)

[b]Prior to October 1, 1973, 2240 ac (907 ha); prior to June 1, 1970, 2189 ac (886 ha).

[c]Prior to June 1965, 1773 ac (718 ha); June to Sept. 1965, 1658 ac (671 ha); Oct. 1965 to May 1967, 1722 ac (697 ha); June 1967 to March 1969, 1754 ac (710 ha). New drainage areas due to road construction.

[d]Mostly open channel drainage, heavily vegetated.

[e]First value, October 1964, second value, March 1969.

[f]Value of 22%, February 1967.

[g]Includes all open channels, ditches and storm sewers $\geq$ 36 in. (91 cm).

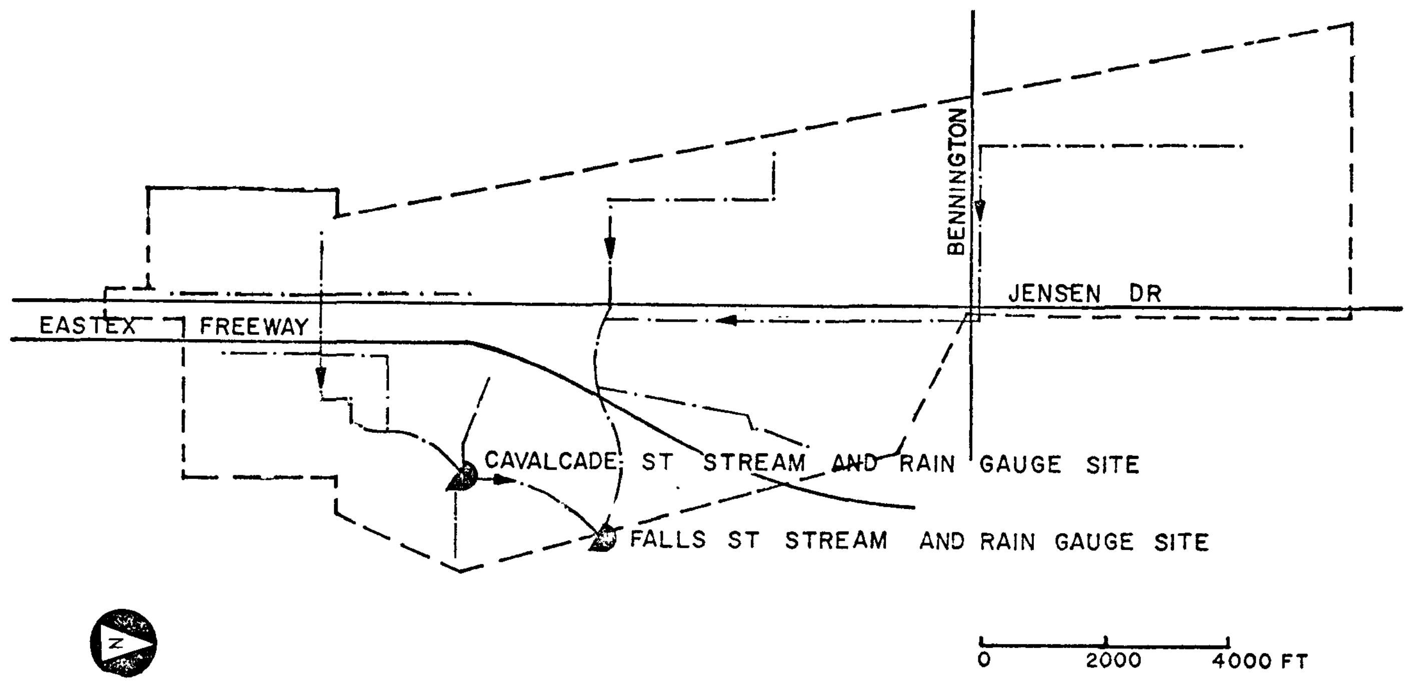
Table VIII-30. Quantity Data - Houston

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Hunting Bayou at Calvalcade St.	f_1	15-60	1	2	r_1	10-60	8	5/65-9/68
2	Hunting Bayou at Falls St.	f_1	15-60	2	1	r_1	10-60	11	5/65-11/69
3	Bering Ditch at Woodway Dr.	f_1	15-60	1	-	r_1	10-60	10	12/64-9/68
4	Berry Creek at Galveston Rd.	f_1	15-60	1	2	r_1	10-60	10	11/64-9/68

f_1 - Stage measurements with stage-discharge rating curve.

r_1 - USGS Type SR continuous rain gage.

Time synchronization, rain-flow: Good, since most storms utilize rainfall data measured at same location as flow.



HOUSTON , TEXAS
HUNTING BAYOU SUBCATCHMENTS
CAVALCADE ST (TX 1 1) FALLS ST (TX 1 2)

Figure VIII-14 Houston, Texas, Hunting Bayou at Cavalcade St. Catchment, and Hunting Bayou at Falls St. Catchment, 768 ac (311 ha).

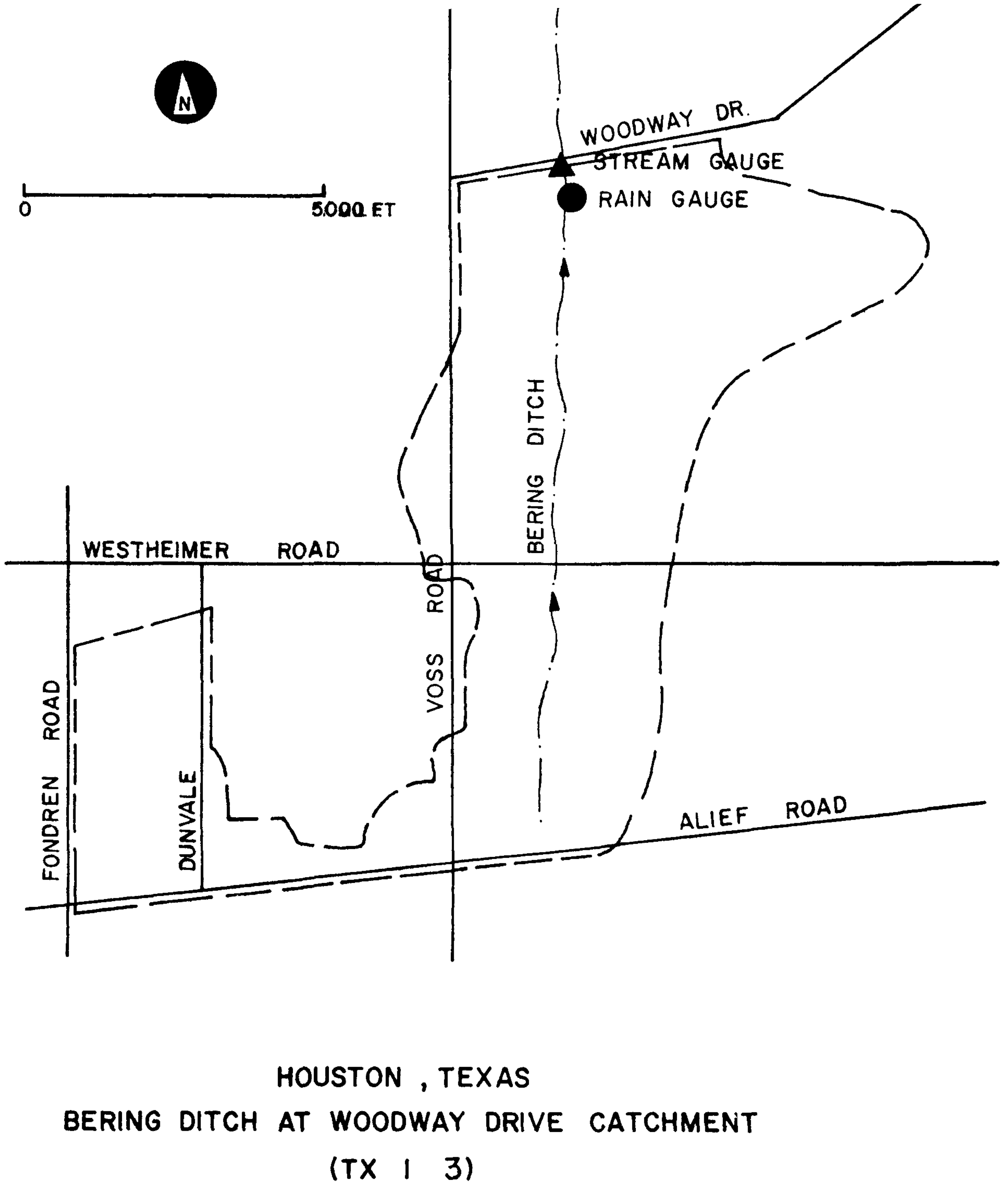


Figure VIII-15 Houston, Texas, Bering Ditch Catchment, 1894 ac (767 ha).

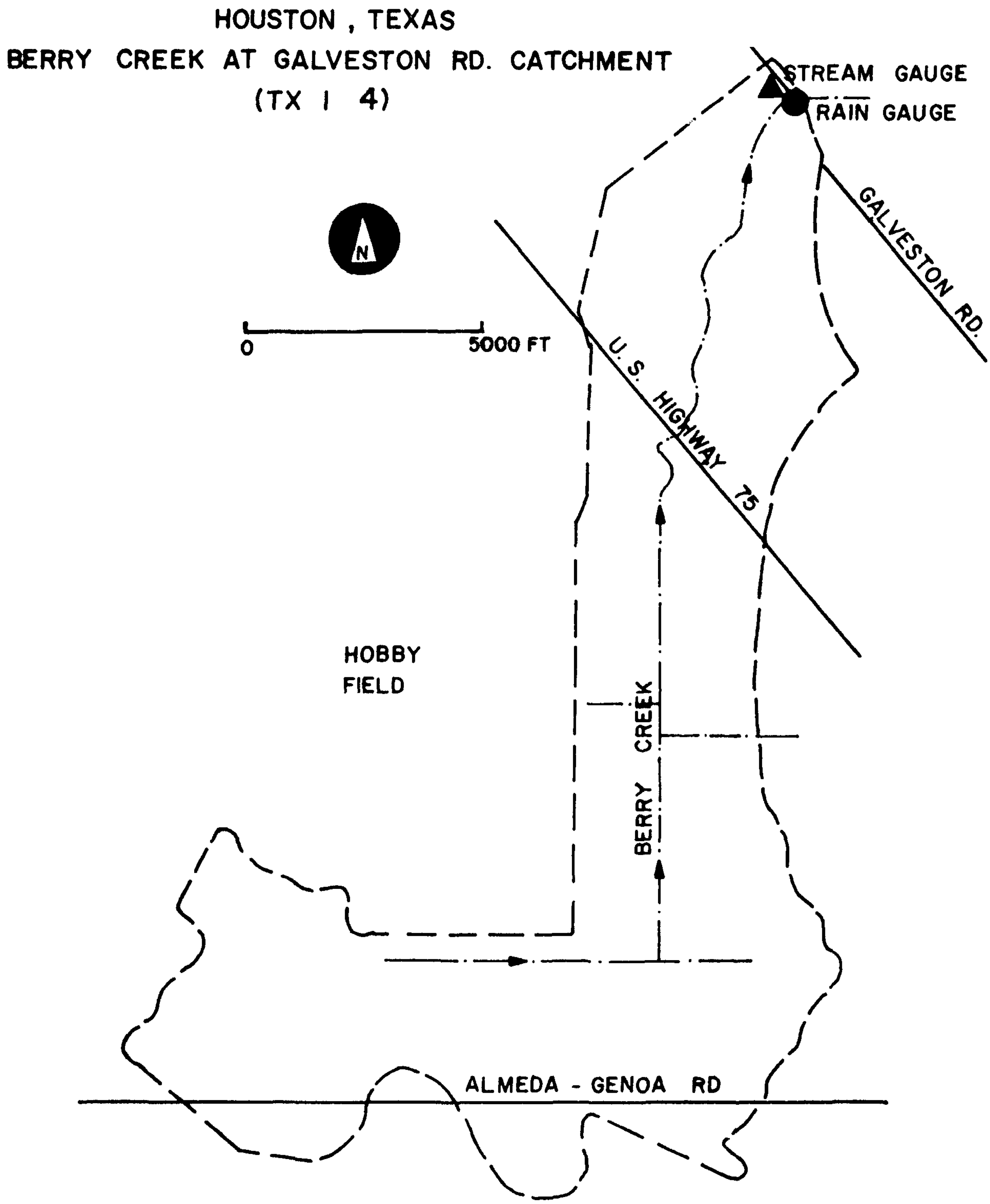


Figure VIII-16 Houston, Texas, Berry Creek Catchment, 3110 ac (1259 ha).

SALT LAKE CITY, UTAH

Through a contract between the Federal Highway Administration and Utah State University, (contract number DOT-FH-11-7806), quantity data were gathered during rainfall seasons in 1972 and 1973 on two urban highway cross-sections in the Salt Lake City area.

In addition, minimum and maximum temperatures and wind speeds for each runoff event were measured along with antecedent soil moisture levels for several runoff events in 1973. These data are included in tabular form in this report.

Further information on this study (along with the information contained herein) can be found in the final report(159). The data were taken directly from the report and keypunched by the University of Florida.

State and City Code: UT 01

Table VIII-31 Catchments - Salt Lake City

Number	Name	Area, ac (ha)	Sewerage	Soil Type	Land Use
1	Layton (Hwy) (Near Gentile Street on I-15)	1.35 (0.55)	Storm[a]	Well aggregated clay loam	Roadway (impervious) and sideslope paved or grassed (crested wheat grass)[b].
2	Parleys Canyon I (Hwy) (33rd South Street and I-215)	0.54 (0.22)	Storm[a]	Sandy loam with some silty clay lenses of very loose, poorly aggregated structure.	Drainage from a sideslope to a gutter.
3	Parleys Canyon II (33rd South Street and I-215)	0.55 (0.22)	Storm[a]	Sandy loam with some silty clay lenses of very loose, poorly aggregated structure.	Drainage from a roadway (4 traffic lanes) to a curb and gutter[b].

[a] Open channel, roadside drainage.

[b] See Figures VIII-18 and VIII-19

Table VIII-32 Quantity Data - Salt Lake City

		Flow		Rain					
				Gages Used					
No.	Catchment	Type of flow meas.	Sampling Interval, min	No. in Catchment	No. near Catchment	Type	Sampling Interval, min	No. of Storms	Period
1	Layton (Hwy)	f_1	1 - 60[a]	7	6	r_1 (7 gages)	2[b]	23	9/72-11/73
						r_2 (6 gages)	Days[c]		
2	Parleys Canyon I (Hwy)	f_1	1 - 60[a]	4	9	r_1 (7 gages)	2[b]	42	8/72-10/73
						r_2 (6 gages)	Days[c]		
3	Parleys Canyon II (Hwy)	f_2	1 - 60[a]	4	9	r_1 (7 gages)	2[b]	42	8/72-10/73
						r_2 (6 gages)	Days[c]		

f_1 - 90° bobbed tailed cutthroat flume. Calibrated in laboratory. Stage measured using a Belfort 5-FW-1 level recorder.

[a] Flow monitored continuously, data reduced to varying time increments.

[b] Rainfall monitored continuously for Belfort gages, data reduced to varying time increments.

[c] Rainfall measured with Truchek gages at the time the gages were serviced (various days).

f_2 - 2 foot, acute angled, V-notched cutthroat flume. Water level is sensed with a helical wound electrical depth sensor and remotely recorded on an Esterline Angus minigraph recorder.

r_1 - Belfort 5-780 dual traverse, 6 inches per traverse, weighing recording gage.

r_2 - Weather Measure model P567, 6-inch capacity Truchek rain gages.

Table VIII-33 Minimum and Maximum Temperature During Runoff Events, Winds, and Wind Direction - Layton Site

	Runoff Time		Temperature, °F[b]		Wind		
					Speed, miles/hr[c]		
Date	Start	End	Max.	Min.	Max.	Min.	Direction
1972							
5 Sept.	5:28P	9:40P	71	60	7	1	NE
19 Sept.	2:08A	4:10A	65	46	NR	NR	NR
5 Oct.	7:56A	10:00A	46	44	3	0	NE
9 Oct.	1:55A	2:50A	52	44	2	0	S
20 Oct.	3:16A	10:00A	44	38	3	0	W
20 Oct.	4:16P	6:52P	54	41	5	2	E
23-24 Oct.	9:52P	1:40A	57	27	3	0	E
28-29 Oct.	9:50P	1:12A	29	29	10	3	NNE
4-5 Nov.	-	-			7	0	NNE
1973							
17 April	8:22A	11:52A	NR[a]	NR	5	2	N
17 April	12:42P	3:58P	NR	NR	5	3	N
28 April	5:38P	7:51P	NR	NR	NR	NR	NR
29 April	8:46A	2:21P	60	54	NR	NR	NR
25 May	5:53A	7:53A	59	57	2	0	NE
25 May	10:03A	2:43P	61	56	2	0	NE
25 May	7:52P	11:44P	52	51	3	2	S
26 May	12:04A	4:29A	50	48	3	0	E
18 July	6:46P	7:53P	76	68	32	5	SSW
19 July	12:13P	6:33P	74	68	10	0	NW
2 Sept.	12:41A	7:53A	32	29	10	2	SW
8 Sept.	12:33A	9:00A	39	35	NR	NR	NR
23 Sept.	9:14A	4:21P	50	32	17	0	NW
18 Nov.	7:40A	5:54P	46	28	10	0	S to NE

[a]Note: NR implies no record
[b]Note: °C = 5/9(°F-32)
[c]Note: 1 mile/hr = 0.477 m/sec

Table VIII-34 Minimum and Maximum Temperature During Runoff Events, Winds, and Wind Direction - Parleys Site

Date	Runoff Time		Temperature, °F[b]		Wind		
					Speed, miles/hr[c]		
	Start	End	Max.	Min.	Max.	Min.	Direction
1972							
13 Aug.	8:46P	9:00P	NR[a]	NR	NR	NR	NR
2 Sept.	9:02P	9:48P	NR	NR	9	2	SSW
5 Sept.	8:24A	9:03A	60	58	3	2	SSE
5 Sept.	10:59A	3:07P	54	52	7	4	NE
5 Sept.	3:07P	4:00P	54	52	7	4	NE
19 Sept.	1:40A	3:50A	56	52	5	3	NNE
19 Sept.	3:52P	4:32P	54	52	7	2	NNE
4 Oct.	8:14P	9:23P	49	46	8	3	NNE
4-5 Oct.	11:15P	1:14A	49	48	5	2	NE
9 Oct.	2:16A	6:32A	45	44	17	2	ESE
10 Oct.	3:12A	6:24A	50	43	12	2	S
20 Oct.	1:32A	7:45A	54	45	6	2	S
20 Oct.	8:54A	11:26A	54	45	NR	NR	NR
23-24 Oct.	10:26P	2:00A	43	40	NR	NR	NR
28 Oct.	9:43P	10:33P	36	28	20	3	SSW
29 Oct.	12:03A	3:45A	29	26	2	2	S
29 Oct.	4:16A	10:50A	28	26	NR	NR	NR
30 Oct.	2:28P	2:52P	32	26	9	2	S
30 Oct.	3:12P	3:30P	40	21	NR	NR	NR
5-6 Nov.	11:54P	6:09A	32	27	4	2	S

[a]Note: NR implies no record

[b]Note: °C = 5/9(°F-32)

[c]Note: 1 mile/hr = 0.477 m/sec

Table VIII-34 (concluded)

Date	Runoff Time		Temperature, °F[b]		Wind		
					Speed, miles/hr[c]		
	Start	End	Max.	Min.	Max.	Min.	Direction
1973							
12 April	9:31A	10:24A	NR[a]	NR	7	5	SW
17-18 April	2:13P	1:46A	89	68	6	3	NNE
19 April	10:44A	1:37P	90	85	8	2	NNE
19 April	1:52P	7:26P	90	74	5	2	NE
20-21 April	4:40P	2:01A	68	66	4	2	NNE
28 April	9:29P	11:54P	66	58	8	2	NNE
29 April	12:38A	2:14A	77	68	7	5	NE
29 April	6:41A	7:23P	84	68	5	2	S
20-21 May	4:52P	4:00P	69	60	11	2	NE
25-26 May	4:31A	7:44A	59	57	10	2	E
1 June	5:11P	6:50P	62	61	4	2	S
19 July	12:08P	6:35P	80	67	NR	NR	NR
19 July	6:35P	11:00P	71	65	NR	NR	NR
16 Aug.	3:50P	8:58P	70	48	19	4	NE
31 Aug.	11:08P	11:42P	NR	NR	6	2	NNE
1 Sept.	12:43A	1:00A	NR	NR	NR	NR	NR
1-2 Sept.	5:35A	12:10A	NR	NR	11	1	NE
2 Sept.	12:10A	1:32A	NR	NR	5	2	NE
23 Sept.	7:57A	3:32P	89	42	9	2	SSE
25 Sept.	1:23A	4:00P	66	44	8	3	NE
8 Oct.	2:24P	10:16P	30	26	16	3	NNE
23-24 Oct.	4:28P	12:30A	35	26	18	2	NNE

[a]Note: NR implies no record

[b]Note: °C = 5/9(°F-32)

[c]Note: 1 mile/hr = 0.477 m/sec

Table VIII-35 Soil Moisture Levels at the Beginning of Each Runoff Event - Layton Site

Date 1973	Soil Moisture Content, %, at depth 0-152mm	152-305mm	305-610mm
18 July	4.89	2.20	5.15
19 July	16.93	10.58	7.45
2 Sept.	9.39	7.86	11.35
8 Sept.	16.94	15.49	13.46
23 Sept.	10.97	6.67	8.60
18 Nov.	14.78	11.84	10.61

Table VIII-36 Soil Moisture Levels at the Beginning of Each Runoff Event - Parleys Site

Date 1973	Soil Moisture Content, %, at depth 0-152mm	152-305mm	305-610mm
19 July	6.86	6.07	9.62
16 Aug.	3.58	4.12	2.17
31 Aug.	3.58	4.12	2.17
1-2 Sept.	3.58	4.12	2.17
23 Sept.	12.98	12.26	14.05
25 Sept.	3.92	4.14	1.50
8 Oct.	19.77	16.76	14.07
23-24 Oct.	7.67	12.49	10.39

Table VIII-37 Parameter Codes for Rain Gages--Salt Lake City

Layton Site Gage No.	Parameter Code	Parleys Site Gage No.	Parameter Code
L1	90040	P1	90040
L2	90039	P2	90039
L3	90038	P3	90038
L4	90037	P4	90037
L5	90036	P5	90036
L6	90035	P6	90035
L7	90034	P7	90034

The locations of these gages are shown on Figures VIII-18 and VIII-19.

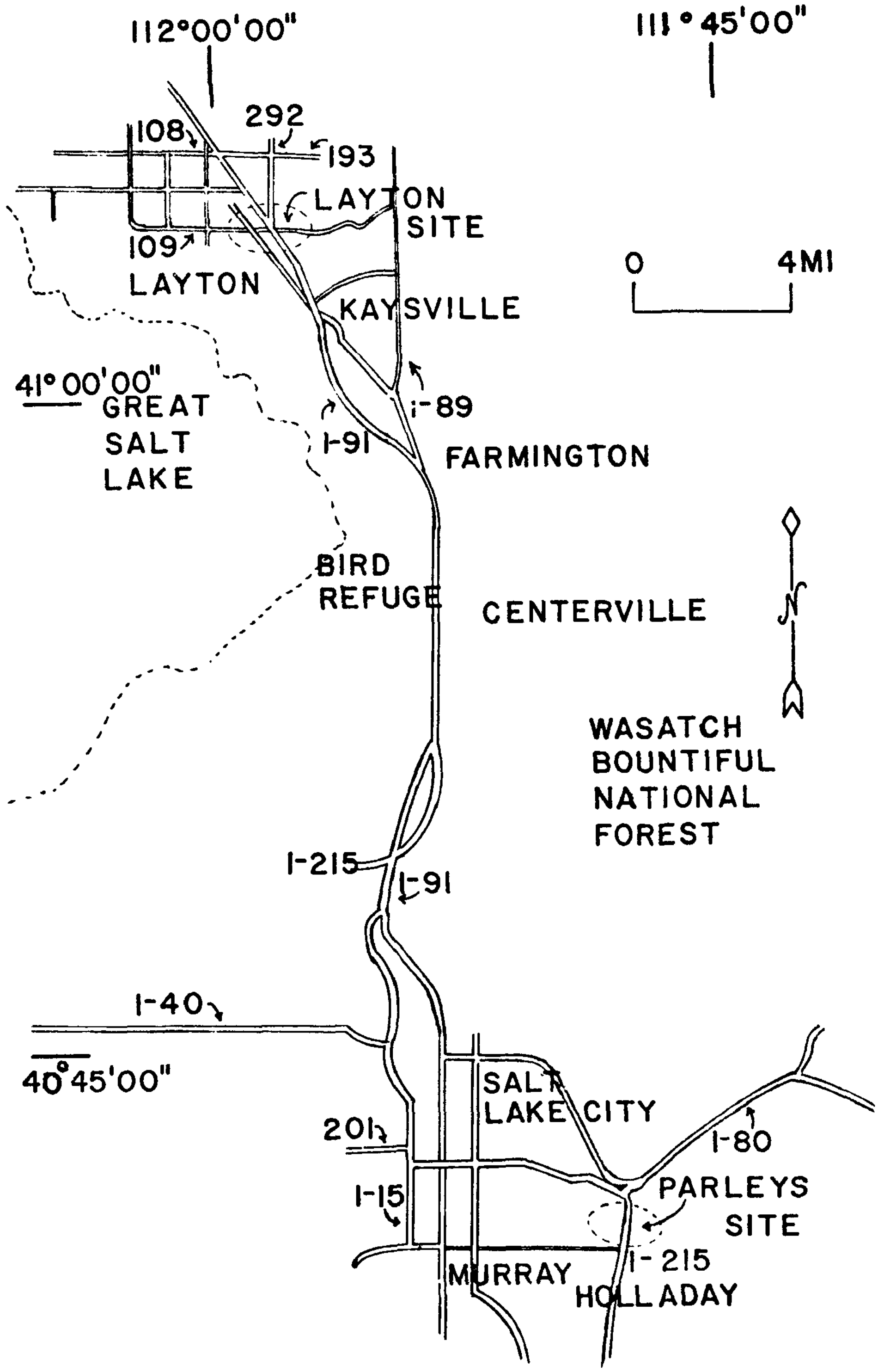


Figure VIII-17. Location map for the highway drainage monitoring sites in the Salt Lake City area.

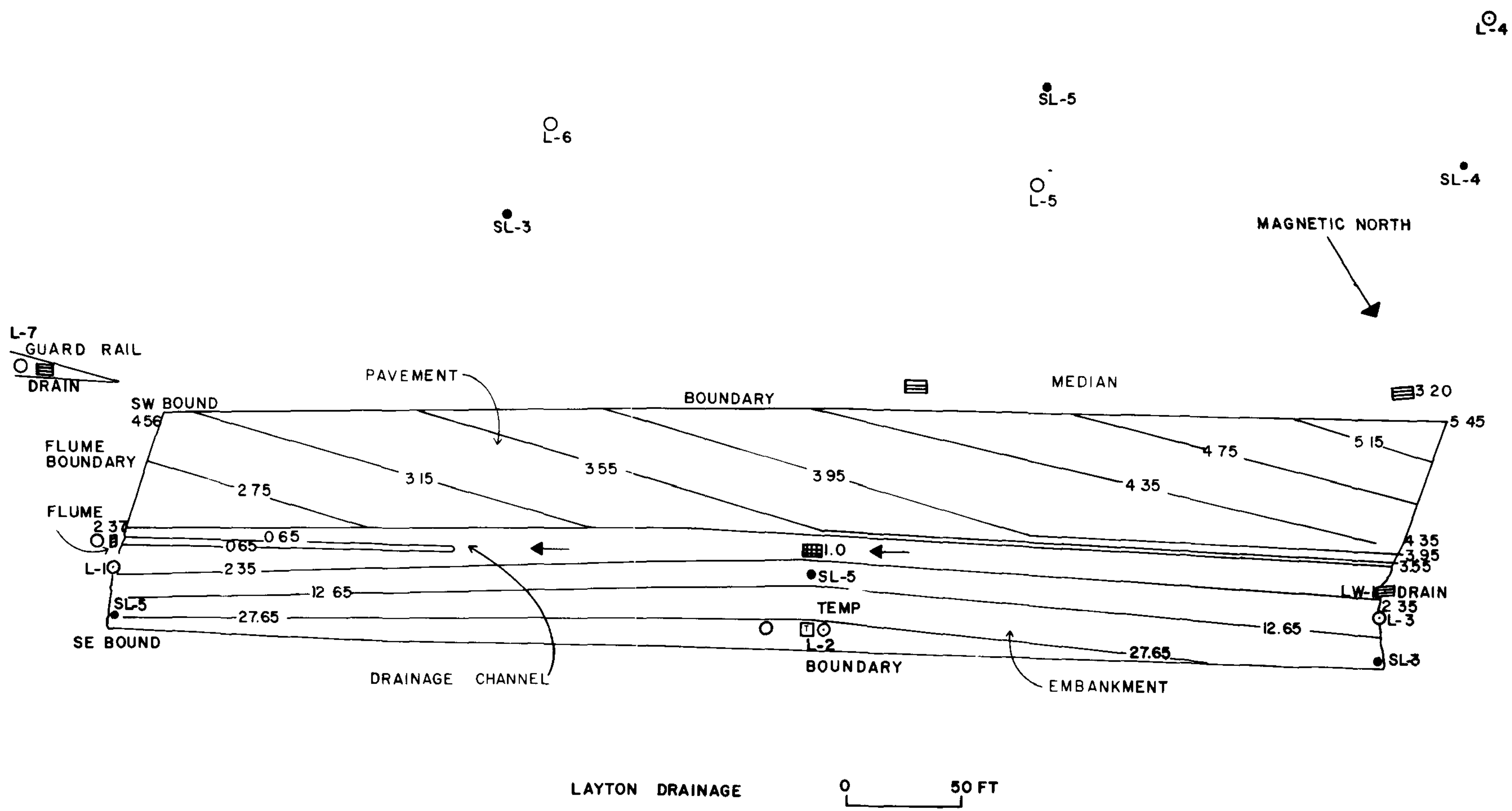


Figure VIII-18. Salt Lake City, Utah, Layton Catchment (UT0101), 58,625 ft^2 (5,449 m^2). See figure VIII-19 for legend of gages, etc. The left edge of the northbound lanes of I-15 forms the southwest boundary. Water from the drainage flows through the flume at the left and then free-falls into the grate inlet. Contour elevations are in feet, with the datum at the flume.

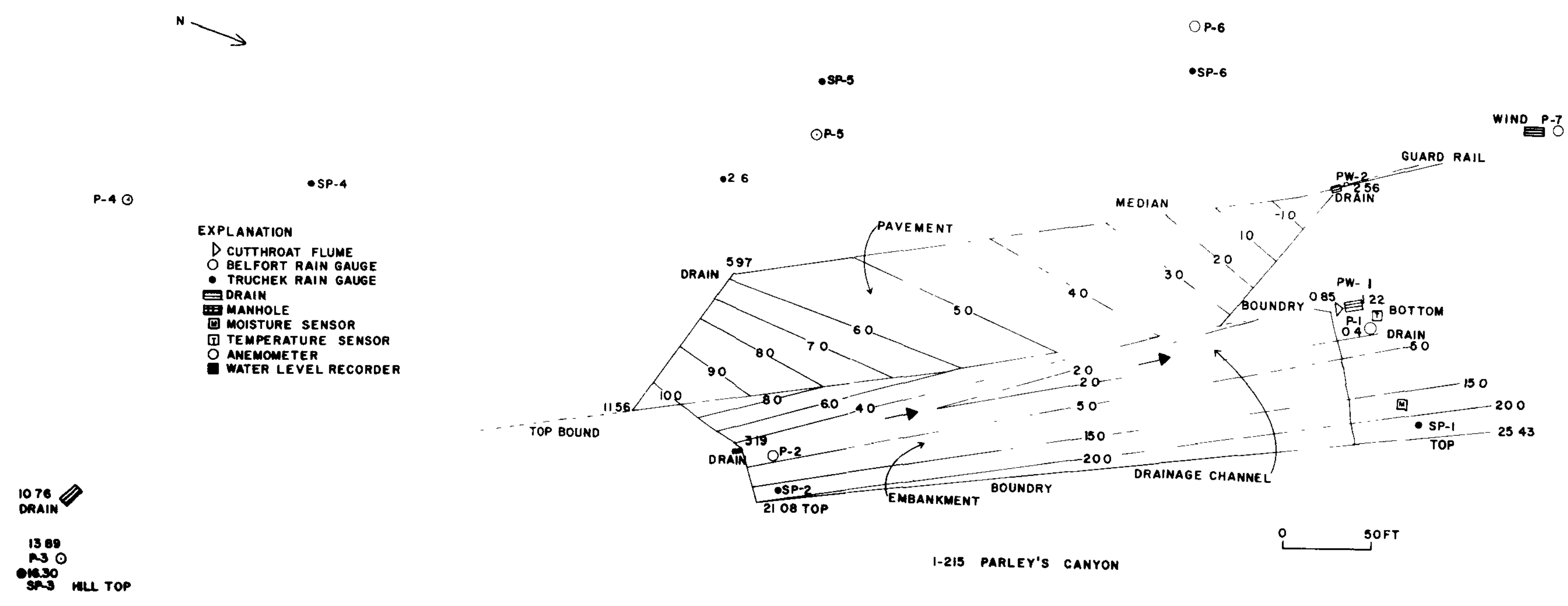


Figure VIII-19. Salt Lake City, Utah, Parleys Canyon Catchments. Catchment I (UT0102) drains the 23,529 ft^2 (2917 m^2) area from the top of the embankment to the edge of the pavement. Runoff is monitored at location PW-1. Catchment II (UT0103) drains the 23,812 ft^2 (2213 m^2) area of the asphalt-paved northbound traffic lanes of I-215. Runoff is monitored at location PW-2. A curb forms the west boundary of the paved drainage at the median. Contour elevations are in feet, with the datum at the flume at PW-1.

SECTION IX

MAINTENANCE, UPDATING AND DISSEMINATION

MAINTENANCE AND UPDATING

As indicated in Section V, many data sources already extant may be suitable for inclusion in the data base. In addition, approximately 150 EPA Section 208 Areawide Waste Managment Studies have been conducted, a few of which collected storm event data of the type included in this report. As such sources are processed, periodic addenda to this report will be issued. These will consist primarily of documentation for new sources of the nature of that found in Sections VII and VIII. Simultaneously, the data will be placed on the magnetic tape with the previous sources. Updating of the tape for previous sources will also include addition of new storm events to those already included on the tape. Any changes in the catchment parameters (e.g., imperviousness, population) will also be noted.

DISSEMINATION

The format of the magnetic tape containing the data was described in Section VI. As discussed, retrieval of the data can take the form of a listing or various searches for desired parameters. No special software is required since the tape is merely a substitute for input from punched cards. Copies of the tape will be mailed by UF at cost (anticipated to be about $40) to those who request it. It is possible that the tape may also be made available through the National Technical Information Service (NTIS).

The data are presently (June 1979) being placed on the EPA STORET data management system, facilitating access by a wide variety of users as well as access to STORET software for purposes of analysis. All data are being stored, including rainfall and flow values that are not usually found with quality data in STORET. Station codes or identification numbers are those given in this report, (e.g., CA0101 is Baker St., San Francisco), except for stations that already possess STORET station codes (e.g., Broward County). Station descriptions incorporating these station numbers are presently in the STORET system and may be retrieved in accordance with usual STORET procedures.

While preparing the station descriptions, it was necessary to determine the latitude and longitude of each catchment sampling location, which was usually done using USGS quadrangle maps. This information is given for convenience in Table IX-1.

In-house modeling data vary in quantity from location to location. They generally consist of maps, photos, drainage plans and written descriptions of each location, but few sites have all such material. Available data will be made available on a loan basis for short time periods. Future refinements may include placing maps, plans, etc. on a microfiche file

Table IX-1 Catchment Latitude, Longitude and U.S.G.S. Quadrangle Map Information.
Except as noted, all coordinates are accurate to within one second and are of the quantity/quality sampling location.
Map names are titles of U.S. Geological Survey Quadrangle maps that contain the catchments.

City	Catchment	N.Latitude-W.Longitude (deg-min-sec)		Map Name
Broward County,FL	Residential	26-16-15	80-5-59	Boca Raton, FL
	Commercial	26-16-29	80-7-24	Boca Raton, FL
	Transportation	26-10-2	80-7-1	Pompano Beach, FL
San Francisco,CA	Baker St.	37-48-15	122-26-43	San Fran. North,CA
	Mariposa St.	37-45-52	122-23-12	San Fran. North,CA
	Brotherhood Way	37-42-44	122-28-10	San Fran. South,CA
	Vicente St. N	37-44-18	122-30-19	San Fran. South,CA
	Vicente St. S	37-44-18	122-30-19	San Fran. South,CA
	Selby St.	37-44-53	122-23-32	San Fran. South,CA
	Laguna St.	37-48-13	122-25-49	San Fran. North,CA
Racine,WI	Site I	42-44-3	87-47-1	Racine South,WI
Lincoln,NB	39 & Holdredge	40-49-40	96-39-51	Lincoln,NB
	63 & Holdredge	40-49-40	96-38-13	Lincoln,NB
	78 & A	40-47-57	96-36-51	Walton,NB
Windsor,ON	Labadie Rd.	42-18-42	82-59-0	Belle Isle,MI
Lancaster,PA	Stevens Ave.	40-1-53	76-17-21	Lancaster,PA
Seattle,WA	View Ridge 1	47-40-10	122-17-4	Seattle North,WA
	View Ridge 2	47-39-40	122-17-1	Seattle North,WA
	South Seattle	47-32-52	122-19-40	Seattle South,WA
	South Center	47-27-23	122-15-0	Des Moines,WA
	Lake Hills	47-37-3	122-6-35	Issaguah,WA
	Highlands	47-44-11	122-22-12	Seattle North,WA
	Cent. Bus. Dist.	47-37-5	122-20-31	Seattle South,WA
Durham, NC	Third Fork	35-58-37.5	78-54-33.3	Durham South,NC
Baltimore, MD	Gray Haven	39-16-19	76-29-15	Middle River,MD
	Northwood	39-22-9	76-35-16	Baltimore East,MD
Chicago, IL	Oakdale	41-56-2.5	87-44-57	Chicago Loop,IL
Champaign-Urbana, IL	Boneyard Cr.	40-6-39	88-13-43	Urbana,IL
Bucyrus, OH	Sewer Dist. 8	40-48-48	82-58-31	Bucyrus,OH
Falls Church, VA	Tripps Run	38-51-44	77-10-16	Annandale,VA

Table IX-1 (continued)

City	Catchment	N. Latitude (deg-min-sec)	W. Longitude (deg-min-sec)	Map Name
Winston-Salem, NC	Tar Branch	36-5-4	80-14-31	Winston-Salem E, NC
Jackson, MS	Crane Creek	32-21-2	90-9-50	Jackson, MS
Wichita, KS	Dry Creek	37-40-21	97-16-41	Wichita East, KS
Westbury, NY	Woodoak Dr.	40-45-30	73-36-43	Hicksville, NY
Philadelphia, PA	Wingohocking	40-0-51	75-5-49	Frankford, PA/NJ Germantown, PA
Los Angeles, CA	Echo Park	34-4-47	118-15-48	Hollywood, CA
Portland, OR	Eastmoreland	45-30-[a]	122-40-[a]	Lake Oswego, OR
Houston, TX	Hunting Bayou-			
	Cavalcade St.	29-48-1	95-20-0	Settegast, TX
	Falls St.	29-40-28	95-19-51	Park Place, TX
	Bering Ditch	29-45-21	95-29-44	Houston Heights, TX
	Berry Creek	29-40-59	95-15-11	Park Place, TX
West Lafayette, IN	Ross-Ade	40-26-19	86-54-29	Lafayette West, IN
Greenfield, MA	Maple Brook	42-35-30	72-36-0	Greenfield, MA
Northampton, MA	Market Street Brook	42-19-30	72-38-0	Mt. Holyoke, MA Easthampton, MA
Salt Lake City, UT	Layton	41-4-34	111-58-11	Kaysville, UT
	Parleys Canyon I	40-41-57	111-47-49	Sugarhouse, UT
	Parleys Canyon II	40-41-57	111-47-49	Sugarhouse, UT

[a] Accurate only to 10 minutes.

SECTION X

STATISTICAL ANALYSIS OF URBAN RUNOFF DATA

INTRODUCTION

The thousands of data entries assembled as part of the urban rainfall-runoff-quality data base represent a sample from the vast population of such data. As such, they may be used to obtain insight as to the statistical character of urban runoff through generation of means, standard deviations, ranges, loads, etc. These parameters may be used in turn to develop causative relationships among water quality parameters and hydrologic and demographic factors (e.g., used in regression analyses). This latter work will be performed in the future using the characterization results that follow. These consist of the (flow-weighted) means, standard deviations (or variances), ranges, loads and certain other parameters for each event, plus averaged values for each catchment.

METHODS

Nature of Data

The statistical analysis of the data is complicated by several factors, typical of most storm event data included in the data base. From the following list, some or all items may apply for a given event.

1. Quality samples may not be given for all quantity samples.

2. Quantity samples may not be given for all quality samples.

3. The time interval between samples may vary.

4. The quality sampling duration may cover only a small portion of the runoff duration.

5. The start or end of the quantity (or quality) sampling may occur before or after that of the quality (or quantity) sampling.

6. Only a very few samples (e.g., two or three) of certain parameters may be taken during a given event.

7. Base flow samples (from which background levels may be derived) may be unavailable.

8. Sampling intervals may be large (e.g., one hour) making it difficult to determine variations.

The example data shown in Figure VI-2, page 6-13, for Seattle, illustrate problems 1 and 5 above, perhaps the most common of the list. For example, several gaps appear in the quality sampling, and the runoff sampling begins 45 minutes prior to quality sampling. However, if variations in concentrations are gradual during the latter part of an event, as is usually the case, additional sampling by the agency would have gained little additional information. Procedures to overcome some of these limitations are given below.

Storm "events" must be defined as well. As a practical matter, the events were separated, usually by different means, by the sampling agencies, prior to receipt by UF. For example, the USGS in Broward County (105) defines an event as any precipitation which is greater than 0.01 in. (0.25 mm) and which had 45 minutes of prior rain-free conditions. None of their data included in the data base have interevent times of less than 24 hours, however. Almost all other storm events in the data base are separated by at least 12 hours of intervening dry weather (no precipitation). (A minor exception occurs in the Portland, Oregon data in which an interevent time of six hours is used at one point.)

Statistical Parameters

In the context of analysis of urban runoff quality data, there are at least four methods by which the mean and variance may be obtained. (The variance is, of course, the square of the standard deviation.) These methods depend upon whether the data are flow and/or time weighted and are listed below and given in Table X-1.

1. Arithmetic (unweighted)

2. Time weighted

3. Flow weighted

4. Time and flow weighted

Data from which the sample calculations were derived are given in Table X-2 and plotted in Figure X-1.

Arithmetic computations are far and away the easiest and are performed by library routines in the STORET system, for example. But, if samples are taken at varying time intervals, some values (i.e., those taken at the short time intervals) will be unduly weighted with respect to others. Thus, time weighting can be used to give a true average value for a parameter plotted as a function of time (see Figure X-1).

Implications and meanings of the various methods may be studied using Table X-1 and Figure X-1. In spite of the short time period under consideration, the four methods yield quite different results for the particular storm used as an example. (The decreasing values reading down Table X-1 are an artifact of these data.) Since the higher COD values tend to occur during the first few minutes, their impact on the computed average is diminished when weighted with the corresponding lower flows at that time as compared to

Table X-1. Methods of Calculating Mean and Variance

Notation:

$\bar{C} \equiv$ Mean

$S^2 \equiv$ Variance

N = Number of samples

Q = Flow rate

t = Time interval

i = Subscript denoting value at ith time interval or ith sample

Summations are i=1 to N

Shown for comparison are computations for the storm of 4/15/74 for residential catchment, Broward County.

	COD (mg/l)
1. Arithmetic (Unweighted)	
$\bar{C} = \frac{\Sigma C_i}{N}$	150.9
$S^2_{biased} = \frac{\Sigma C_i^2}{N} - \bar{C}^2$	82.9^2
$S^2_{unbiased} = \frac{N}{N-1} S^2_{biased}$	88.0^2
2. Time Weighted	
$\bar{C} = \frac{\Sigma C_i \, \Delta t_i}{\Sigma \, \Delta t_i}$	140.2
$S^2 = \frac{\Sigma C_i^2 \, \Delta t_i}{\Sigma \, \Delta t_i} - \bar{C}^2$	81.9^2
3. Flow Weighted	
$\bar{C} = \frac{\Sigma C_i \, Q_i}{\Sigma \, Q_i}$	117.4
$S^2 = \frac{\Sigma \, C_i^2 \, Q_i}{\Sigma \, Q_i} - \bar{C}^2$	75.0^2
4. Time and Flow Weighted	
$\bar{C} = \frac{\Sigma C_i \, Q_i \, \Delta t_i}{\Sigma Q_i \, \Delta t_i}$	111.6
$S^2 = \frac{\Sigma C_i^2 \, Q_i \, \Delta t_i}{\Sigma \, Q_i \, \Delta t_i} - \bar{C}^2$	72.9^2

Table X-2. Storm Event Data for 4/15/74 for Residential Catchment, Broward County

Sample Number, i	Time of Day	Elapsed Time, t, min	Δt^a min	COD mg/l	Q cfs
1	6:32	0	0.5	249	0.36
2	6:33	1	1.0	196	0.53
3	6:34	2	1.0	208	0.71
4	6:35	3	1.0	65	0.88
5	6:36	4	1.0	289	1.26
6	6:37	5	1.0	145	1.65
7	6:38	6	1.5	57	2.03
8	6:40	8	1.5	75	2.80
9	6:41	9	0.5	74	2.92

[a]Time interval centered at time step i, $\Delta t_i = (t_{i+1} - t_{i-1})/2$.

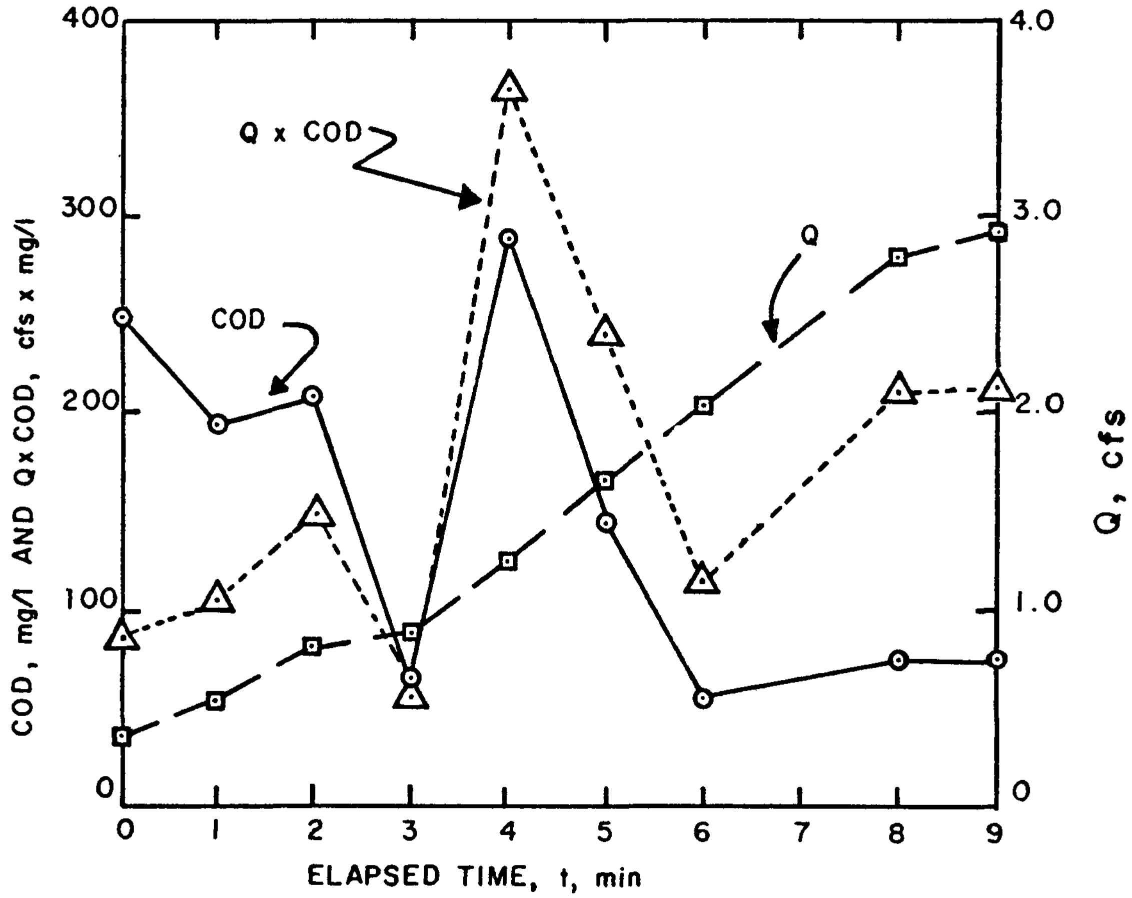


Figure X-1. Concentration, flow and mass load (flow x concentration) for event of 4/15/74 for residential catchment, Broward County.

an arithmetic average in which all values receive equal weight. Time weighting reduces the average for this example because the high first value applies over only half a time interval and because the seventh and eighth COD values (low in magnitude) receive a higher weighting because of the two minute interval between them. Time averaging is equivalent to integration (via the trapezoidal rule) of the COD versus time curve and dividing by the event duration (nine minutes for this example, although the quality measurements covered only a fraction of the total storm).

However, the essence of the problem is the flow weighting, since almost all useful loading parameters must be derived by considering the product of concentrations and flows. Again, the problem of unequal time intervals associated with each data value leads to use of the fourth method, time and flow weighting, for all computations. Average concentrations computed by this method thus reflect within-storm variations in flow and sampling interval and may be multiplied by total flow volume to compute total mass loads.

This is made more clear by examining the computation given in Table X-1 for the mean value using time and flow weighting.

$$\bar{C} = \frac{\Sigma\, C_i\, Q_i\, \Delta t_i}{\Sigma\, Q_i\, \Delta t_i} \qquad \text{(X-1)}$$

where $\bar{C}$ = mean concentration of parameter,

C_i = concentration of parameter at sample number (time step) i,

Q_i = flow rate at sample number (or time step) i, and

Δt_i = time interval at sample number (or time step) i.

Summations are over i = 1 to number of samples (or time steps) N, and the time interval, Δt_i, is computed as

$$\Delta t_i = (t_{i+1} - t_{i-1})/2 \qquad \text{(X-2)}$$

where t_i = time at sample number (or time step) i.

For the first and last samples, Δt is computed as half the following or preceding interval, respectively.

The numerator of equation X-1 is the total mass load of the storm event,

$$M = \Sigma\, C_i\, Q_i\, \Delta t_i \qquad \text{(X-3)}$$

where M = total mass load (e.g., lb or kg).

The denominator is the total runoff volume,

$$V = \Sigma Q_i \Delta t_i \qquad \text{(X-4)}$$

where V = total runoff volume (e.g., ft^3 or m^3).

Of course, the runoff volume can be converted to an equivalent depth over the catchment by dividing by the catchment area.

Thus, the time and flow weighted average concentration is simply the mass load divided by the runoff volume. This is, of course, why it is essential to have flow weighted means when it is desired to compute mass emissions from catchments.

The variance, S^2, (or square of the standard deviation, S) is calculated for the time and flow weighting method by

$$S^2 = \frac{\Sigma C_i^2 Q_i \Delta t_i}{\Sigma Q_i \Delta t_i} - \bar{C}^2 \qquad \text{(X-5)}$$

and has the usual interpretation as the (weighted) average squared deviation from the mean.

Equations X-1 through X-5 are used to compute means and standard deviations for all data in the data base. Also listed are ranges of quality parameters, selected simply by a search of the data for a given storm.

Interpolation

For the majority of the storm events found in the data base, there are segments within the event for which quality data have been reported but no flow value, or flow value but no quality data. The latter situation is the most frequent. Since the computations for mean and variance require a product of flow and concentration, either the missing parameter must be supplied or else the given parameter cannot be used. If the given parameter is not used then some of the supplied data are wasted. Furthermore, the computation of the total load (and mean concentration) may have a significant error. For instance, if a gap exists in the quality record over a time period when the flow increases temporarily, this increase in mass load will be missed if those data are not used.

The above considerations led to an interpolation scheme to supply "missing" values of either flow or quality parameters. In the computation scheme, it has been found most convenient to have a value for both at every sample number. Missing values are supplied simply by linear interpolation within the flow or quality parameter time series. Other ideas were also considered. For example, linear interpolation could be used along the mass load time series, and the missing value computed by division of the interpolated mass load by the given value. However, this tends to produce an inverse relationship between flow and concentration which may not exist in fact. And the interpolation scheme used is quicker, saving computer time during analysis of the many events. Interpolation for missing values within each individual time series has been used by Seattle Metro (John Buffo, personal communication, 1978) for analysis of their data and will be documented in a future report.

In order to give an idea of the extent of interpolation necessary for analysis of each storm event, the number of measured and interpolated points are listed for each parameter. In addition, the duration of quality sampling is listed for comparison with the total runoff duration.

No data have been extrapolated beyond the end (or prior to the beginning) of the sampling period. Although reasonable extrapolations could be made in some cases, this would require visual inspection of the data from every storm event, not possible for computer analysis of so many events and parameters.

Since the quality sampling duration is often less than the runoff duration, a reasonable estimate of the total mass load for the event can be made by taking the product of the computed average concentration and the total flow volume. This is often necessary in urban runoff studies to compute, say, total annual loads (e.g., 105). Its accuracy increases as the ratio of quality sampling duration to total runoff duration increases.

Background Concentrations

In combined sewers there is an existing dry-weather flow in the conduits at the beginning of a storm. This is often the case in storm drains as well due to infiltration or unknown connections to the system. Since wet-weather sampling measures the combination of existing dry-weather flow plus the storm runoff, it is desirable to subtract the background load from the total in order to isolate the contributions due to surface runoff and scour of deposited material (in a combined sewer). This can be done if initial conditions are known, e.g., the dry-weather flow rate and parameter concentrations just prior to the storm.

Unfortunately, automatic samplers often do not "trigger" until the first pulse of the runoff has already arrived at the sampler location. It is then necessary to make a subjective judgment as to background levels, usually by visual inspection of the data. Again, this is not possible for the present analyses. Alternatively, an arbitrary rule, such as using the first (or last) sample as the base flow value often fails in practice. Still another option would be to utilize infiltration-inflow studies performed under other programs (e.g., EPA "201" projects). These studies provide information on total dry-weather flow in sewers, but they are not readily available for all sites. Thus, background loads have not been subtracted from the loads computed herein. In one instance, Seattle, suitable background values have been determined by Metro personnel; they will be used in a future analysis. Fortunately, the background loads are usually small compared to the total load computed.

PRESENTATION OF COMPUTATIONS

Description of Summary Tables

For each catchment, three tables have been computed. The first presents quantity data for each storm event. Listed parameters included the date and time, precipitation and runoff durations and depths and preceding dry days, if available. This latter parameter is important in future analysis for causative effects; unfortunately, it is currently available for only a few catchments. This is because the assembled storm event data do not necessarily include all storms that occured during the agency's sampling program. In most cases, weather records will need to be examined to determine antecedent conditions.

The second table presents all the previously indicated calculations (mean, standard deviation, range, etc.) for each quality parameter for each event. For catchments with several parameters and events, this table is quite lengthy. A few parameters are not amenable to load calculations, e.g., temperature, color, conductivity, pH, etc. Flow weighted means and variances are still utilized, however. Coliform loads are given as total count MPN or MF (membrane filter), instead of pounds, and coliform concentrations are rounded to three significant figures. The total number of pages generated by these tables is about 400. Hence, they are not included in this report. However, they are available to interested parties for the cost of reproduction and possibly through NTIS in the future. Inquiries should be addressed to the authors.

The third table summarizes all the storm event quality statistics for each catchment A grand average concentration is computed as the ratio of the total computed load to total runoff volume

$$\bar{C}_c = \frac{\sum_{i=1}^{N} M_i}{\sum_{i=1}^{N} V_i} \qquad \text{(X-6)}$$

where $\bar{C}_c$ = average concentration of the parameter,

M_i = load for storm event i,

V_i = runoff volume for storm event i, and

N = number of events.

The flow weighted variance S_c^2 is computed as

$$S_c^2 = \frac{\sum_{i=1}^{N} \bar{C}_i^2 \cdot V_i}{\sum_{i=1}^{N} V_i} - \bar{C}_c^2 \qquad \text{(X-7)}$$

where $\bar{C}_i$ = average concentration for event i.

The range of the parameters and number of events are also listed. Finally, an average loading for the catchment is given in units of lb/ac-in. This can be computed either by dividing the sum of the loads by the catchment area and total inches of runoff or simply by converting the mean concentration in mg/l computed using equation X-6 to units of lb/ac-in. by multiplying by 0.2265.

Column headings for each parameter are identical to headings used for STORET output. The parameter code (e.g., 310 = BOD_5) is given first, followed by the abreviation and units used by STORET. Codes for all parameters are identified in Table VI-3 of the first report. Codes can be indicative of the laboratory method as well as the parameter itself. For example, total coliforms determined by the membrane filter technique could be given code number 31501 (depending on whether immediate or delayed and on the type of media); those determined as MPN could be given code number 31505.

For ease of programming, no attempt was made to round to three significant figures for other than bacteria. (Otherwise a separate format would have been required for each parameter, leading to time consuming complications.) Hence, calculated values should not be utilized beyond three significant figures.

Blank spaces under a column heading indicate the parameter was unavailable or not measured. This appears most often under "preceding dry days", which were usually not measured.

Summary Tables

The first and third tables discussed above thus provide the statistical results for 22 catchments with quality data. They are presented for each catchment in the following pages, in Tables X-3 to X-43. Two catchments, Vicente St. North and South in San Francisco, are analyzed for only one storm. Since a quality summary table is meaningless for this case, the event analysis (the second table discussed above) is given for these catchments and may be seen as an example of such tables.

As a brief comparison of results, average concentrations of BOD_5 and suspended solids (SS) for the 22 catchments are given in Table X-3. These are the only parameters sampled for all catchments. A few generalizations may be made. Combined sewers consistently have higher BOD values than do storm sewers (as is expected). SS values may not be so differentiated from these catchments, however. Too few catchments are analyzed to distinguish trends among land uses. The high BOD and SS values for Durham apparently result from the nature of the drainage channel which is an open channel filled with considerable refuse.

It is clear from examination of Table X-3 and the quality summary tables that there is a high variability among data from the same catchments. The coefficient of variation (standard deviation/mean) is often greater than 1.0, indicating a skewed distribution for most parameters. That is, high outliers are expected among the data. For this reason, the range listed for

Table X-3. Comparison of flow-weighted BOD_5 and suspended solids means and standard deviations by land use and type of sewerage.

Means and standard deviations are taken from the statistical summary table for each city and are calculated using equations X-6 and X-7.

City-Catchment	Storm or Combined Sewerage	00310[a]-BOD_5 Mean (mg/l)	00310[a]-BOD_5 Std. Dev. (mg/l)	Number of Events	00530[a]-Susp. Solids Mean (mg/l)	00530[a]-Susp. Solids Std. Dev. (mg/l)	Number of Events
Single-Family Residential							
San Francisco,CA-Selby St.	C	38.1	30.0	8	215.4	146.0	8
Racine,WI-Site I	C	89.6	17.7	7	178.9	137.3	7
Lancaster,PA-Stevens Ave.	C	56.2	49.3	5	271.3	171.1	5
Broward County,FL-Residential	S	6.7	4.3	20	28.4[b]	16.7[b]	28
San Francisco,CA-Vicente St. N.	S	9.8	11.4[c]	1	48.3	29.2[c]	1
San Francisco,CA-Vicente St. S.	S	4.5	3.4[c]	1	45.8	29.3[c]	1
Lincoln,NB-39 & Holdrege	S	37.6	51.8	13	735.9	302.8	18
Lincoln,NB-63 & Holdrege	S	22.1	32.5	11	827.7	228.4	12
Lincoln,NB-78 & A	S	8.7	5.1	9	1532.0	780.4	10
Windsor,ON-Labadie Rd.	S	16.9	8.2	20	389.8	254.2	20
Seattle,WA-View Ridge 1	S	18.4	11.2	7	55.6	102.5	28
Seattle,WA-View Ridge 2	S	12.9	9.4	5	107.7	33.1	4
Seattle,WA-Lake Hills	S	6.3	2.9	5	61.3	9.9	5
Seattle,WA-Highlands	S	4.2	3.8	4	109.3	71.5	4
West Lafayette,IN-Ross-Ade	S	59.6	89.7	8	104.7	52.0	8
Greenfield,MA-Maple Brook	S	11.6	7.2	4	147.4	112.1	5
Multiple-Family Residential							
San Francisco,CA-Baker St.	C	22.9	6.0	3	90.7	14.5	3
San Francisco,CA-Brotherhood Way	C	45.6	24.7	3	654.8	524.6	3
San Francisco,CA-Laguna St.	C	46.3	8.8	2	210.7	101.0	2
Commercial							
Seattle,WA-Central Bus. Dist.	C	64.3	37.7	5	161.8	21.7	5
Seattle,WA-Southcenter	S	12.5	7.7	7	93.5	237.0	27

Table X-3(Continued)

City-Catchment	Storm or Combined Sewerage	00310-BOD_5 Mean (mg/l)	00310-BOD_5 Std. Dev. (mg/l)	Number of Events	00530-Susp. Solids Mean (mg/l)	00530-Susp. Solids Std. Dev. (mg/l)	Number of Events
Industrial							
Seattle,WA-South Seattle	S	11.9	8.2	7	114.2	176.3	29
Mixture-Res., Com., Other							
San Francisco,CA-Mariposa St.	C	43.2	42.5	3	172.4	86.4	3
Durham,NC-Third Fork	S	127.3	13.6	2	1498.3	171.2	4
Northampton,MA-Market St. Brook	S	30.1	19.4	3	149.2	55.0	6

[a]STORET code for parameter. Refer to Table VI-3

[b]Parameter 70299 reported instead of 00530, i.e., suspended solids determined by evaporation instead of filtration.

[c]Standard deviation based on within-storm variation, 8 samples for BOD_5 and 10 samples for SS.

each parameter in the summary tables may be misleading in that the maximum value is usually several standard deviations away from the mean and is therefore of a very rare magnitude.

The nature of the rainfall-runoff data analyzed for the event summaries makes it difficult to get a clear perspective of runoff coefficients for several catchments. When the ratio of runoff volume to rainfall volume is computed for each storm, several catchments exhibit a wide variation, and a few values greater than 1.0 may be found. In the latter case, a remark is usually made in the table caption and a reason given, if known . The main problem appears to be the duration of rainfall and runoff sampling. In some cases one or the other was not sampled long enough to obtain the total volume. Since it has only been possible to analyze the data presented in the source material, there is no way to rectify this situation, especially if flow data are missing, although it may be possible to supplement rainfall data with the nearest National Weather Service or airport station records. (This was done in some instances in San Francisco, according to references 34 and 35.) Hence, if the total rainfall duration was not sampled, abnormally high runoff coefficients can result.

High runoff coefficients can also be caused by too small a catchment area, unknown diversions into the catchment during storm events and by the presence of dry-weather flow or base flow. (The latter has not been subtracted during runoff computations.) In several cases, runoff coefficients greater than 1.0 are also computed in documentation accompanying the hydrologic data, with little or no explanation given.

Table X-4. Event Summary, Broward County, FL, Residential Catchment (FL0101).

BROWARD COUNTY, FLORIDA. FL0101

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE (START-END) (YR, MON, D, HR, MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE (START-END) (YR, MON, D, HR, MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	74/ 4/15 6:15 74/ 4/15 7:45	1.50	0.57		74/ 4/15 6:30 74/ 4/15 10:35	4.08	0.0471
2	74/ 5/ 7 20:23 74/ 5/ 7 20:48	0.42	0.37		74/ 5/ 7 20:33 74/ 5/ 7 23:18	2.75	0.0163
3	74/ 5/28 19:20 74/ 5/28 20:40	1.33	0.17		74/ 5/28 19:45 74/ 5/28 20:30	0.75	0.0013
4	74/ 6/ 3 20:38 74/ 6/ 3 21:18	0.67	0.16		74/ 6/ 3 21: 3 74/ 6/ 3 22: 3	1.00	0.0025
5	74/ 6/15 15:25 74/ 6/15 16:35	1.17	0.56		74/ 6/15 15:40 74/ 6/15 18: 5	2.42	0.0264
6	74/ 6/16 9:57 74/ 6/16 11:27	1.50	1.08		74/ 6/16 10: 2 74/ 6/16 12:37	2.58	0.1453
7	74/ 7/ 1 18:38 74/ 7/ 1 19:53	1.25	1.29		74/ 7/ 1 18:53 74/ 7/ 1 22:43	3.83	0.1941
8	74/ 7/ 2 11: 8 74/ 7/ 2 11:38	0.50	0.46		74/ 7/ 2 11:13 74/ 7/ 2 12:23	1.17	0.0224
9	74/ 7/15 22:38 74/ 7/15 23:38	1.00	0.46		74/ 7/15 22:48 74/ 7/16 1:13	2.42	0.0207
10	74/ 7/18 2: 5 74/ 7/18 3:35	1.50	0.85		74/ 7/18 2:35 74/ 7/18 6:15	3.67	0.0828
11	74/ 7/21 17:12 74/ 7/21 18:32	1.33	0.27		74/ 7/21 17:22 74/ 7/21 19:32	2.17	0.0100
12	74/ 7/31 14:25 74/ 7/31 14:35	0.17	0.15		74/ 7/31 14:35 74/ 7/31 16:30	1.92	0.0073
13	74/ 8/17 19:14 74/ 8/17 20: 4	0.83	0.68		74/ 8/17 19:24 74/ 8/17 21:19	1.92	0.0456
14	74/ 8/23 5:27 74/ 8/23 6:17	0.83	0.31		74/ 8/23 5:32 74/ 8/23 8:52	3.33	0.0265
15	74/ 9/ 5 18:50 74/ 9/ 5 19: 0	0.17	0.12		74/ 9/ 5 18:55 74/ 9/ 5 21: 5	2.17	0.0070
16	74/ 9/ 6 10:38 74/ 9/ 6 10:53	0.25	0.23		74/ 9/ 6 10:43 74/ 9/ 6 13:13	2.50	0.0183
17	74/ 9/30 14:10 74/ 9/30 15: 5	0.92	0.98		74/ 9/30 14:35 74/ 9/30 18:45	4.17	0.1128
18	74/12/26 21:11 74/12/26 21:36	0.42	0.14		74/12/26 21:16 74/12/26 23:26	2.17	0.0080
19	75/ 2/ 5 13:29 75/ 2/ 5 13:49	0.33	0.16		75/ 2/ 5 13:49 75/ 2/ 5 15:19	1.50	0.0096
20	75/ 2/10 13: 6 75/ 2/10 14:31	1.42	0.38		75/ 2/10 13:36 75/ 2/10 15:41	2.08	0.0181
21	75/ 2/24 21: 2 75/ 2/24 22: 2	1.00	0.56		75/ 2/24 21:22 75/ 2/25 1: 7	3.75	0.0338
22	75/ 4/12 10:55 75/ 4/12 11:10	0.25	0.15		75/ 4/12 11: 0 75/ 4/12 14:30	3.50	0.0188
23	75/ 5/ 5 19:31 75/ 5/ 5 20:11	0.67	0.27		75/ 5/ 5 19:41 75/ 5/ 5 21:46	2.08	0.0285
24	75/ 5/ 9 17: 3 75/ 5/ 9 18:33	1.50	0.22		75/ 5/ 9 17:33 75/ 5/ 9 19:58	2.42	0.0133
25	75/ 6/17 11: 7 75/ 6/17 12:32	1.42	1.24		75/ 6/17 11:17 75/ 6/17 13:42	2.42	0.0894
26	75/ 6/19 6:38 75/ 6/19 6:48	0.17	0.09		75/ 6/19 7:48 75/ 6/19 8:38	0.83	0.0025
27	75/ 6/24 15:33 75/ 6/24 16:53	1.33	0.98		75/ 6/24 15:48 75/ 6/24 22:48	7.00	0.0472
28	75/ 7/14 22:18 75/ 7/14 23:28	1.17	0.26		75/ 7/14 22:28 75/ 7/14 23:23	0.92	0.0084
29	75/ 7/17 6: 7 75/ 7/17 6:52	0.75	0.33		75/ 7/17 7:22 75/ 7/17 8:42	1.33	0.0200
30	75/ 8/23 15:37 75/ 8/23 17:17	1.67	0.97		75/ 8/23 15:47 75/ 8/23 17:52	2.08	0.0568
31	75/ 9/17 14: 5 75/ 9/17 14:50	0.75	0.49		75/ 9/17 14:10 75/ 9/17 15:55	1.75	0.0159
32	75/ 9/26 21:37 75/ 9/26 22:52	1.25	0.72		75/ 9/26 21:42 75/ 9/26 23: 7	1.42	0.0606

Table X-5. Quality Summary, Broward County, FL, Residential Catchment (FL0101).

BROWARD COUNTY, FLORIDA. FL0101

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	31679 FECSTREP MF M-ENT /100ML	00070 TURB JKSN JTU	00080 COLOR PT-CO UNITS	00095 CNDUCTVY AT 25C MICRCMHO	00400 PH SU	70299 RES-SUSP AT 180 C MG/L	70507 PHOS-T ORTHO MG/L P	71887 TOTAL N AS NO3 MG/L	00610 NH3-N TOTAL MG/L
MEAN	355000.	31200.	43700.	13.285	19.563	72.567	7.287	28.392	0.163	6.455	0.148
STD. DEVIATION	373000.	50900.	26800.	5.903	18.535	45.309	0.304	16.694	0.150	6.284	0.326
PARAMETER RANGE											
MIN	24000.	1000.	5000.	3.000	5.000	33.990	6.600	1.000	0.030	1.800	0.010
MAX	1780000.	486000.	125000.	69.990	159.900	349.900	8.100	248.900	1.800	51.000	2.600
NO. OF EVENTS	7	7	7	29	27	28	7	28	29	23	29
TOT. MASS LOAD(LBS)	0.803E 12	0.706E 11	0.989E 11	*********	*********	*********	*********	200.470	1.156	37.882	1.055
TOT. FLOW VOL.(IN)	0.0464	0.0463	0.0463	0.6608	0.6519	0.6321	0.0568	0.6560	0.6608	0.5452	0.6608
CONC.(LBS/AC-IN)	0.364E 12	0.321E 11	0.449E 11	********	********	********	********	6.4339	0.0368	1.4629	0.0336

	00615 NO2-N TOTAL MG/L	00620 NO3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00300 DO MG/L	00440 HCO3 ION HCO3 MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00405 CO2 MG/L	00410 T ALK CACO3 MG/L	00500 RESIDUE TOTAL MG/L
MEAN	0.029	0.317	1.091	0.364	6.871	36.218	6.703	21.914	7.714	31.370	103.850
STD. DEVIATION	0.077	0.194	1.207	0.237	0.168	12.943	4.299	24.978	3.250	10.659	71.666
PARAMETER RANGE											
MIN	0.010	0.010	0.220	0.020	6.700	27.990	1.900	2.000	0.800	23.000	9.000
MAX	1.500	2.100	10.290	2.240	8.100	347.900	19.590	288.900	18.000	285.000	624.900
NO. OF EVENTS	28	29	23	23	2	5	20	29	5	5	25
TOT. MASS LOAD(LBS)	0.190	2.257	6.404	2.135	1.146	5.673	21.123	154.894	1.145	4.656	613.764
TOT. FLOW VOL.(IN)	0.6140	0.6608	0.5452	0.5452	0.0155	0.0138	0.2928	0.6566	0.0138	0.0138	0.5491
CONC.(LBS/AC-IN)	0.0065	0.0719	0.2473	0.0825	1.5571	8.6607	1.5190	4.9661	1.7481	7.1089	23.5339

	00515 RESIDUE DISS-105 C MG/L	00600 TOTAL N N MG/L	00605 ORG N N MG/L	00665 PHOS-P P-WET MG/L	00680 T ORG C C MG/L	00685 T.INCRG C MG/L	00690 T-CARBON C MG/L	00940 CHLORIDE CL MG/L	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L
MEAN	69.350	1.455	0.870	0.237	7.254	4.170	11.258	4973.664	1.334	10.015	6.922
STD. DEVIATION	56.633	1.417	0.832	0.205	10.320	1.821	11.959	0.000	0.558	0.051	4.416
PARAMETER RANGE											
MIN	9.000	0.400	0.140	0.070	1.000	1.000	3.000	1.300	1.000	10.000	1.000
MAX	573.900	11.490	9.400	2.400	103.900	16.990	119.900	19.990	6.000	20.000	41.000
NO. OF EVENTS	28	23	29	28	28	28	28	5	5	7	7
TOT. MASS LOAD(LBS)	489.671	8.539	6.188	1.643	50.834	29.355	79.242	1.866	0.003	0.028	0.019
TOT. FLOW VOL.(IN)	0.6560	0.5452	0.6608	0.6433	0.6510	0.6539	0.6539	0.0349	0.1972	0.2610	0.2610
CONC.(LBS/AC-IN)	15.7156	0.3297	0.1972	0.0538	1.6439	0.9451	2.5512	1.1271	0.0003	0.0023	0.0016

	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	248.984	155.295	76.965
STD. DEVIATION	175.400	93.176	33.857
PARAMETER RANGE			
MIN	10.000	30.000	10.000
MAX	5300.000	1100.000	560.000
NO. OF EVENTS	24	7	7
TOT. MASS LOAD(LBS)	1.738	0.436	0.216
TOT. FLOW VOL.(IN)	0.6485	0.2610	0.2610
CONC.(LBS/AC-IN)	0.0564	0.0352	0.0174

Table X-6. Event Summary, Durham, NC, Third Fork Catchment (NC0201).

DURHAM, NORTH CAROLINA, NC0201

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	69/ 6/ 9 14: 0 69/ 6/ 9 23:45	9.75	0.64		69/ 6/ 9 13:50 69/ 6/10 1: 0	11.17	0.1653
2	69/ 6/15 9:35 69/ 6/15 21:30	11.92	1.80		69/ 6/15 9:35 69/ 6/16 0: 0	14.42	0.8269
3	69/ 7/28 16:10 69/ 7/29 1:20	9.17	0.93		69/ 7/28 16: 0 69/ 7/29 2: 0	10.00	0.3582
4	69/ 8/ 1 11:25 69/ 8/ 1 16:35	5.17	0.72		69/ 8/ 1 11:25 69/ 8/ 1 18: 0	6.58	0.2024
5	69/ 8/ 3 16:15 69/ 8/ 3 18: 0	1.75	0.93		69/ 8/ 3 16:15 69/ 8/ 3 21: 0	4.75	0.5035
6	69/ 8/ 4 5:35 69/ 8/ 4 8:15	2.67	0.50		69/ 8/ 4 6: 0 69/ 8/ 4 10:30	4.50	0.2109
7	69/ 8/13 16:10 69/ 8/13 21:45	5.58	0.53		69/ 8/13 16:10 69/ 8/13 23: 0	6.83	0.1871
8	69/ 8/15 13:50 69/ 8/15 17:25	3.58	1.96		69/ 8/15 13:30 69/ 8/15 21: 0	7.50	0.8567
9	69/ 9/ 2 14:40 69/ 9/ 2 15:50	1.17	0.73		69/ 9/ 2 14: 0 69/ 9/ 2 18: 0	4.00	0.3288
10	69/ 9/17 11:45 69/ 9/17 14:50	3.08	1.29		69/ 9/17 11:45 69/ 9/17 14:50	3.08	0.4964
11	69/ 9/24 12: 5 69/ 9/24 16:30	4.42	0.60		69/ 9/24 12: 0 69/ 9/24 18: 0	6.00	0.3388
12	69/12/10 7:55 69/12/10 15: 5	7.17	1.05		69/12/10 7:50 69/12/10 17: 0	9.17	0.4488
13	69/12/21 22:15 69/12/22 3:40	5.42	0.83		69/12/21 22:30 69/12/22 5:30	7.00	0.3032
14	69/12/25 19:20 69/12/26 1:10	5.83	0.73		69/12/25 19: 0 69/12/26 4:30	9.50	0.4250
15	70/ 2/16 7:40 70/ 2/17 4:45	21.08	2.11		70/ 2/16 8: 0 70/ 2/17 9: 0	25.00	1.2405
16	72/ 6/20 6:10 72/ 6/20 8:55	2.75	0.20		72/ 6/20 6:16 72/ 6/20 12:10	5.90	0.0600
17	72/ 8/28 10: 5 72/ 8/28 12:30	2.42	0.93		72/ 8/28 10:30 72/ 8/28 11: 0	0.50	0.0013
18	72/ 9/21 6: 0 72/ 9/21 10:50	4.83	0.34		72/ 9/21 8:55 72/ 9/21 11: 0	2.08	0.0381
19	72/10/ 5 8: 0 72/10/ 5 14:10	6.17	0.26		72/10/ 5 8:50 72/10/ 5 14: 0	5.17	1.2660

Table X-7. Quality Summary, Durham, NC, Third Fork Catchment (NC0201).

DURHAM, NORTH CAROLINA. NC0201

STATISTICAL SUMMARY

	31616 FEC COLI MFM-FCBR /100ML	00400 PH SU	00340 COD HI LEVEL MG/L	00341 DISS COD MG/L	00505 RESIDUE TOT VOL MG/L	00535 RESIDUE VOL NFLT MG/L
MEAN	44600.	6.981	161.019	67.476	210.499	131.699
STD. DEVIATION	14400.	0.066	57.340	2.022	14.068	34.136
PARAMETER RANGE						
MIN	320.	6.800	0.700	61.000	105.000	40.000
MAX	200000.	7.500	605.000	100.000	460.000	375.000
NO. OF EVENTS	2	3	4	2	4	4
TOT. MASS LOAD(LBS)	0.480E 13	*********	53254.21	642.85	69549.06	43557.42
TOT. FLOW VOL.(IN)	0.0981	1.3612	1.3653	0.0393	1.3639	1.3653
CONC.(LBS/AC-IN)	0.458E 11	********	36.4890	15.2910	47.7021	29.8449

	00625 TOT KJEL N MG/L	00310 BOD 5 DAY MG/L	00530 RESIDUE TOT NFLT MG/L	00410 T ALK CACO3 MG/L	00500 RESIDUE TOTAL MG/L
MEAN	0.281	127.254	1499.322	36.972	551.349
STD. DEVIATION	0.160	13.596	171.207	7.949	213.107
PARAMETER RANGE					
MIN	0.200	39.000	13.350	26.000	11.350
MAX	1.400	150.000	5460.000	98.000	7300.000
NO. OF EVENTS	3	2	4	2	4
TOT. MASS LOAD(LBS)	92.82	40874.91	495545.30	824.34	182165.90
TOT. FLOW VOL.(IN)	1.3640	1.3259	1.3653	0.0920	1.3639
CONC.(LBS/AC-IN)	0.0637	23.8376	339.5408	8.3784	124.9435

	00665 PHOS-P P-WET MG/L	00680 T ORG C C MG/L	01055 MANGNESE MN UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L
MEAN	0.82	27.30	1270.78	21433.03	800.61
STD. DEVIATION	0.36	8.13	516.59	1983.23	447.41
PARAMETER RANGE					
MIN	0.270	0.500	350.000	1600.000	100.000
MAX	3.500	72.000	2310.000	27000.000	1510.000
NO. OF EVENTS	3	3	2	2	2
TOT. MASS LOAD(LBS)	270.91	656.71	30.19	509.10	19.02
TOT. FLOW VOL.(IN)	1.3640	0.0993	0.0981	0.0981	0.0981
CONC.(LBS/AC-IN)	0.1958	6.1862	0.2880	4.8570	0.1914

Table X-8. Event Summary, Lancaster, PA, Stevens Avenue Catchment (PA0101). The reason for the excessive runoff volume for event 6 is unknown.

LANCASTER, PENNSYLVANIA. PA0101

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
1	73/ 9/14 6: 5.0 73/ 9/14 20:55.0	14.83	2.50		73/ 9/14 7:30.0 73/ 9/14 20:58.5	13.47	0.4918
2	73/10/29 7:20.0 73/10/29 12:15.0	4.92	1.54		73/10/29 8: 8.0 73/10/29 11:11.0	3.05	0.8992
3	73/11/24 11:10.0 73/11/24 13:50.0	2.67	0.13		73/11/24 13:14.0 73/11/24 14:51.5	1.63	0.0576
4	73/11/28 15: 0.0 73/11/28 15:45.0	0.75	0.23		73/11/28 15:11.5 73/11/28 16:53.5	1.70	0.1464
5	73/12/13 15:30.0 73/12/13 23:15.0	7.75	0.18		73/12/13 16:12.0 73/12/13 18:21.0	2.15	0.1273
6	74/ 1/21 9:10.0 74/ 1/21 13:15.0	4.08	0.81		74/ 1/21 10: 0.0 74/ 1/21 13:54.0	3.90	0.8827

Table X-9. Quality Summary, Lancaster PA, Stevens Avenue Catchment (PA0101).

LANCASTER,PENNSYLVANIA, PA0101

STATISTICAL SUMMARY

	00011 WATER TEMP FAHN	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00299 DO PROBE MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00500 RESIDUE TOTAL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00540 RESIDUE FIX NFLT MG/L
MEAN	55.824	154.344	6.994	9.163	56.210	208.563	436.985	164.667	271.341	118.912	152.501
STD. DEVIATION	8.835	80.795	0.122	0.958	49.267	118.051	168.120	35.198	171.143	66.439	113.529
PARAMETER RANGE											
MIN	34.000	20.000	5.500	1.100	12.000	40.000	112.000	36.000	34.000	1.000	1.000
MAX	76.000	650.000	8.000	12.100	587.000	1090.000	1512.000	598.000	1172.000	778.000	548.000
NO. OF EVENTS	6	6	6	6	5	5	5	5	5	5	5
TOT. MASS LOAD(LBS)	*********	*********	*********	706.184	3293.246	12219.230	25280.220	9526.227	15735.410	6895.863	8854.430
TOT. FLOW VOL.(IN)	2.5566	2.5566	2.5566	2.5379	1.9294	1.9294	1.9051	1.9051	1.9097	1.9097	1.9120
CONC.(LBS/AC-IN)	********	********	********	2.0765	12.7381	47.2632	99.0269	37.3158	61.4897	26.9472	34.5588

	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00620 NO3-N TOTAL MG/L	00665 PHOS-P P-WET MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	70507 PHOS-T ORTHO MG/L P	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L
MEAN	2.169	3.539	0.095	5.898	20.870	0.882	10.299	0.710	29.698	2219.157	156.408
STD. DEVIATION	1.673	1.448	0.005	1.405	5.377	0.321	6.192	0.251	4.884	785.155	35.133
PARAMETER RANGE											
MIN	0.100	1.000	0.050	0.500	7.200	0.060	2.500	0.400	10.000	100.000	90.000
MAX	9.900	14.700	0.200	17.000	78.000	5.100	54.200	2.650	180.000	18000.000	550.000
NO. OF EVENTS	5	5	3	5	5	5	5	5	3	3	5
TOT. MASS LOAD(LBS)	126.677	207.127	5.050	345.192	1195.422	50.463	602.786	41.561	1.380	102.824	8.091
TOT. FLOW VOL.(IN)	1.9229	1.9275	1.7498	1.9275	1.8863	1.8840	1.9275	1.9275	1.5300	1.5259	1.7035
CONC.(LBS/AC-IN)	0.4916	0.8019	0.0215	1.3365	4.7294	0.1999	2.3338	0.1609	0.0067	0.5029	0.0354

	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	7539.121	361.120
STD. DEVIATION	7281.113	193.306
PARAMETER RANGE		
MIN	100.000	100.000
MAX	33000.000	1350.000
NO. OF EVENTS	3	5
TOT. MASS LOAD(LBS)	349.324	18.706
TOT. FLOW VOL.(IN)	1.5259	1.7058
CONC.(LBS/AC-IN)	1.7085	0.0818

Table X-10. Event Summary, Lincoln, NB, 39th and Holdrege Catchment (NB0101).

LINCOLN, NEBRASKA. NB0101

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
1	72/ 4/15 16:15 72/ 4/16 0:45	8.50	0.60	5.00	72/ 4/15 16:35 72/ 4/15 18:40	2.08	0.0675
2	72/ 4/27 12: 0 72/ 4/27 21: 0	9.00	1.46	5.00	72/ 4/27 14:10 72/ 4/27 21: 0	6.83	0.3384
3	72/ 5/23 11:45 72/ 5/23 15:15	3.50	0.85	10.00	72/ 5/23 12:30 72/ 5/23 14: 0	1.50	0.1285
4	72/ 6/ 4 6: 5 72/ 6/ 4 7: 5	1.00	0.50	5.00	72/ 6/ 4 6:20 72/ 6/ 4 7: 5	0.75	0.0360
5	72/ 6/13 17:45 72/ 6/13 21:45	4.00	0.57	2.00	72/ 6/13 17:55 72/ 6/13 19: 5	1.17	0.0943
6	72/ 6/16 5: 0 72/ 6/16 7:15	2.25	0.15	1.00	72/ 6/16 5:30 72/ 6/16 6:35	1.08	0.0544
7	72/ 7/ 4 5:48 72/ 7/ 4 6:48	1.00	0.10	15.00	72/ 7/ 4 6: 3 72/ 7/ 4 9:54	3.85	0.0023
8	72/ 7/11 1:46 72/ 7/11 3:16	1.50	0.15	2.00	72/ 7/11 2: 1 72/ 7/11 3:30	1.48	0.0143
9	72/ 7/25 23:15 72/ 7/26 4:15	5.00	0.90	7.00	72/ 7/25 23:30 72/ 7/26 3:50	4.33	0.2917
10	72/ 7/31 11:55 72/ 7/31 14:25	2.50	0.35	4.00	72/ 7/31 12:10 72/ 7/31 13: 0	0.83	0.0251
11	72/ 8/ 8 1: 0 72/ 8/ 8 1:20	0.33	0.65	4.00	72/ 8/ 8 1:15 72/ 8/ 8 2: 5	0.83	0.1570
12	73/ 3/10 1: 0 73/ 3/10 10:30	9.50	1.30		73/ 3/10 2:30 73/ 3/10 11:15	8.75	0.9653
13	73/ 3/22 23:30 73/ 3/23 19:30	20.00	1.05		73/ 3/23 1: 0 73/ 3/23 7: 0	6.00	0.6814
14	73/ 4/19 7:45 73/ 4/19 9: 0	1.25	0.25		73/ 4/19 8: 0 73/ 4/19 9:30	1.50	0.0864
15	73/ 5/21 5:15 73/ 5/21 6:15	1.00	0.18		73/ 5/21 5:45 73/ 5/21 6:30	0.75	0.0792
16	73/ 6/ 2 10: 0 73/ 6/ 2 12:30	2.50	0.30		73/ 6/ 2 10:45 73/ 6/ 2 13: 0	2.25	0.1937
17	73/ 6/ 4 8: 0 73/ 6/ 4 9: 0	1.00	0.15		73/ 6/ 4 8:10 73/ 6/ 4 10: 0	1.83	0.1053
18	73/ 7/ 3 22:30 73/ 7/ 4 0: 0	1.50	0.76		73/ 7/ 3 22:45 73/ 7/ 4 0:45	2.00	0.5160

Table X-11. Quality Summary Lincoln, NB, 39th and Holdrege Catchment (NB0101).

LINCOLN,NEBRASKA. NB0101

STATISTICAL SUMMARY

	00070 TURB JKSN JTU	00095 CNDUCTVY AT 25C MICROMHO	00671 PHOS-D ORTHO MG/L P	00340 COD HI LEVEL MG/L	00500 RESIDUE TOTAL MG/L	00505 RESIDUE TOT VOL MG/L	00605 ORG N N MG/L	00620 NO3-N TOTAL MG/L	00535 RESIDUE VOL NFLT MG/L	00480 SALINITY PPTH	00310 BOD 5 DAY MG/L
MEAN	798.544	103.550	0.566	212.922	977.475	325.540	4.099	0.484	151.646	1.333	37.613
STD. DEVIATION	374.503	59.172	0.421	114.911	329.357	2[illegible]7.482	4.076	0.186	83.803	0.540	51.796
PARAMETER RANGE											
MIN	31.000	49.000	0.050	23.000	175.000	24.000	0.600	0.010	10.000	1.000	1.000
MAX	3000.000	650.000	4.700	1740.000	5220.000	2250.000	34.300	1.200	720.000	10.000	885.000
NO. OF EVENTS	13	17	13	14	17	16	14	13	12	9	13
TOT. MASS LOAD(LBS)	*********	*********	19.558	13347.330	60092.630	17768.120	207.916	12.573	5981.961	19440.000	2240.477
TOT. FLOW VOL.(IN)	2.6059	3.0809	1.9286	3.5016	3.6191	3.0498	2.8334	1.4516	2.2034	0.8149	3.3273
CONC.(LBS/AC-IN)	*********	*********	0.1284	48.2511	210.1788	73.7719	0.9289	0.1096	34.3650	301.9863	8.5236

	00530 RESIDUE TOT NFLT MG/L
MEAN	735.932
STD. DEVIATION	302.807
PARAMETER RANGE	
MIN	8.000
MAX	4530.000
NO. OF EVENTS	16
TOT. MASS LOAD(LBS)	47511.[illegible]00
TOT. FLOW VOL.(IN)	3.6062
CONC.(LBS/AC-IN)	166.7725

Table X-12. Event Summary, Lincoln, NB, 63rd and Holdrege Catchment (NB0102).

LINCOLN,NEBRASKA. NB0102

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
1	72/ 4/15 16:15 72/ 4/16 0:45	8.50	0.60	5.00	72/ 4/15 16:55 72/ 4/15 19: 0	2.08	0.5346
2	72/ 5/11 11:15 72/ 5/11 15:45	4.50	0.62	3.00	72/ 5/11 12:35 72/ 5/11 15:15	2.67	0.7827
3	72/ 7/25 11:10 72/ 7/25 16:10	5.00	0.80	7.00	72/ 7/25 11:25 72/ 7/25 13:50	2.42	0.1300
4	72/ 7/31 18: 5 72/ 7/31 20:35	2.50	0.35	3.00	72/ 7/31 18:20 72/ 7/31 19:35	1.25	0.0458
5	73/ 3/10 2:40 73/ 3/10 11:40	9.00	0.90		73/ 3/10 2:55 73/ 3/10 11:10	8.25	0.9030
6	73/ 3/23 0:45 73/ 3/23 8:15	7.50	1.65		73/ 3/23 1: 0 73/ 3/23 7:35	6.58	0.9970
7	73/ 4/19 8:15 73/ 4/19 9:45	1.50	0.25		73/ 4/19 8:30 73/ 4/19 9:45	1.25	0.0503
8	73/ 6/ 2 21:50 73/ 6/ 3 0:20	2.50	0.30		73/ 6/ 2 22: 5 73/ 6/ 3 0:55	2.83	0.2569
9	73/ 6/ 4 7:50 73/ 6/ 4 9:20	1.50	0.15		73/ 6/ 4 8: 5 73/ 6/ 4 9:15	1.17	0.0463
10	73/ 6/ 5 4:55 73/ 6/ 5 5:25	0.50	0.15		73/ 6/ 5 5:10 73/ 6/ 5 6: 0	0.83	0.0588
11	73/ 6/18 6:30 73/ 6/18 7: 0	0.50	0.22		73/ 6/18 6:45 73/ 6/18 7:20	0.58	0.0318
12	73/ 7/13 10:35 73/ 7/13 12:35	2.00	1.23		73/ 7/13 10:50 73/ 7/13 12:30	1.67	0.4689
13	73/ 7/18 4:45 73/ 7/18 5:40	0.92	0.60		73/ 7/18 4:50 73/ 7/18 5:55	1.08	0.2086
14	74/ 5/26 5:10 74/ 5/26 6:15	1.08	0.85		74/ 5/26 5:15 74/ 5/26 6:30	1.25	0.6719

Table X-13. Quality Summary, Lincoln, NB, 63rd and Holdrege Catchment (NB0102).

LINCOLN, NEBRASKA. NB0102

STATISTICAL SUMMARY

	00070 TURB JKSN JTU	00095 CNDUCTVY AT 25C MICROMHO	00671 PHOS-D ORTHO MG/L P	00340 COD HI LEVEL MG/L	00500 RESIDUE TOTAL MG/L	00505 RESIDUE TOT VOL MG/L	00605 ORG N N MG/L	00620 NO3-N TOTAL MG/L	00535 RESIDUE VOL NFLT MG/L	00480 SALINITY PPTH	00310 BOD 5 DAY MG/L
MEAN	779.355	90.044	0.156	156.457	1134.276	228.874	3.066	0.847	118.570	1.012	22.067
STD. DEVIATION	178.029	33.015	0.057	119.437	277.065	108.471	0.783	2.868	30.554	0.031	32.492
PARAMETER RANGE											
MIN	50.000	40.000	0.010	24.000	115.000	50.000	1.200	0.100	6.000	1.000	0.600
MAX	2000.000	1090.000	0.380	1450.000	3130.000	1305.000	7.400	71.000	315.000	2.000	350.000
NO. OF EVENTS	11	13	11	14	11	11	11	11	7	4	11
TOT. MASS LOAD(LBS)	**********	**********	10.990	15631.270	86840.370	16524.930	202.389	55.058	3389.979	27501.150	1941.587
TOT. FLOW VOL.(IN)	4.5393	4.0393	3.0646	5.1868	3.9746	3.7483	3.4273	3.3747	1.4842	1.4108	4.5678
CONC.(LBS/AC-IN)	**********	**********	0.0353	35.4553	257.0427	51.8661	0.6947	0.1919	26.8697	229.3309	5.0007

	00530 RESIDUE TOT NFLT MG/L
MEAN	827.719
STD. DEVIATION	228.437
PARAMETER RANGE	
MIN	30.000
MAX	2230.000
NO. OF EVENTS	12
TOT. MASS LOAD(LBS)	71893.370
TOT. FLOW VOL.(IN)	4.5052
CONC.(LBS/AC-IN)	187.5727

Table X-14. Event Summary, Lincoln, NB, 78th and A Catchment (NB0103).

LINCOLN, NEBRASKA. NB0103

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR.MON.D.HR.MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR.MON.D.HR.MIN)	DURATION (HRS)	VOLUME (INCH)
1	72/ 4/27 12: 0 72/ 4/27 21: 0	9.00	1.46	5.00	72/ 4/27 14: 0 72/ 4/27 21: 0	7.00	0.1559
2	72/ 5/23 0: 0 72/ 5/23 2:30	2.50	0.85	10.00	72/ 5/23 0:30 72/ 5/23 3:30	3.00	0.0864
3	72/ 6/ 4 5:20 72/ 6/ 4 5:32	0.20	0.16	5.00	72/ 6/ 4 6:20 72/ 6/ 4 8:15	1.92	0.0065
4	72/ 6/13 12:15 72/ 6/13 21: 0	8.75	0.65	2.00	72/ 6/13 18: 3 72/ 6/13 21:30	3.45	0.0663
5	72/ 6/16 17: 0 72/ 6/16 18:15	1.25	0.75	1.00	72/ 6/16 17:39 72/ 6/16 17:44	0.08	0.0199
6	72/ 7/ 4 9: 0 72/ 7/ 4 10: 0	1.00	0.05	15.00	72/ 7/ 4 10: 0 72/ 7/ 4 10:30	0.50	0.0002
7	72/ 7/25 9:50 72/ 7/25 14:50	5.00	0.80	7.00	72/ 7/25 10: 5 72/ 7/25 16: 0	5.92	0.0705
8	73/ 6/ 5 5: 0 73/ 6/ 5 5:45	0.75	0.15		73/ 6/ 5 5:30 73/ 6/ 5 6:30	1.00	0.0023
9	73/ 6/18 6:30 73/ 6/18 7: 0	0.50	0.23		73/ 6/18 7: 0 73/ 6/18 8: 0	1.00	0.0064
10	73/ 6/30 7:30 73/ 6/30 8:15	0.75	0.10		73/ 6/30 7:45 73/ 6/30 8:45	1.00	0.0020
11	73/ 7/13 1:45 73/ 7/13 3:45	2.00	1.23		73/ 7/13 2: 0 73/ 7/13 10:15	8.25	0.0166

Table X-15. Quality Summary, Lincoln, NB, 78th and A Catchment (NB0103).

LINCOLN,NEBRASKA, NB0103

STATISTICAL SUMMARY

	00070 TURB JKSN JTU	00095 CNDUCTVY AT 25C MICROMHO	00671 PHOS-D ORTHO MG/L P	00340 COD HI LEVEL MG/L	00500 RESIDUE TOTAL MG/L	00505 RESIDUE TOT VOL MG/L	00605 ORG N N MG/L	00620 NO3-N TOTAL MG/L	00535 RESIDUE VOL NFLT MG/L	00480 SALINITY PPTH	00310 BOD 5 DAY MG/L
MEAN	1128.673	141.746	0.665	94.237	1723.969	292.640	3.592	0.703	189.142	1.030	8.737
STD. DEVIATION	582.674	59.628	0.319	37.760	925.307	114.363	1.351	0.318	90.454	0.027	5.106
PARAMETER RANGE											
MIN	25.000	60.000	0.050	3.000	32.000	20.000	0.200	0.120	1.000	1.000	1.000
MAX	5000.000	850.000	1.700	1355.000	29250.000	2630.000	15.900	1.800	2700.000	6.000	50.000
NO. OF EVENTS	9	11	10	10	10	9	10	11	5	5	9
TOT. MASS LOAD(LBS)	*********	*********	13.518	3293.764	55573.890	6164.871	66.485	21.222	2755.865	30700.080	277.604
TOT. FLOW VOL.(IN)	0.2710	0.4329	0.2514	0.4320	0.3985	0.2604	0.2288	0.3732	0.1801	0.3686	0.3927
CONC.(LBS/AC-IN)	*********	*********	0.1506	21.3554	390.6753	66.3162	0.8141	0.1593	42.8623	233.3075	1.9800

	00530 RESIDUE TOT NFLT MG/L
MEAN	1532.044
STD. DEVIATION	780.411
PARAMETER RANGE	
MIN	10.000
MAX	26750.000
NO. OF EVENTS	10
TOT. MASS LOAD(LBS)	51597.470
TOT. FLOW VOL.(IN)	0.4163
CONC.(LBS/AC-IN)	347.1824

Table X-16. Event and Quality Summaries, Racine, WI, Site I Catchment (WI0101).

RACINE,WISCONSIN. WI0101

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	73/ 7/20 13:55 73/ 7/20 19:40	5.75	3.32		73/ 7/20 13:57 73/ 7/20 19:30	5.55	0.2230
2	73/ 9/24 22:15 73/ 9/25 3:10	4.92	0.62		73/ 9/24 23:10 73/ 9/25 4:50	5.67	0.0758
3	73/11/14 16:20 73/11/14 22:55	6.58	0.64		73/11/14 16:50 73/11/15 0: 0	7.17	0.1132
4	74/ 4/18 14: 0 74/ 4/18 17: 0	3.00	0.26		74/ 4/18 15: 0 74/ 4/18 18:30	3.50	0.0263
5	74/ 4/28 22:30 74/ 4/29 3: 0	4.50	1.45		74/ 4/28 23:50 74/ 4/29 8: 0	8.17	0.2053
6	74/ 5/ 5 8:50 74/ 5/ 5 10:15	1.42	0.11		74/ 5/ 5 10:20 74/ 5/ 5 11:30	1.17	0.0046
7	74/ 5/13 12: 0 74/ 5/13 12:55	0.92	0.24		74/ 5/13 12:40 74/ 5/13 14:30	1.83	0.0213
8	74/ 6/ 6 16:50 74/ 6/ 6 22: 5	5.25	0.68		74/ 6/ 6 17:20 74/ 6/ 7 0: 0	6.67	0.0817
9	74/ 8/16 12:30 74/ 8/16 15: 5	2.58	0.25		74/ 8/16 13: 0 74/ 8/16 20:10	7.17	0.0456

RACINE,WISCONSIN. WI0101

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	00310 BOD 5 DAY MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	14700000.	89.622	178.914
STD. DEVIATION	19500000.	17.670	137.347
PARAMETER RANGE			
MIN	2000.	17.000	7.000
MAX	240000000.	238.000	725.000
NO. OF EVENTS	6	7	7
TOT. MASS LOAD(LBS)	0.291E 16	5319.387	10619.150
TOT. FLOW VOL.(IN)	0.2319	0.3158	0.3158
CONC.(LBS/AC-IN)	0.151E 14	20.3096	40.5444

Table X-17. Event and Quality Summaries, San Francisco, CA, Baker St. Catchment (CA0101). Runoff greater than rainfall for one storm is noted in documentation (35) and possibly explained by flows diverted into the catchment during high rainfalls.

SAN FRANCISCO,CALIFORNIA. CA0101

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
1	69/ 4/ 4 22: 0 69/ 4/ 5 7: 0	9.00	0.32		69/ 4/ 4 22:40 69/ 4/ 5 6:30	7.83	0.3442
2	69/10/14 23:41 69/10/15 7:18	7.62	0.39		69/10/15 3:10 69/10/15 6:40	3.50	0.1919
3	69/11/ 5 3:20 69/11/ 5 8:15	4.92	0.53		69/11/ 5 4: 0 69/11/ 5 8:10	4.17	0.4645

SAN FRANCISCO,CALIFORNIA. CA0101

STATISTICAL SUMMARY

	31505 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	00095 CNDUCTVY AT 25C MICROMHO	00400 PH SU	90065 % SUSP SOLIDS 75U FLT	90066 % SUSP SOLIDS 14U FLT	90067 % SUSP SOLIDS 5U FLT	90068 % SUSP SOLIDS .45U FLT	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00410 T ALK CACO3 MG/L
MEAN	24100000.	4930000.	753.341	7.011	44.683	32.651	17.098	11.614	22.921	138.071	51.507
STD. DEVIATION	12400000.	5200000.	787.177	0.161	27.772	6.053	13.601	1.964	6.018	56.291	9.669
PARAMETER RANGE											
MIN	430000.	0.	127.000	6.600	1.700	2.000	1.200	4.400	5.000	12.000	24.600
MAX	110000000.	24000000.	23000.000	7.400	100.000	112.000	58.000	21.700	80.000	626.000	152.000
NO. OF EVENTS	3	3	3	2	3	3	2	2	3	3	3
TOT. MASS LOAD(LBS)	0.405E 16	0.830E 15	*********	*********	*********	*********	*********	*********	865.309	5259.711	1962.138
TOT. FLOW VOL.(IN)	0.9742	0.9742	1.0006	0.8087	1.0006	0.9916	0.7655	0.7710	0.9916	1.0006	1.0006
CONC.(LBS/AC-IN)	0.248E 14	0.507E 13	********	********	********	********	********	********	5.1941	31.2887	11.6723

	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00545 RESIDUE, SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P	90055 FLOATBLS MG/L
MEAN	90.654	53.745	1.749	1.321	14.065	0.844	2.144
STD. DEVIATION	14.473	8.808	0.490	0.343	9.118	0.163	0.915
PARAMETER RANGE							
MIN	20.000	15.000	0.400	0.200	0.100	0.080	0.100
MAX	340.000	155.000	5.500	3.800	110.300	3.300	10.500
NO. OF EVENTS	3	3	3	3	3	3	3
TOT. MASS LOAD(LBS)	3453.411	2047.392	66.616	50.312	535.798	30.941	81.678
TOT. FLOW VOL.(IN)	1.0006	1.0006	1.0006	1.0006	1.0006	0.9630	1.0006
CONC.(LBS/AC-IN)	20.5435	12.1794	0.3963	0.2993	3.1873	0.1913	0.4859

Table X-18. Event and Quality Summaries, San Francisco, CA, Mariposa St. Catchment (CA0102).

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	69/ 2/27 21:14 69/ 2/28 5:15	8.02	0.33		69/ 2/27 17:50 69/ 2/28 6:13	12.38	0.3216
2	69/ 3/20 10:30 69/ 3/20 15: 0	4.50	0.22		69/ 3/20 11: 0 69/ 3/20 16: 0	5.00	0.1560
3	69/ 4/ 2 10:30 69/ 4/ 2 11:20	0.83	0.07		69/ 4/ 2 11:20 69/ 4/ 2 13:30	2.17	0.0321

STATISTICAL SUMMARY

	31501 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	90065 % SUSP SOLIDS 75U FLT	90066 % SUSP SOLIDS 14U FLT	90067 % SUSP SOLIDS 5U FLT	90069 % SUSP SOLIDS .45U FLT	00095 CNDUCTVY AT 25C MICROMHO	00400 PH SU	90055 FLOATBLS MG/L	70507 PHOS-T ORTHO MG/L P	70351 GREASE HEX SOL MG/L
MEAN	5980000.	2200000.	20.035	74.113	3.420	4.060	430.997	6.036	2.217	2.268	17.836
STD. DEVIATION	7790000.	1600000.	2.319	0.982	2.053	0.275	164.377	0.415	1.440	0.515	11.144
PARAMETER RANGE											
MIN	230000.	30000.	3.400	41.900	0.800	0.600	138.000	1.900	0.100	0.800	0.800
MAX	45599990.	75000000.	56.000	87.400	15.800	14.800	3100.000	9.100	23.700	11.400	1327.000
NO. OF EVENTS	3	3	2	2	2	2	3	2	3	3	3
TOT. MASS LOAD(LBS)	0.699E 15	0.257E 15	*********	*********	*********	*********	*********	*********	52.553	58.413	459.438
TOT. FLOW VOL.(IN)	0.5097	0.5097	0.1787	0.1787	0.1688	0.1763	0.5097	0.1882	0.4691	0.5097	0.5097
CONC.(LBS/AC-IN)	0.615E 13	0.226E 13	********	********	********	********	********	********	0.5023	0.5139	4.0418

	00610 NH3-N TOTAL MG/L	00340 COD HI LEVEL MG/L	00545 RESIDUE SETTLBLE MG/L	00535 RESIDUE VOL NFLT MG/L	00310 BOD 5 DAY MG/L	00530 RESIDUE TOT NFLT MG/L	00410 T ALK CACO3 MG/L
MEAN	1.556	188.831	4.047	78.088	43.154	172.432	82.358
STD. DEVIATION	1.610	121.864	0.431	35.789	42.497	86.389	18.031
PARAMETER RANGE							
MIN	0.100	16.000	0.100	4.000	10.000	32.000	47.000
MAX	11.900	12800.000	19.000	4420.000	327.000	4948.000	341.000
NO. OF EVENTS	3	3	2	3	3	3	2
TOT. MASS LOAD(LBS)	40.070	4864.223	38.485	2011.511	1036.906	4441.789	783.167
TOT. FLOW VOL.(IN)	0.5097	0.5097	0.1882	0.5097	0.4617	0.5097	0.1882
CONC.(LBS/AC-IN)	0.3525	42.7917	0.9171	17.6957	9.7793	39.0754	18.6634

Table X-19. Event and Quality Summaries, San Francisco, CA, Brotherhood Way Catchment (CA0103).

SAN FRANCISCO,CALIFORNIA. CA0103

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR.MON.D.HR.MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR.MON.D.HR.MIN)	DURATION (HRS)	VOLUME (INCH)
1	70/ 1/14 1: 0 70/ 1/14 3:30	2.50	0.27		70/ 1/14 1: 0 70/ 1/14 5: 0	4.00	0.2034
2	70/ 1/15 18: 0 70/ 1/15 23: 0	5.00	0.46		70/ 1/15 18:45 70/ 1/15 22:45	4.00	0.1437
3	70/ 1/23 3: 0 70/ 1/23 5: 0	2.00	0.02		70/ 1/23 2:40 70/ 1/23 5:29	2.82	0.0148

SAN FRANCISCO,CALIFORNIA. CA0103

STATISTICAL SUMMARY

	31505 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	00095 CNDUCTVY AT 25C MICROMHO	00400 PH SU	90065 % SUSP SOLIDS 75U FLT	90066 % SUSP SOLIDS 14U FLT	90067 % SUSP SOLIDS 5U FLT	90068 % SUSP SOLIDS .45U FLT	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00410 T ALK CACO3 MG/L
MEAN	4510000.	743000.	75.364	6.738	79.772	8.689	6.104	7.888	45.620	100.057	15.879
STD. DEVIATION	1690000.	1140000.	39.008	0.258	0.573	1.508	2.075	0.122	24.727	92.231	6.519
PARAMETER RANGE											
MIN	360000.	0.	38.000	6.300	57.100	1.800	0.400	2.800	9.000	19.000	8.800
MAX	11000000.	11000000.	443.000	7.100	100.000	19.600	12.900	25.000	131.000	1252.000	62.400
NO. OF EVENTS	3	3	3	3	2	2	2	2	3	3	3
TOT. MASS LOAD(LBS)	0.302E 15	0.498E 14	*********	*********	*********	*********	*********	*********	651.776	1477.244	234.434
TOT. FLOW VOL.(IN)	0.3619	0.3619	0.3619	0.3619	0.3471	0.3394	0.3329	0.3329	0.3503	0.3619	0.3619
CONC.(LBS/AC-IN)	0.463E 13	0.764E 12	********	********	********	********	********	********	10.3382	22.6744	3.5984

	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00545 RESIDUE SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P	90055 FLOATBLS MG/L
MEAN	654.847	500.404	1.308	0.809	34.356	0.815	37.129
STD. DEVIATION	524.571	457.136	0.844	0.264	24.161	0.179	105.115
PARAMETER RANGE							
MIN	15.000	10.000	0.100	0.130	3.100	0.200	2.100
MAX	5540.000	5517.000	10.000	6.100	423.000	2.460	1415.000
NO. OF EVENTS	3	3	3	3	3	3	3
TOT. MASS LOAD(LBS)	9668.129	7387.949	19.307	11.944	507.229	11.770	548.176
TOT. FLOW VOL.(IN)	0.3619	0.3619	0.3619	0.3619	0.3619	0.3542	0.3619
CONC.(LBS/AC-IN)	148.3974	113.3986	0.2964	0.1833	7.7855	0.1846	8.4140

Table X-20. Event and Quality Summaries, San Francisco, CA, Vicente St. North Catchment (CA0104). The quality summary is for variation within the one storm event. Runoff greater than rainfall is noted in documentation (35) and possibly explained by unknown diversions into the drainage system during high flows.

SAN FRANCISCO, CALIFORNIA. CA0104

EVENT INFORMATION

EVENT NUMBER

	RAINFALL				FLOW		
	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
	70/ 2/16 16: 0 70/ 2/16 21: 0	5.00	0.39		70/ 2/16 16:20 70/ 2/16 21:20	5.00	0.4783

PARAMETER INFORMATION

(1) 70/ 2/16 16: 0	31505 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	00095 CNDUCTVY AT 25C MICROMHO	00400 PH SU	90065 % SUSP SOLIDS 75U FLT	90066 % SUSP SOLIDS 14U FLT	90067 % SUSP SOLIDS 5U FLT	90068 % SUSP SOLIDS .45U FLT	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00410 T ALK CACO3 MG/L
MEAN	568000.	108000.	177.103	5.495	78.707	11.257	6.476	3.559	9.784	66.176	10.264
STD. DEVIATION	473000.	228000.	67.258	2.033	9.480	6.502	3.777	2.477	11.395	55.210	7.050
PARAMETER RANGE MIN	90000.	20000.	113.000	0.400	40.600	4.300	2.700	0.600	3.000	27.000	6.300
MAX	4300000.	2300000.	600.000	6.700	89.200	29.800	18.900	21.600	98.000	428.000	42.000
TIME RANGE OF MEASUREMENTS START	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20
END	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20
NO.OF MEASURED DATA POINTS	8	8	8	8	8	8	8	8	8	10	8
TIME RANGE USED IN CALCULATIONS START	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20	16:20
END	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20	21:20
NO.OF DATA POINTS USED IN CALCS.	8	8	8	8	8	8	8	8	8	10	8
NO.OF INTERPOLATED DATA POINTS	4	4	4	4	4	4	4	4	4	2	4
MASS LOAD(POUNDS)	0.447E 13	0.852E 12	*********	*********	*********	*********	*********	*********	16.967	114.759	17.799
FLOW VOLUME(INCH) FOR PARAMETER	0.4783	0.4783	0.4783	0.4783	0.4783	0.4783	0.4783	0.4783	0.4783	0.4783	0.4783
CONC.(LBS/AC-IN)	0.584E 12	0.111E 12	********	********	********	********	********	********	2.2172	14.9963	2.3259
NO.OF USED FLOW VALUES	12	12	12	12	12	12	12	12	12	12	12
NO.OF INTERPOLATED FLOW VALUES	0	0	0	0	0	0	0	0	0	0	0

(1) 70/ 2/16 16: 0	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00545 RESIDUE SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P	90055 FLOATBLS MG/L
MEAN	48.270	18.711	0.568	0.209	7.456	0.098	2.716
STD. DEVIATION	29.246	11.385	0.744	0.128	2.692	0.070	1.082
PARAMETER RANGE MIN	20.000	7.000	0.350	0.120	4.500	0.080	1.000
MAX	210.000	77.000	5.700	1.360	17.900	0.770	6.300
TIME RANGE OF MEASUREMENTS START	16:20	16:20	16:20	16:20	16:20	16:20	16:20
END	21:20	21:20	18:20	21:20	21:20	21:20	21:20.
NO.OF MEASURED DATA POINTS	10	10	5	8	8	8	8
TIME RANGE USED IN CALCULATIONS START	16:20	16:20	16:20	16:20	16:20	16:20	16:20
END	21:20	21:20	18:20	21:20	21:20	21:20	21:20
NO.OF DATA POINTS USED IN CALCS.	10	10	5	8	8	8	8
NO.OF INTERPOLATED DATA POINTS	2	2	1	4	4	4	4
MASS LOAD(POUNDS)	83.708	32.448	0.577	0.363	12.929	0.170	4.711
FLOW VOLUME(INCH) FOR PARAMETER	0.4783	0.4783	0.2799	0.4783	0.4783	0.4783	0.4783
CONC.(LBS/AC-IN)	10.9386	4.2402	0.1288	0.0474	1.6895	0.0222	0.6156
NO.OF USED FLOW VALUES	12	12	6	12	12	12	12
NO.OF INTERPOLATED FLOW VALUES	0	0	0	0	0	0	0

Table X-21. Event and Quality Summaries, San Francisco, CA, Vicente, St. South Catchment (CA0105). The quality summary is for variation within the one storm event.

SAN FRANCISCO, CALIFORNIA, CA0105

EVENT NUMBER

EVENT INFORMATION

RAINFALL DATE (START-END) (YR.MON.D.HR.MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE (START-END) (YR.MON.D.HR.MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
70/ 2/16 16:10 70/ 2/16 20:50	4.67	0.38		70/ 2/16 16:25 70/ 2/16 21:25	5.00	0.2916

PARAMETER INFORMATION

(1) 70/ 2/16 16:10	31505 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	90065 % SUSP SOLIDS 75U FLT	90066 % SUSP SOLIDS 14U FLT	90067 % SUSP SOLIDS 5U FLT	90068 % SUSP SOLIDS .45U FLT	00095 CNDUCTVY AT 25C MICROMHO	00400 PH SU	90055 FLOATRLS MG/L	70507 PHOS-T ORTHO MG/L P	70351 GREASE HEX SOL MG/L
MEAN	200000.	39900.	86.200	7.689	4.841	4.475	255.215	6.309	4.012	0.387	12.483
STD. DEVIATION	456000.	75700.	6.000	3.091	2.451	0.645	93.521	0.113	1.239	0.133	3.010
PARAMETER RANGE MIN	40000.	0.	73.600	1.600	0.600	1.800	144.000	6.100	1.200	0.020	6.600
MAX	2300000.	930000.	99.000	12.500	21.100	6.230	630.000	6.900	7.400	1.250	21.520
TIME RANGE OF MEASUREMENTS START	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25
END	21:25	21:25	21:25	21:25	21:25	20:25	21:25	21:25	21:25	21:25	20:25
NO. OF MEASURED DATA POINTS	8	8	8	7	8	6	9	9	8	8	7
TIME RANGE USED IN CALCULATIONS START	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25	16:25
END	21:25	21:25	21:25	21:25	21:25	20:25	21:25	21:25	21:25	21:25	20:25
NO. OF DATA POINTS USED IN CALCS.	8	8	8	7	8	6	9	9	8	8	7
NO. OF INTERPOLATED DATA POINTS	5	5	5	6	5	5	4	4	5	5	4
MASS LOAD (POUNDS)	0.126E 13	0.251E 12	*********	*********	*********	*********	*********	*********	5.567	0.121	16.247
FLOW VOLUME (INCH) FOR PARAMETER	0.2916	0.2916	0.2916	0.2916	0.2916	0.2735	0.2916	0.2916	0.2916	0.2916	0.2735
CONC. (LBS/AC-IN)	0.205E 12	0.410E 11	********	********	********	********	********	********	0.9091	0.0197	2.8287
NO. OF USED FLOW VALUES	13	13	13	.3	13	11	13	13	13	13	11
NO. OF INTERPOLATED FLOW VALUES	0	0	0	0	0	0	0	0	0	0	0

(1) 70/ 2/16 16:10	00610 NH3-N TOTAL MG/L	00340 COD HI LEVEL MG/L	00545 RESIDUE SETTLBLE MG/L	00535 RESIDUE VOL NFLT MG/L	00310 BOD 5 DAY MG/L	00530 RESIDUE TOT NFLT MG/L	00410 T ALK CACO3 MG/L
MEAN	0.296	61.161	0.367	17.045	4.529	45.801	11.920
STD. DEVIATION	0.892	38.076	0.685	12.446	3.421	29.310	6.315
PARAMETER RANGE MIN	0.010	31.000	0.040	5.000	1.000	11.000	9.000
MAX	4.840	230.000	5.250	77.000	29.000	210.000	42.400
TIME RANGE OF MEASUREMENTS START	16:25	16:25	16:25	16:25	16:25	16:25	16:25
END	21:25	21:25	21:25	21:25	21:25	21:25	21:25
NO. OF MEASURED DATA POINTS	8	10	8	10	8	10	9
TIME RANGE USED IN CALCULATIONS START	16:25	16:25	16:25	16:25	16:25	16:25	16:25
END	21:25	21:25	21:25	21:25	21:25	21:25	21:25
NO. OF DATA POINTS USED IN CALCS.	8	10	8	10	8	10	9
NO. OF INTERPOLATED DATA POINTS	5	3	5	3	5	3	4
MASS LOAD (POUNDS)	0.410	84.875	0.509	23.654	6.284	63.560	16.403
FLOW VOLUME (INCH) FOR PARAMETER	0.2916	0.2916	0.2916	0.2916	0.2916	0.2916	0.2916
CONC. (LBS/AC-IN)	0.0670	13.8598	0.0831	3.8626	1.0262	10.3792	2.6785
NO. OF USED FLOW VALUES	13	13	13	13	13	13	13
NO. OF INTERPOLATED FLOW VALUES	0	0	0	0	0	0	0

Table X-22. Event Summary, San Francisco, CA, Selby St. Catchment (CA0106). The storage capacity of the Selby St. trunk sewer is equivalent to 0.043 in. over the catchment area (34). This volume must be filled for each event before the monitored combined sewer overflow begins.

SAN FRANCISCO, CALIFORNIA. CA0106

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR.MON.D.HR.MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR.MON.D.HR.MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	66/11/ 6 9: 0 66/11/ 6 12:40	3.67	0.92		66/11/ 6 10:34 66/11/ 6 15:24	4.83	0.1621
2	66/11/14 20: 0 66/11/15 0: 0	4.00	0.18		66/11/14 21:55 66/11/15 1: 5	3.17	0.0705
3	66/11/15 5:55 66/11/15 11:30	5.58	0.24		66/11/15 6:35 66/11/15 12:20	5.75	0.2054
4	67/ 1/20 4:30 67/ 1/21 23: 0	42.50	4.59		67/ 1/20 7:10 67/ 1/22 1:30	42.33	3.1704
5	67/ 1/23 20:15 67/ 1/24 5: 0	8.75	1.11		67/ 1/23 21:25 67/ 1/24 3:30	6.08	0.5188
6	67/ 2/24 20: 0 67/ 2/25 0: 0	4.00	0.17		67/ 2/24 20:50 67/ 2/24 22: 0	1.17	0.0304
7	67/ 3/10 20:15 67/ 3/11 1:45	5.50	1.27		67/ 3/10 21:50 67/ 3/11 0:40	2.83	0.2871
8	67/ 3/15 18: 0 67/ 3/16 1:35	7.58	1.17		67/ 3/15 22:25 67/ 3/16 1:34	3.15	0.2608

Table X-23. Quality Summary, San Francisco, CA, Selby St. Catchment (CA0106).

STATISTICAL SUMMARY

	31505 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	00095 CNDUCTVY AT 25C MICROMHO	90055 FLOATBLS MG/L	70351 GREASE HEX SOL MG/L	00610 NH3-N TOTAL MG/L	00340 COD HI LEVEL MG/L	90060 RES-SETL 30 MIN ML/L	00625 TOT KJEL N MG/L	00650 T PO4 PO4 MG/L	00535 RESIDUE VOL NFLT MG/L
MEAN	11900000.	1290000.	173.664	4.475	11.887	1.757	148.057	0.759	3.835	0.795	67.845
STD. DEVIATION	9620000.	2380000.	42.348	3.299	11.641	1.970	101.099	1.098	3.657	0.580	64.869
PARAMETER RANGE											
MIN	230000.	0.	67.000	0.500	0.400	0.350	33.000	0.100	0.350	0.220	4.000
MAX	130000000.	62000000.	714.000	44.600	122.000	19.600	1762.000	14.500	54.000	8.550	886.000
NO. OF EVENTS	4	4	5	7	8	7	8	7	8	8	7
TOT. MASS LOAD(LBS)	0.455E 17	0.495E 16	*********	15275.66	43098.59	3785.82	536788.90	2592.23	13799.55	2881.15	232344.30
CA 1 66611 6 855	1.0971	1.0971	0.9859	4.4301	4.7056	2.7973	4.7056	4.4301	4.6706	4.7056	4.4448
CONC.(LBS/AC-IN)	0.122E 14	0.133E 13	********	1.0142	2.6939	0.3980	33.5517	0.1721	0.8690	0.1801	15.3746

	00945 SULFATE SO4 MG/L	00929 SODIUM NA.TOT MG/L	00310 BOD 5 DAY MG/L	00530 RESIDUE TOT NFLT MG/L	00410 T ALK CACO3 MG/L	00937 PTSSIUM K.TOT MG/L	00916 CALCIUM CA-TOT MG/L	00927 MGNSIUM MG.TOT MG/L	00544 RESIDUE VOL SET MG/L	90063 COD SETTLED MG/L	00940 CHLORIDE CL MG/L
MEAN	21.773	10.350	38.087	215.436	34.389	2.034	9.821	2.772	36.631	66.275	12.014
STD. DEVIATION	3.641	3.158	30.048	146.021	7.663	0.581	1.718	0.648	7.718	46.841	3.191
PARAMETER RANGE											
MIN	10.000	5.000	2.000	24.000	13.800	0.800	4.000	0.490	5.000	16.300	4.200
MAX	92.000	84.500	480.000	1260.000	855.000	12.300	46.400	19.900	442.000	2209.000	129.200
NO. OF EVENTS	8	8	8	8	8	8	8	8	2	2	7
TOT. MASS LOAD(LBS)	71435.56	37523.79	138088.30	781076.50	124678.70	7372.79	35321.02	9970.65	104124.00	140056.60	42057.60
CA 1 66611 6 855	4.2582	4.7056	4.7056	4.7056	4.7056	4.7056	4.6680	4.6680	3.6892	2.7428	4.5434
CONC.(LBS/AC-IN)	4.9341	2.3454	8.6311	48.8207	7.7930	0.4608	2.2255	0.6282	8.3011	15.0187	2.7226

Table X-24. Event and Quality Summaries, San Francisco, CA, Laguna St. Catchment (CA0107).

SAN FRANCISCO, CALIFORNIA. CA0107

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR.MON.D.HR.MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR.MON.D.HR.MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	67/ 3/10 20:35 67/ 3/11 0: 0	3.42	0.97		67/ 3/10 20:45 67/ 3/11 0: 0	3.25	0.1940
2	67/ 3/15 19:55 67/ 3/16 0: 0	4.08	0.93		67/ 3/15 20:20 67/ 3/16 0: 0	3.67	0.3470

SAN FRANCISCO, CALIFORNIA. CA0107

STATISTICAL SUMMARY

	31505 TOT COLI MPN CONF /100ML	31615 FEC COLI MPNECMED /100ML	00095 CNDUCTVY AT 25C MICROMHO	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00410 T ALK CACO3 MG/L	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00650 T PO4 PO4 MG/L
MEAN	14500000.	1430000.	115.396	46.337	145.469	24.535	210.717	98.398	2.386	4.691	0.881
STD. DEVIATION	5720000.	125000.	11.167	8.796	33.093	3.620	100.958	37.553	0.762	0.918	0.132
PARAMETER RANGE											
MIN	0.	0.	62.000	4.000	41.000	13.800	53.000	28.000	0.350	1.050	0.240
MAX	70000000.	13000000.	338.000	252.000	458.000	82.000	483.000	264.000	23.800	19.950	3.200
NO. OF EVENTS	2	2	2	2	2	2	2	2	2	2	2
TOT. MASS LOAD(LBS)	0.302E 16	0.299E 15	*********	2130.284	6687.777	1127.968	9687.469	4523.750	85.260	186.864	40.522
CA 1 767 3102030	0.5410	0.5410	0.5410	0.5410	0.5410	0.5410	0.5410	0.5410	0.4204	0.4688	0.5410
CONC.(LBS/AC-IN)	0.149E 14	0.147E 13	********	10.5006	32.9653	5.5600	47.7513	22.2984	0.5408	1.0629	0.1997

	00916 CALCIUM CA-TOT MG/L	00927 MGNSIUM MG.TOT MG/L	00929 SODIUM NA.TOT MG/L	00937 PTSSIUM K.TOT MG/L	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L	90055 FLOATBLS MG/L	90060 RES-SETL 30 MIN ML/L
MEAN	6.148	2.139	8.059	1.752	8.023	11.144	17.704	2.741	0.888
STD. DEVIATION	0.865	0.085	0.556	0.074	0.745	1.170	7.928	2.054	0.167
PARAMETER RANGE									
MIN	4.000	0.700	2.000	1.050	3.000	5.000	2.200	0.400	0.200
MAX	15.200	5.800	29.500	6.700	32.000	29.000	63.400	7.800	4.000
NO. OF EVENTS	2	2	2	2	2	2	2	2	2
TOT. MASS LOAD(LBS)	282.663	98.346	370.501	80.525	368.852	512.341	813.941	126.019	23.736
CA 1 767 3102030	0.5410	0.5410	0.5410	0.5410	0.5410	0.5410	0.5410	0.5410	0.3145
CONC.(LBS/AC-IN)	1.3933	0.4848	1.8263	0.3969	1.8181	2.5254	4.0121	0.6212	0.2013

Table X-25. Event Summary, Seattle, WA, Viewridge 1 Catchment (WA0101).

SEATTLE,WASHINGTON,VIEW RIDGE 1, WA 0101

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	RAINFALL PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	73/ 2/14 14: 5 73/ 2/14 18:35	4.50	0.07		73/ 2/14 13: 0 73/ 2/14 22: 0	9.00	0.0042
2	73/ 3/16 9: 5 73/ 3/16 10:15	1.17	0.04		73/ 3/16 8: 0 73/ 3/16 12:45	4.75	0.0097
3	73/ 6/ 6 12:30 73/ 6/ 6 15:50	3.33	0.13		73/ 6/ 6 12: 0 73/ 6/ 6 17:15	5.25	0.0065
4	73/ 8/16 12:30 73/ 8/16 15:40	3.17	0.09		73/ 8/16 11:30 73/ 8/16 16:45	5.25	0.0028
5	73/ 9/19 10: 5 73/ 9/19 19:15	9.17	0.28		73/ 9/19 9:45 73/ 9/19 19:15	9.50	0.0189
6	74/10/20 2: 0 74/10/20 7: 0	5.00	0.41	40.00	74/10/20 3:20 74/10/20 8: 0	4.67	0.0750
7	74/11/17 2:15 74/11/18 4:30	26.25	1.70	5.00	74/11/17 7:30 74/11/17 15: 0	7.50	0.0677
8	75/ 2/12 0: 0 75/ 2/12 15: 0	15.00	0.34	0.10	75/ 2/12 12:30 75/ 2/12 17:45	5.25	0.0095
9	75/ 2/13 2: 0 75/ 2/13 12: 0	10.00	0.03	0.50	75/ 2/13 3:30 75/ 2/13 5:45	2.25	0.0037
10	75/ 2/13 16: 0 75/ 2/13 23: 0	7.00	0.18	0.50	75/ 2/13 17:45 75/ 2/14 1:15	7.50	0.0324
11	75/ 2/15 12: 0 75/ 2/15 23: 0	11.00	0.16	1.50	75/ 2/15 13:45 75/ 2/15 19:30	5.75	0.0198
12	75/ 8/22 13:30 75/ 8/23 12:15	22.75	1.04		75/ 8/23 7: 0 75/ 8/23 11:45	4.75	0.0264
13	75/ 8/27 13: 0 75/ 8/27 21: 0	8.00	0.14	4.00	75/ 8/27 14: 0 75/ 8/27 22:30	8.50	0.0196
14	75/ 9/16 15: 0 75/ 9/16 23: 0	8.00	0.10	15.00	75/ 9/16 17: 0 75/ 9/17 0:45	7.75	0.0211
15	75/10/ 2 21: 0 75/10/ 3 7:15	10.25	0.33	16.00	75/10/ 3 0:30 75/10/ 3 8:15	7.75	0.0379
16	75/10/ 5 6:45 75/10/ 5 20: 0	13.25	0.98	1.20	75/10/ 5 6:30 75/10/ 5 20: 0	13.50	0.0944
17	75/10/ 9 0: 0 75/10/ 9 23: 0	23.00	0.65	3.50	75/10/ 9 1: 0 75/10/10 5:45	28.75	0.1460
18	75/10/14 14: 0 75/10/14 21: 0	7.00	0.12	4.80	75/10/14 15:30 75/10/14 22: 0	6.50	0.0193
19	75/10/20 21: 0 75/10/21 10: 0	13.00	0.34	1.80	75/10/20 22:45 75/10/21 12: 0	13.25	0.0782
20	75/10/21 14: 0 75/10/21 23: 0	9.00	0.39	0.20	75/10/21 15: 0 75/10/22 0:45	9.75	0.0483
21	75/10/22 7: 0 75/10/22 9: 0	2.00	0.13	0.40	75/10/22 0: 0 75/10/22 15: 0	15.00	0.0552
22	75/10/22 19: 0 75/10/22 22: 0	3.00	0.24	0.50	75/10/22 21: 0 75/10/23 7:45	10.75	0.0318
23	75/10/24 18: 0 75/10/24 23: 0	5.00	0.03	1.90	75/10/24 20: 0 75/10/25 12:45	16.75	0.0523
24	75/10/26 7: 0 75/10/26 23: 0	16.00	0.34	0.80	75/10/26 10: 0 75/10/26 22: 0	12.00	0.0458
25	75/10/27 2: 0 75/10/27 19: 0	17.00	0.36	0.10	75/10/27 1: 0 75/10/27 15:15	14.25	0.0459
26	75/11/13 12: 0 75/11/15 16: 0	52.00	2.30	0.40	75/11/14 13:45 75/11/15 8: 0	18.25	0.1314
27	75/11/15 20: 0 75/11/16 6: 0	10.00	0.71	0.20	75/11/15 21: 0 75/11/16 7: 0	10.00	0.1372
28	75/11/16 12: 0 75/11/16 16: 0	4.00	0.05	0.30	75/11/16 7: 0 75/11/16 19: 0	12.00	0.0733
29	75/11/22 7: 0 75/11/22 20: 0	13.00	0.52	5.80	75/11/22 7: 0 75/11/23 7:15	24.25	0.2320
30	75/12/ 7 2: 0 75/12/ 8 0: 0	22.00	0.48	2.70	75/12/ 7 4: 0 75/12/ 8 3:45	23.75	0.1250

Table X-26. Quality Summary, Seattle, WA, Viewridge 1 Catchment (WA0101).

SEATTLE,WASHINGTON,VIEW RIDGE 1. WA 0101

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	26100.	8280.	11.808	12.889	105.022	6.838	8.542	18.391	84.325	142.048	55.627
STD. DEVIATION	13400.	5720.	2.931	9.355	37.998	0.243	1.732	11.197	30.760	68.985	102.495
PARAMETER RANGE											
MIN	490.	50.	7.20	0.11	29.00	6.40	4.70	0.50	3.00	12.00	1.00
MAX	88000.	38000.	18.30	116.00	400.00	8.30	11.80	150.00	370.00	500.00	4803.00
NO. OF EVENTS	5	7	6	28	24	6	5	7	7	5	28
TOT. MASS LOAD(LBS)	0.574E 12	0.630E 12	**********	**********	**********	**********	41.412	463.868	2126.897	688.669	11053.180
TOT. FLOW VOL.(IN)	0.0340	0.1176	0.1739	1.3918	1.3341	0.1641	0.0340	0.1767	0.1767	0.0340	1.3918
CONC.(LBS/AC-IN)	0.268E 11	0.851E 10	********	********	********	********	1.9357	4.1677	19.1093	32.1902	12.6059

	00546 RESIDUE SETTLBLE MG/L	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00665 PHOS-P P-WET MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L
MEAN	125.535	1.063	0.075	0.079	2.124	0.571	0.255	0.369	7.680	18.932	12.490
STD. DEVIATION	80.325	1.051	0.153	0.038	1.381	0.237	0.236	0.193	4.203	8.211	2.451
PARAMETER RANGE											
MIN	0.10	0.01	0.01	0.01	0.42	0.02	0.05	0.10	1.00	1.00	1.00
MAX	440.00	9.99	2.20	0.22	15.00	4.30	4.44	3.00	25.00	34.00	55.00
NO. OF EVENTS	7	20	28	5	5	28	25	5	5	5	7
TOT. MASS LOAD(LBS)	3157.774	200.144	14.902	0.381	10.300	113.485	57.445	1.787	37.232	84.400	262.128
TOT. FLOW VOL.(IN)	0.1762	1.3189	1.3918	0.0340	0.0340	1.3918	1.5790	0.0340	0.0340	0.0312	0.1470
CONC.(LBS/AC-IN)	28.4479	0.2409	0.0170	0.0178	0.4814	0.1294	0.0577	0.0835	1.7403	4.2903	2.8303

	70507 PHOS-T ORTHO MG/L P	01002 ARSENIC AS.TOT UG/L	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	0.069	51.427	4.033	18.819	23.595	2015.066	137.056	71.929
STD. DEVIATION	0.060	3.837	0.285	19.792	14.803	830.354	136.539	49.462
PARAMETER RANGE								
MIN	0.01	49.00	0.40	9.00	10.00	90.00	20.00	5.00
MAX	1.13	100.00	10.00	100.00	230.00	9600.00	3000.00	990.00
NO. OF EVENTS	30	3	26	7	7	7	26	26
TOT. MASS LOAD(LBS)	15.857	0.155	0.743	0.316	0.396	33.699	25.261	13.257
TOT. FLOW VOL.(IN)	1.6130	0.0212	1.2910	0.1176	0.1176	0.1171	1.2910	1.2910
CONC.(LBS/AC-IN)	0.0156	0.0117	0.0009	0.0043	0.0053	0.4566	0.0311	0.0163

Table X-27. Event Summary, Seattle, WA, Viewridge 2 Catchment (WA0102). Runoff greater than rainfall is consistent with value given in documentation (33) and is unexplained.

SEATTLE,WASHINGTON,VIEW RIDGE 2, WA 0102

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	73/ 2/14 14:20 73/ 2/14 18:25	4.08	0.06		73/ 2/14 14:20 73/ 2/14 20:55	6.58	0.0407
2	73/ 3/10 0: 5 73/ 3/10 6:10	6.08	0.31		73/ 3/10 0: 5 73/ 3/10 6:10	6.08	0.7070
3	73/ 3/16 9: 5 73/ 3/16 10:10	1.08	0.05		73/ 3/16 7:37 73/ 3/16 12:55	5.30	0.0786
4	73/ 8/16 12:30 73/ 8/16 15:40	3.17	0.09		73/ 8/16 10:55 73/ 8/16 16:45	5.83	0.0271
5	73/ 9/19 9:30 73/ 9/19 19: 0	9.50	0.29		73/ 9/19 9:30 73/ 9/19 19: 0	9.50	0.1566

Table X-28. Quality Summary, Seattle, WA, Viewridge 2 Catchment (WA0102).

SEATTLE,WASHINGTON,VIEW RIDGE 2. WA 0102

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	17000.	5910.	10.218	26.769	95.222	7.343	10.800	12.925	62.398	84.084	107.673
STD. DEVIATION	10500.	2830.	2.914	6.091	38.485	0.352	1.252	9.424	14.127	28.948	33.157
PARAMETER RANGE											
MIN	1400.	30.	8.00	1.90	50.00	6.40	5.70	1.00	3.00	46.00	1.00
MAX	93000.	32000.	18.00	77.00	325.00	7.90	13.40	260.00	360.00	280.00	470.00
NO. OF EVENTS	5	5	5	5	5	4	5	5	5	5	4
TOT. MASS LOAD(LBS)	0.177E 13	0.613E 12	**********	**********	**********	**********	246.788	295.329	1426.620	1922.440	2358.674
TOT. FLOW VOL.(IN)	0.9609	0.9609	0.9603	0.9609	0.9609	0.8868	0.9603	0.9603	0.9609	0.9609	0.9206
CONC.(LBS/AC-IN)	0.175E 11	0.608E 10	********	********	********	********	2.4475	2.9289	14.1402	19.0546	24.4001

	00546 RESIDUE SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P	01002 ARSENIC AS.TOT UG/L
MEAN	46.269	0.098	0.052	1.181	0.520	0.285	3.103	9.431	20.037	0.060	49.833
STD. DEVIATION	23.183	0.119	0.033	0.775	0.208	0.098	3.159	6.065	6.936	0.043	0.389
PARAMETER RANGE											
MIN	0.10	0.02	0.02	0.03	0.25	0.09	0.90	1.00	0.50	0.03	49.00
MAX	480.00	1.60	0.23	10.10	2.40	2.60	62.00	39.00	40.00	0.57	50.00
NO. OF EVENTS	5	5	5	5	5	5	4	5	5	5	2
TOT. MASS LOAD(LBS)	1057.855	2.230	1.194	26.991	11.900	6.518	67.966	189.002	458.101	1.362	0.170
TOT. FLOW VOL.(IN)	0.9609	0.9609	0.9609	0.9609	0.9609	0.9609	0.9206	0.8423	0.9609	0.9609	0.1438
CONC.(LBS/AC-IN)	10.4851	0.0221	0.0118	0.2675	0.1179	0.0646	0.7031	2.1371	4.5406	0.0135	0.0113

	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	4.124	9.201	49.336	911.561	168.979	51.987
STD. DEVIATION	0.116	0.402	30.497	849.532	117.390	48.522
PARAMETER RANGE						
MIN	3.90	9.00	10.00	120.00	100.00	5.00
MAX	11.00	10.00	200.00	7400.00	2500.00	640.00
NO. OF EVENTS	5	5	5	5	5	5
TOT. MASS LOAD(LBS)	0.094	0.210	1.128	20.841	3.863	1.189
TOT. FLOW VOL.(IN)	0.9609	0.9609	0.9609	0.9609	0.9609	0.9609
CONC.(LBS/AC-IN)	0.0009	0.0021	0.0112	0.2066	0.0383	0.0118

Table X-29. Event Summary, Seattle, WA, South Seattle Catchment (WA0103). Runoff greater than rainfall for some events is unexplained. Large difference for event 5 is consistent with documentation (33).

SEATTLE,WASHINGTON,SOUTH SEATTLE, WA 0103

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	RAINFALL PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	73/ 3/10 0: 5 73/ 3/10 4: 5	4.00	0.41		73/ 3/10 0: 5 73/ 3/10 7:40	7.58	0.2565
2	73/ 3/16 8: 5 73/ 3/16 12:15	4.17	0.09		73/ 3/16 7:49 73/ 3/16 12:44	4.92	0.0181
3	73/ 6/ 6 12:15 73/ 6/ 6 16:10	3.92	0.16		73/ 6/ 6 11:10 73/ 6/ 6 18:30	7.33	0.0399
4	73/ 8/16 11: 0 73/ 8/16 15:30	4.50	0.06		73/ 8/16 11: 0 73/ 8/16 17:55	6.92	0.0045
5	73/ 9/19 9:15 73/ 9/19 18:30	9.25	0.28		73/ 9/19 9:15 73/ 9/19 19: 0	9.75	0.4974
6	74/10/20 2: 0 74/10/20 8: 0	6.00	0.57	40.00	74/10/20 3:30 74/10/20 8:30	5.00	0.2296
7	74/11/17 6:15 74/11/18 4:15	22.00	1.25	5.00	74/11/17 7:15 74/11/17 15: 0	7.75	0.2840
8	75/ 2/12 0: 0 75/ 2/12 22: 0	22.00	0.48	0.20	75/ 2/12 11:15 75/ 2/12 18:30	7.25	0.0177
9	75/ 2/13 2: 0 75/ 2/13 11: 0	9.00	0.31	0.60	75/ 2/13 3:15 75/ 2/13 7:30	4.25	0.0094
10	75/ 2/13 11: 0 75/ 2/13 23: 0	12.00	0.18	0.30	75/ 2/13 12:15 75/ 2/14 2:45	14.50	0.0727
11	75/ 2/15 13: 0 75/ 2/15 22: 0	9.00	0.30	1.50	75/ 2/15 13:15 75/ 2/15 21: 0	7.75	0.0452
12	75/ 2/23 15:30 75/ 2/23 20:30	5.00	0.42	3.50	75/ 2/23 16:15 75/ 2/23 22:30	6.25	0.1161
13	75/ 3/ 8 18: 0 75/ 3/ 8 23: 0	5.00	0.28	6.00	75/ 3/ 8 19:15 75/ 3/ 9 2:30	7.25	0.0670
14	75/ 4/14 18: 0 75/ 4/14 22: 0	4.00	0.08	2.40	75/ 4/14 19:45 75/ 4/15 0: 0	4.25	0.0244
15	75/ 6/17 1: 0 75/ 6/17 11: 0	10.00	0.16	13.00	75/ 6/17 2:45 75/ 6/17 13:30	10.75	0.1913
16	75/ 6/24 7: 0 75/ 6/24 13: 0	6.00	0.20	1.10	75/ 6/24 8: 0 75/ 6/24 14: 0	6.00	0.1779
17	75/ 8/27 13: 0 75/ 8/27 21: 0	8.00	0.15	4.20	75/ 8/27 16: 0 75/ 8/27 23:15	7.25	0.1401
18	75/10/ 3 1: 0 75/10/ 3 3:30	2.50	0.21	36.00	75/10/ 3 0:15 75/10/ 3 7:15	7.00	0.1835
19	75/10/ 3 15:45 75/10/ 3 20: 0	4.25	0.20	0.60	75/10/ 3 15: 0 75/10/ 3 23: 0	8.00	0.2305
20	75/10/ 5 5: 0 75/10/ 5 16:15	11.25	0.58	1.50	75/10/ 5 7:15 75/10/ 5 20:45	13.50	0.4770
21	75/10/14 14: 0 75/10/14 22: 0	8.00	0.14	4.80	75/10/14 15:30 75/10/14 23:30	8.00	0.1095
22	75/10/24 18: 0 75/10/25 4: 0	10.00	0.11	1.90	75/10/24 20: 0 75/10/25 14:45	18.75	0.2401
23	75/10/26 1: 0 75/10/27 12: 0	35.00	0.61	0.30	75/10/26 11: 0 75/10/27 2: 0	15.00	0.3038
24	75/10/27 15: 0 75/10/27 19: 0	4.00	0.12	0.10	75/10/27 15: 0 75/10/28 0:45	9.75	0.1215
25	75/11/13 13: 0 75/11/14 11: 0	22.00	1.05	5.20	75/11/13 12:30 75/11/14 12:30	24.00	0.9212
26	75/11/14 15: 0 75/11/15 7: 0	16.00	0.51	0.20	75/11/14 16: 0 75/11/15 8: 0	16.00	0.4256
27	75/11/22 5: 0 75/11/22 22: 0	17.00	0.44	5.50	75/11/22 6:45 75/11/23 6:15	23.50	0.4632
28	75/12/ 7 4: 0 75/12/ 7 13: 0	9.00	0.37	2.70	75/12/ 7 5:15 75/12/ 7 14:45	9.50	0.3671
29	75/12/ 7 15: 0 75/12/ 8 6: 0	15.00	0.09	0.10	75/12/ 7 16:45 75/12/ 8 3: 0	10.25	0.1151

Table X-30. Quality Summary, Seattle, WA, South Seattle Catchment (WA0103).

SEATTLE.WASHINGTON.SOUTH SEATTLE. WA 0103

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	11400.	485.	13.691	23.163	60.434	6.757	8.842	11.927	86.803	140.627	114.198
STD. DEVIATION	3200.	324.	4.388	14.804	43.105	0.445	1.817	8.157	38.675	10.382	176.272
PARAMETER RANGE											
MIN	4.	2.	7.100	0.710	13.000	6.000	4.000	0.500	5.000	26.000	1.000
MAX	35000.	1700.	23.000	220.000	500.000	7.800	16.000	88.000	340.000	340.000	2976.000
NO. OF EVENTS	4	6	6	28	23	7	5	7	7	4	29
TOT. MASS LOAD(LBS)	0.165E 12	0.135E 11	*********	*********	*********	*********	42.122	93.969	691.341	450.118	4192.625
TOT. FLOW VOL.(IN)	0.5136	0.9870	1.0484	5.6454	5.3891	1.2780	0.7645	1.2642	1.2780	0.5136	5.8913
CONC.(LBS/AC-IN)	0.117E 11	0.498E 09	********	********	********	********	2.0036	2.7029	19.6708	31.8679	25.8789

	00546 RESIDUE SETTLBLE MG/L	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00665 PHOS-P P-WET MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L
MEAN	151.471	0.710	0.137	0.062	2.089	0.379	0.241	0.134	3.509	43.752	12.430
STD. DEVIATION	151.193	0.514	0.144	0.001	0.263	0.476	0.152	0.047	5.789	6.304	2.777
PARAMETER RANGE											
MIN	0.100	0.010	0.010	0.010	0.250	0.030	0.010	0.040	0.900	2.000	2.800
MAX	1270.000	9.990	4.190	0.160	7.100	4.600	2.620	0.900	84.000	78.000	100.000
NO. OF EVENTS	6	22	28	4	4	28	24	4	5	4	6
TOT. MASS LOAD(LBS)	961.270	22.318	4.825	0.198	6.686	13.333	7.830	0.431	16.718	133.956	69.032
TOT. FLOW VOL.(IN)	1.0184	5.0445	5.6411	0.5136	0.5136	5.6454	5.2065	0.5136	0.7645	0.4913	0.8912
CONC.(LBS/AC-IN)	34.3254	0.1609	0.0311	0.0140	0.4733	0.0859	0.0547	0.0305	0.7952	9.9148	2.8167

	70507 PHUS-T ORTHO MG/L P	01002 ARSENIC AS.TOT UG/L	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	0.052	50.047	4.955	18.015	119.878	4236.922	225.348	234.387
STD. DEVIATION	0.038	1.513	1.571	11.373	97.041	3091.664	153.549	134.420
PARAMETER RANGE								
MIN	0.010	40.000	3.900	9.000	4.000	220.000	11.000	17.000
MAX	0.960	100.000	40.000	90.000	400.000	26000.000	1360.000	2300.000
NO. OF EVENTS	28	3	26	7	7	6	26	26
TOT. MASS LOAD(LBS)	1.850	0.153	0.177	0.143	0.955	27.006	8.043	8.366
TOT. FLOW VOL.(IN)	5.7048	0.4911	5.7272	1.2780	1.2780	1.0228	5.7272	5.7272
CONC.(LBS/AC-IN)	0.0118	0.0113	0.0011	0.0041	0.0272	0.9601	0.0511	0.0531

Table X-31. Event Summary, Seattle, WA, Southcenter Catchment (WA0104). Run-off greater than rainfall for some events is possibly due to shorter duration of runoff measurements, contribution of base flow or ambiguous catchment area definition.

SEATTLE,WASHINGTON,SOUTH CENTER, WA 0104

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	RAINFALL PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D-HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	73/ 2/14 14: 5 73/ 2/14 18:40	4.58	0.12		73/ 2/14 14: 5 73/ 2/14 22: 0	7.92	0.0202
2	73/ 3/ 9 23: 5 73/ 3/10 4:30	5.42	0.43		73/ 3/ 9 23: 5 73/ 3/10 6:30	7.42	0.2957
3	73/ 6/ 6 12: 0 73/ 6/ 6 16:25	4.42	0.26		73/ 6/ 6 11:45 73/ 6/ 6 18:45	7.00	0.1798
4	73/ 8/16 13: 0 73/ 8/16 15:35	2.58	0.06		73/ 8/16 12:15 73/ 8/16 19:55	7.67	0.0920
5	73/ 9/19 9:15 73/ 9/19 17:35	8.33	0.32		73/ 9/19 8:30 73/ 9/19 19:30	11.00	0.2274
6	74/10/20 3: 0 74/10/20 9: 0	6.00	0.33	40.00	74/10/20 3:45 74/10/20 8:30	4.75	0.0587
7	74/11/17 5:45 74/11/18 1: 0	19.25	0.54	5.00	74/11/17 7:15 74/11/17 17:15	10.00	0.2449
8	75/ 2/13 2: 0 75/ 2/14 2: 0	24.00	0.20	0.30	75/ 2/13 11:45 75/ 2/14 6:15	18.50	0.1055
9	75/ 2/15 12: 0 75/ 2/15 23: 0	11.00	0.25	1.50	75/ 2/15 12:15 75/ 2/15 21:15	9.00	0.1647
10	75/ 2/23 16: 0 75/ 2/23 22: 0	6.00	0.39	3.50	75/ 2/23 16:30 75/ 2/24 3:15	10.75	0.2529
11	75/ 2/28 1:45 75/ 2/28 8: 0	6.25	0.34	0.30	75/ 2/28 2:15 75/ 2/28 16:15	14.00	0.3038
12	75/ 3/ 1 5: 0 75/ 3/ 2 7: 0	26.00	0.93	0.50	75/ 3/ 1 1: 0 75/ 3/ 2 9:15	32.25	0.8830
13	75/ 4/ 2 0: 0 75/ 4/ 2 17: 0	17.00	0.36	1.50	75/ 4/ 2 0:45 75/ 4/ 2 8:30	7.75	0.1341
14	75/ 4/14 17: 0 75/ 4/14 22: 0	5.00	0.07	6.00	75/ 4/14 19:15 75/ 4/15 1: 0	5.75	0.0735
15	75/ 5/ 3 0: 0 75/ 5/ 3 18: 0	18.00	0.20	0.50	75/ 5/ 3 12:30 75/ 5/ 3 22:30	10.00	0.0584
16	75/ 5/10 15: 0 75/ 5/10 23: 0	8.00	0.23	6.20	75/ 5/10 15:30 75/ 5/10 19:45	4.25	0.0443
17	75/ 6/23 0: 0 75/ 6/23 5: 0	5.00	0.04	5.70	75/ 6/23 0:45 75/ 6/23 6:45	6.00	0.0390
18	75/ 8/ 8 9: 0 75/ 8/ 8 20: 0	11.00	0.08	11.50	75/ 8/ 8 16:45 75/ 8/ 8 22: 0	5.25	0.0214
19	75/ 8/22 12: 0 75/ 8/22 16: 0	4.00	0.09	4.00	75/ 8/22 14: 0 75/ 8/22 18: 0	4.00	0.0299
20	75/ 8/22 21: 0 75/ 8/22 23: 0	2.00	0.02	0.30	75/ 8/22 22:15 75/ 8/23 0:45	2.50	0.0114
21	75/ 8/26 12:45 75/ 8/27 23: 0	34.25	1.26	4.00	75/ 8/27 14:15 75/ 8/27 22: 0	7.75	0.2455
22	75/ 8/28 0: 0 75/ 8/29 10: 0	34.00	0.80	0.40	75/ 8/28 1:15 75/ 8/28 7: 0	5.75	0.0505
23	75/10/ 3 0: 0 75/10/ 3 6:15	6.25	0.22		75/10/ 3 0:45 75/10/ 3 6:15	5.50	0.1406
24	75/10/ 5 6:45 75/10/ 5 22:15	15.50	0.97	1.40	75/10/ 5 8:45 75/10/ 5 20:45	12.00	0.5426
25	75/10/24 18: 0 75/10/25 3: 0	9.00	0.10	1.90	75/10/24 20: 0 75/10/25 21:15	25.25	0.5002
26	75/10/27 0: 0 75/10/28 2: 0	26.00	0.45	0.20	75/10/27 15:30 75/10/28 2: 0	10.[illegible]	0.1855
27	75/10/28 3: 0 75/10/28 23: 0	20.00	0.56	0.20	75/10/28 2: 0 75/10/28 12:30	10.50	0.1285
28	75/11/13 12: 0 75/11/14 14: 0	26.00	1.39	5.10	75/11/13 13:45 75/11/14 15: 0	25.25	1.1607
29	75/11/14 14: 0 75/11/16 6: 0	10.00	0.99	0.40	75/11/14 15:15 75/11/15 10:45	19.50	0.5506

Table X-32. Quality Summary, Seattle, WA, Southcenter Catchment (WA0104).

SEATTLE.WASHINGTON.SOUTH CENTER. WA 0104

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	2650.	67.	13.051	11.606	62.234	6.523	9.562	12.459	62.090	48.517	93.510
STD. DEVIATION	2900.	57.	4.635	5.541	38.700	0.445	1.304	7.706	26.165	35.109	237.035
PARAMETER RANGE											
MIN	30.	2.	7.60	0.89	11.00	5.60	6.00	1.00	8.00	1.00	1.00
MAX	26000.	1100.	19.20	120.00	1530.00	7.50	11.90	230.00	870.00	510.00	14090.00
NO. OF EVENTS	5	7	7	27	23	7	5	7	7	5	27
TOT. MASS LOAD(LBS)	0.506E 11	0.177E 10	*********	*********	*********	*********	40.209	72.861	363.619	203.991	3172.600
TOT. FLOW VOL.(IN)	0.7732	1.0768	1.0768	6.2780	5.7169	1.0768	0.7732	1.0753	1.0768	0.7731	6.2382
CONC.(LBS/AC-IN)	0.273E 10	0.686E 08	********	********	********	********	2.1669	2.8233	14.0704	10.9946	21.1906

	00546 RESIDUE SETTLBLE MG/L	00605 ORG N N MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00665 PHOS-P P-WET MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L
MEAN	50.498	0.535	0.097	0.030	1.293	0.232	0.184	0.148	3.141	12.340	11.485
STD. DEVIATION	37.210	0.375	0.198	0.013	0.793	0.313	0.098	0.061	3.259	5.290	4.850
PARAMETER RANGE											
MIN	0.10	0.01	0.01	0.01	0.25	0.01	0.01	0.03	0.90	4.00	1.00
MAX	1100.00	18.00	3.40	0.13	7.70	9.99	4.50	0.70	65.00	138.00	130.00
NO. OF EVENTS	6	21	28	5	5	28	24	4	5	5	7
TOT. MASS LOAD(LBS)	239.825	15.626	3.318	0.126	5.437	7.965	5.762	0.609	13.210	51.847	60.195
TOT. FLOW VOL.(IN)	0.8732	5.3719	6.3174	0.7732	0.7732	6.3174	5.7522	0.7546	0.7732	0.7725	0.9637
CONC.(LBS/AC-IN)	11.4435	0.1212	0.0219	0.0068	0.2930	0.0525	0.0417	0.0337	0.7119	2.7963	2.6027

	70507 PHOS-T ORTHO MG/L P	01002 ARSENIC AS.TOT UG/L	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	0.045	48.551	20.882	104.932	70.463	806.176	233.491	135.569
STD. DEVIATION	0.053	2.878	79.818	159.860	91.622	950.812	176.513	126.689
PARAMETER RANGE								
MIN	0.01	45.00	0.60	9.00	10.00	20.00	10.00	10.00
MAX	6.14	70.00	7005.00	11000.00	310.00	17000.00	2720.00	1680.00
NO. OF EVENTS	29	3	23	7	7	7	23	22
TOT. MASS LOAD(LBS)	1.602	0.124	0.665	0.615	0.413	4.721	7.433	4.302
TOT. FLOW VOL.(IN)	6.5253	0.4687	5.8517	1.0768	1.0768	1.0768	5.8534	5.8348
CONC.(LBS/AC-IN)	0.0102	0.0110	0.0047	0.0238	0.0160	0.1827	0.0529	0.0307

Table X-33. Event Summary, Seattle, WA, Lake Hills Catchment (WA0105).

SEATTLE,WASHINGTON,LAKE HILLS, WA0105

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	73/ 3/10 0:10 73/ 3/10 4:55	4.75	0.38		73/ 3/10 0:10 73/ 3/10 8: 0	7.83	0.0954
2	73/ 3/16 8: 5 73/ 3/16 11: 5	3.00	0.05		73/ 3/16 8: 5 73/ 3/16 13:45	5.67	0.0168
3	73/ 6/ 6 12:30 73/ 6/ 6 16: 5	3.58	0.26		73/ 6/ 6 12:30 73/ 6/ 6 17:46	5.27	0.0097
4	73/ 8/16 13:15 73/ 8/16 15:55	2.67	0.04		73/ 8/16 13: 0 73/ 8/16 21: 0	8.00	0.0110
5	73/ 9/19 10:15 73/ 9/19 19: 5	8.83	0.25		73/ 9/19 10: 0 73/ 9/19 20:30	10.50	0.0398
6	75/ 4/22 18: 0 75/ 4/23 5: 0	11.00	0.12	4.40	75/ 4/22 19:15 75/ 4/23 5:45	10.50	0.0044
7	75/ 6/24 0:30 75/ 6/24 11: 0	10.50	0.35	1.00	75/ 6/24 8: 0 75/ 6/24 13:30	5.50	0.0234

Table X-34. Quality Summary, Seattle, WA, Lake Hills Catchment (WA0105).

SEATTLE,WASHINGTON,LAKE HILLS. WA0105

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	11900.	3630.	12.124	11.221	40.914	7.380	10.250	6.310	44.023	71.545	61.277
STD. DEVIATION	12200.	4210.	4.555	6.559	13.052	0.430	1.134	2.852	20.176	9.608	9.898
PARAMETER RANGE											
MIN	100.	50.	8.500	2.700	18.000	6.200	3.900	1.400	18.000	1.000	4.000
MAX	78000.	50000.	18.500	44.000	210.000	7.900	11.600	48.000	380.000	370.000	316.000
NO. OF EVENTS	5	5	5	5	5	4	5	5	5	5	5
TOT. MASS LOAD(LBS)	0.284E 12	0.870E 11	*********	*********	*********	*********	54.095	33.166	232.336	377.584	323.394
WA 1 573 310 5	0.1553	0.1553	0.1553	0.1553	0.1553	0.1193	0.1553	0.1546	0.1553	0.1553	0.1553
CONC.(LBS/AC-IN)	0.122E 11	0.373E 10	********	********	********	********	2.3228	1.4299	9.9763	16.2131	13.8862

	00546 RESIDUE SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00665 PHOS-P P-WET MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P
MEAN	45.833	0.118	0.017	0.856	0.377	0.325	0.523	3.052	5.367	9.468	0.076
STD. DEVIATION	12.893	0.084	0.009	0.634	0.167	0.027	1.043	2.922	2.797	2.977	0.063
PARAMETER RANGE											
MIN	0.100	0.020	0.010	0.220	0.050	0.160	0.120	0.900	1.000	0.200	0.010
MAX	390.000	1.100	0.190	5.800	2.400	0.590	9.000	60.000	34.000	52.000	0.470
NO. OF EVENTS	5	5	5	5	5	2	5	5	5	5	4
TOT. MASS LOAD(LBS)	241.885	0.621	0.091	4.520	1.989	0.280	2.762	16.108	26.903	49.969	0.369
WA 1 573 310 5	0.1553	0.1553	0.1553	0.1553	0.1553	0.0254	0.1553	0.1553	0.1475	0.1553	0.1423
CONC.(LBS/AC-IN)	10.3863	0.0267	0.0039	0.1941	0.0854	0.0736	0.1186	0.6917	1.2163	2.1456	0.0173

	01002 ARSENIC AS.TOT UG/L	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	50.648	4.413	9.873	81.400	289.447	205.502	62.487
STD. DEVIATION	1.244	0.349	0.329	92.416	172.391	93.250	51.833
PARAMETER RANGE							
MIN	49.000	3.900	9.000	9.000	60.000	90.000	10.000
MAX	60.000	8.000	210.000	350.000	1900.000	2500.000	490.000
NO. OF EVENTS	3	5	5	5	5	5	5
TOT. MASS LOAD(LBS)	0.097	0.023	0.052	0.430	1.528	1.106	0.330
WA 1 573 310 5	0.0563	0.1553	0.1553	0.1553	0.1553	0.1553	0.1553
CONC.(LBS/AC-IN)	0.0115	0.0010	0.0022	0.0184	0.0656	0.0475	0.0142

Table X-35. Event Summary, Seattle, WA, Highlands Catchment (WA0106).

SEATTLE,WASHINGTON,HIGH LANDS, WA 0106

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
1	73/ 3/10 0: 5 73/ 3/10 5: 5	5.00	0.35		73/ 3/10 0: 5 73/ 3/10 8: 0	7.92	0.0370
2	73/ 3/16 8:30 73/ 3/16 10:10	1.67	0.04		73/ 3/16 7:30 73/ 3/16 12:15	4.75	0.0279
3	73/ 6/ 6 12: 5 73/ 6/ 6 15:10	3.08	0.05		73/ 6/ 6 12: 5 73/ 6/ 6 17:15	5.17	0.0030
4	73/ 9/19 9:15 73/ 9/19 16:20	7.08	0.26		73/ 9/19 9:15 73/ 9/19 18:15	9.00	0.0049

Table X-36. Quality Summary, Seattle, WA, Highlands Catchment (WA0106).

SEATTLE,WASHINGTON,HIGH LANDS. WA 0106

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	3050.	1560.	8.529	26.331	117.798	7.157	10.191	4.189	64.971	94.385	109.267
STD. DEVIATION	6770.	3450.	1.684	19.868	46.187	0.415	0.511	3.771	37.022	16.068	71.460
PARAMETER RANGE MIN	110.	27.	8.00	1.00	56.00	6.10	5.20	0.50	5.00	8.00	4.00
MAX	35000.	18000.	14.80	57.00	970.00	7.90	11.70	33.50	220.00	210.00	620.00
NO. OF EVENTS	4	3	4	4	4	4	4	4	4	4	4
TOT. MASS LOAD(LBS)	0.158E 11	0.378E 10	*********	*********	*********	*********	11.628	4.793	74.329	107.980	124.678
TOT. FLOW VOL.(IN)	0.0594	0.0278	0.0592	0.0594	0.0594	0.0592	0.0592	0.0594	0.0594	0.0594	0.0592
CONC.(LBS/AC-IN)	0.314E 10	0.160E 10	********	********	********	********	2.3094	0.9494	14.7233	21.3889	24.7614

	00546 RESIDUE SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00669 PHOS-T HYDRO MG/L P	00940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P	01002 ARSENIC AS.TOT UG/L
MEAN	72.113	0.084	0.016	1.370	0.984	0.360	6.682	21.197	9.540	0.078	49.620
STD. DEVIATION	57.392	0.033	0.004	0.768	0.256	0.200	3.911	7.839	6.379	0.031	0.501
PARAMETER RANGE MIN	0.10	0.01	0.01	0.22	0.20	0.08	2.00	6.00	0.60	0.03	49.00
MAX	390.00	0.20	0.03	4.10	1.40	0.80	15.00	36.00	38.00	0.24	50.00
NO. OF EVENTS	4	4	4	4	4	4	4	4	4	4	2
TOT. MASS LOAD(LBS)	82.501	0.096	0.018	1.568	1.126	0.411	7.644	20.697	10.914	0.089	0.005
TOT. FLOW VOL.(IN)	0.0594	0.0594	0.0594	0.0594	0.0594	0.0592	0.0594	0.0507	0.0594	0.0594	0.0056
CONC.(LBS/AC-IN)	16.3419	0.0190	0.0035	0.3105	0.2230	0.0816	1.5142	4.8034	2.1618	0.0176	0.0112

	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	4.479	9.964	158.654	345.367	103.238	43.728
STD. DEVIATION	0.620	0.187	58.989	166.857	19.622	27.988
PARAMETER RANGE MIN	3.90	9.00	9.00	20.00	9.00	9.00
MAX	10.00	10.00	350.00	3100.00	270.00	180.00
NO. OF EVENTS	4	4	3	4	4	4
TOT. MASS LOAD(LBS)	0.005	0.011	0.085	0.395	0.118	0.050
TOT. FLOW VOL.(IN)	0.0594	0.0594	0.0278	0.0594	0.0594	0.0594
CONC.(LBS/AC-IN)	0.0010	0.0023	0.0360	0.0783	0.0234	0.0099

Table X-37. Event Summary, Seattle, WA, Central Business District Catchment (WA0107). Runoff greater than rainfall is due to the contribution of dry-weather flow in the combined sewer, flowing at a rate of about 0.012 in./hr over the catchment area.

CENTRAL BUSINESS DISTRICT. WA0107

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR.MON.D,HR.MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR.MON.D.HR.MIN)	DURATION (HRS)	VOLUME (INCH)
1	73/ 3/10 0:10 73/ 3/10 3:50	3.67	0.28		73/ 3/10 0:10 73/ 3/10 7: 0	6.83	0.3324
2	73/ 3/16 7: 5 73/ 3/16 10:25	3.33	0.05		73/ 3/16 7: 5 73/ 3/16 12:30	5.42	0.0907
3	73/ 6/ 6 12: 0 73/ 6/ 6 15:45	3.75	0.16		73/ 6/ 6 11:30 73/ 6/ 6 16:30	5.00	0.1246
4	73/ 8/16 12:15 73/ 8/16 15:35	3.33	0.07		73/ 8/16 12:15 73/ 8/16 16: 0	3.75	0.1425
5	73/ 9/19 9:20 73/ 9/19 16:30	7.17	0.25		73/ 9/19 9: 2 73/ 9/19 18:35	9.55	0.250

Table X-38. Quality Summary, Seattle, WA, Central Business District Catchment (WA0107).

CENTRAL BUSINESS DISTRICT. WA0107

STATISTICAL SUMMARY

	31501 TOT COLI MFIMENDO /100ML	31616 FEC COLI MFM-FCBR /100ML	00010 WATER TEMP CENT	00070 TURB JKSN JTU	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00300 DO MG/L	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00515 RESIDUE DISS-105 C MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	33700.	22200.	17.481	43.655	166.718	6.487	7.670	64.319	175.890	150.247	161.783
STD. DEVIATION	12700.	11600.	1.698	6.623	86.846	0.755	2.339	37.655	67.939	47.741	21.663
PARAMETER RANGE											
MIN	170.	8.	11.200	10.000	25.000	3.900	1.800	9.000	31.000	1.000	4.000
MAX	92000.	92000.	20.700	180.000	430.000	7.700	11.900	220.000	480.000	2300.000	724.000
NO. OF EVENTS	5	5	4	5	5	5	5	5	5	5	5
TOT. MASS LOAD(LBS)	0.785E 12	0.522E 12	*********	*********	*********	*********	37.935	318.103	869.903	778.001	800.134
WA 1 773 310 5	0.8160	0.8219	0.4921	0.8219	0.8219	0.7851	0.7851	0.7851	0.7851	0.8219	0.7851
CONC.(LBS/AC-IN)	0.346E 11	0.229E 11	********	********	********	********	1.7382	14.5756	39.8592	34.0481	36.6623

	00546 RESIDUE SETTLBLE MG/L	00610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00669 PHOS-T HYDRO MG/L P	C0940 CHLORIDE CL MG/L	00945 SULFATE SO4 MG/L	70351 GREASE HEX SOL MG/L	70507 PHOS-T ORTHO MG/L P	01002 ARSENIC AS.TOT UG/L
MEAN	100.542	2.296	0.104	8.665	0.719	1.560	65.673	20.376	18.176	0.456	49.808
STD. DEVIATION	28.500	2.236	0.060	5.939	0.278	1.207	162.553	11.287	8.913	0.490	0.541
PARAMETER RANGE											
MIN	0.100	0.080	0.010	0.270	0.150	0.080	4.000	2.000	1.000	0.010	49.000
MAX	570.000	18.000	0.300	31.000	2.100	15.200	3000.000	55.000	140.000	3.200	60.000
NO. OF EVENTS	5	5	5	5	5	5	5	5	5	5	3
TOT. MASS LOAD(LBS)	520.618	11.891	0.540	44.867	3.722	8.078	324.800	104.315	94.120	2.360	0.138
WA 1 773 310 5	0.8219	0.8219	0.8219	0.8219	0.8219	0.8219	0.7851	0.8127	0.8219	0.8219	0.4391
CONC.(LBS/AC-IN)	22.7841	0.5204	0.0236	1.9635	0.1629	0.3535	14.8824	4.6174	4.1190	0.1033	0.0113

	01027 CADMIUM CD.TOT UG/L	01034 CHROMIUM CR.TOT UG/L	01042 COPPER CU.TOT UG/L	01045 IRON TOTAL UG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	27.436	597.665	352.719	1469.597	299.262	931.148
STD. DEVIATION	47.275	693.387	284.865	964.437	163.150	861.971
PARAMETER RANGE						
MIN	3.900	10.000	20.000	110.000	50.000	150.000
MAX	1600.000	4200.000	4200.000	13000.000	1800.000	5300.000
NO. OF EVENTS	5	5	5	5	5	5
TOT. MASS LOAD(LBS)	0.136	2.956	1.744	7.610	1.480	4.605
WA 1 773 310 5	0.7851	0.7851	0.7851	0.8219	0.7851	0.7851
CONC.(LBS/AC-IN)	0.0062	0.1354	0.0799	0.3330	0.0678	0.2110

Table X-39. Event Summary, Windsor, ON, Labadie Road Catchment (ON0101).

WINDSOR,ONTARIO, LABADIE ROAD, ON 1 1

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	72/ 9/18 0: 0 72/ 9/18 6: 0	6.00	0.56		72/ 9/18 0:30 72/ 9/18 10:30	10.00	0.0656
2	72/ 9/26 1: 0 72/ 9/26 12: 0	11.00	0.51		72/ 9/26 6:30 72/ 9/26 10: 0	3.50	0.0806
3	72/10/21 14: 0 72/10/23 10: 0	44.00	2.04		72/10/22 0:30 72/10/23 11: 0	34.50	0.3189
4	72/11/11 0: 0 72/11/11 4: 0	4.00	0.11		72/11/11 0:45 72/11/11 5:45	5.00	0.0136
5	72/12/12 6: 0 72/12/13 0: 0	18.00	0.98		72/12/12 19: 0 72/12/13 5: 0	10.00	0.0773
6	73/ 1/ 3 18: 0 73/ 1/ 4 3: 0	9.00	0.77		73/ 1/ 3 19:30 73/ 1/ 4 6:30	11.00	0.1097
7	73/ 2/ 1 17: 0 73/ 2/ 1 20: 0	3.00	0.11		73/ 2/ 1 17:30 73/ 2/ 1 22:30	5.00	0.0056
8	73/ 3/10 1: 0 73/ 3/10 13: 0	12.00	0.95		73/ 3/10 5: 0 73/ 3/10 13: 0	8.00	0.1415
9	73/ 3/16 19: 0 73/ 3/18 0: 0	29.00	1.27		73/ 3/16 20:15 73/ 3/18 3:15	31.00	0.3259
10	73/ 3/29 17: 0 73/ 3/30 0: 0	7.00	0.50		73/ 3/29 18:30 73/ 3/30 2:30	8.00	0.0475
11	73/ 3/31 18: 0 73/ 4/ 1 0: 0	6.00	0.10		73/ 3/31 21: 0 73/ 4/ 1 6: 0	9.00	0.0693
12	73/ 4/ 9 15: 0 73/ 4/ 9 23: 0	8.00	0.34		73/ 4/ 9 18: 0 73/ 4/10 0: 0	6.00	0.0500
13	73/ 4/16 16: 0 73/ 4/16 19: 0	3.00	0.05		73/ 4/16 17:30 73/ 4/16 20:30	3.00	0.0118
14	73/ 5/ 7 19: 0 73/ 5/ 8 4: 0	9.00	0.16		73/ 5/ 7 21:15 73/ 5/ 8 5:15	8.00	0.0046
15	73/ 5/ 8 10: 0 73/ 5/ 8 17: 0	7.00	0.17		73/ 5/ 8 17:15 73/ 5/ 8 21:15	4.00	0.0377
16	73/ 5/27 12: 0 73/ 5/27 21: 0	9.00	0.40		73/ 5/27 13:30 73/ 5/27 20:30	7.00	0.0323
17	73/ 6/ 6 17: 0 73/ 6/ 6 19: 0	2.00	0.18		73/ 6/ 6 17: 0 73/ 6/ 6 20: 0	3.00	0.0386
18	73/ 6/26 18: 0 73/ 6/26 23: 0	5.00	0.90		73/ 6/26 18: 0 73/ 6/27 5: 0	11.00	0.1394
19	73/ 7/10 8: 0 73/ 7/10 11: 0	3.00	0.09		73/ 7/10 8: 0 73/ 7/10 11: 0	3.00	0.0084
20	73/ 7/20 12: 0 73/ 7/20 22: 0	10.00	0.51		73/ 7/20 14: 0 73/ 7/21 0: 0	10.00	0.0784
21	73/ 7/26 10: 0 73/ 7/26 11: 0	1.00	0.83		73/ 7/26 10: 0 73/ 7/26 13: 0	3.00	0.0898

Table X-40. Quality Summary, Windsor, ON, Labadie Road Catchment (ON0101).

WINDSOR.ONTARIC. LABADIE ROAD. CN 1 1

STATISTICAL SUMMARY

	31504 TOT COLI MFIM LES /100ML	31616 FEC COLI MFM-FCBR /100ML	00070 TURB JKSN JTU	00080 COLOR PT-CO UNITS	00095 CNDUCTVY AT 25C MICROMHO	00400 PH SU	C0610 NH3-N TOTAL MG/L	00615 NO2-N TOTAL MG/L	00620 NO3-N TOTAL MG/L	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L
MEAN	34500.	4350.	458.629	177.306	234.838	7.501	0.049	0.050	0.852	389.844	140.881
STD. DEVIATION	72600.	12200.	200.721	79.4.3	227.603	0.213	0.040	0.033	0.409	254.255	82.316
PARAMETER RANGE											
MIN	100.	10.	7.000	25.000	65.000	6.750	0.001	0.001	0.100	1.000	1.000
MAX	920000.	170000.	1200.000	440.000	2390.000	8.020	0.710	0.570	4.700	1230.000	392.000
NO. OF EVENTS	21	21	14	15	21	21	18	21	21	20	20
TOT. MASS LOAD(LBS)	0.183E 13	0.228E 12	*********	*********	*********	*********	0.529	0.587	9.950	4265.809	1541.573
TOT. FLOW VOL.(IN)	1.7463	1.7309	1.0752	1.0808	1.7466	1.7466	1.6186	1.7466	1.7466	1.6368	1.6369
CONC.(LBS/AC-IN)	0.354E 11	0.447E 10	********	********	********	********	0.0111	0.0114	0.1931	88.3441	31.9257

	00660 ORTHOPO4 PO4 MG/L	00945 SULFATE SO4 MG/L	00901 C HARD CACO3 MG/L	00310 BOD 5 DAY MG/L	00900 TOT HARD CACO3 MG/L	00410 T ALK CACO3 MG/L	00940 CHLCRIDE CL MG/L
MEAN	0.390	26.978	74.695	16.915	101.138	92.551	51191.460
STD. DEVIATION	0.295	14.035	15.927	8.228	30.453	44.535	0.000
PARAMETER RANGE							
MIN	0.001	1.000	40.000	1.700	55.000	40.000	4.000
MAX	2.500	178.000	275.000	78.400	484.000	344.000	1585.000
NO. OF EVENTS	20	21	21	20	21	21	21
TOT. MASS LOAD(LBS)	4.356	314.987	872.128	160.640	1180.878	1080.614	557.707
TOT. FLOW VOL.(IN)	1.6692	1.7466	1.7466	1.4206	1.7466	1.7466	1.7466
CONC.(LBS/AC-IN)	0.0885	6.1135	16.9269	3.8331	22.9153	20.9733	11.6007

Table X-41. Event and Quality Summaries, West Lafayette, IN, Ross-Ade (Upper) Catchment (IN0101).

WEST LAFAYETTE,INDIANA,ROSS ADE(UPPER),IN0101

SUMMARY OF EVENTS

	RAINFALL				FLOW		
EVENT #	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)	PRECEDING DRY DAYS	DATE(START-END) (YR,MON,D,HR,MIN)	DURATION (HRS)	VOLUME (INCH)
1	67/ 8/ 2 17:14 67/ 8/ 2 17:38	0.40	0.37		67/ 8/ 2 17:19 67/ 8/ 2 18:41	1.37	0.0759
2	67/ 8/26 17:35 67/ 8/26 17:49	0.23	0.14		67/ 8/26 17:38 67/ 8/26 18:45	1.12	0.0510
3	74/ 6/21 3:57 74/ 6/21 8:27	4.50	0.61		74/ 6/21 4:27 74/ 6/21 8:27	4.00	0.0796
4	74/ 7/19 3:44 74/ 7/19 9:14	5.50	0.65		74/ 7/19 3:44 74/ 7/19 9:14	5.50	0.0525
5	74/ 8/ 1 22:25 74/ 8/ 2 0:55	2.50	0.04		74/ 8/ 1 22:55 74/ 8/ 2 1:25	2.50	0.0040
6	74/ 8/27 14:52 74/ 8/27 19:22	4.50	1.13		74/ 8/27 14:52 74/ 8/27 19:52	5.00	0.1657
7	74/ 9/11 16:35 74/ 9/12 0:35	8.00	0.83		74/ 9/11 17: 5 74/ 9/12 1: 5	8.00	0.1937
8	74/10/23 17:22 74/10/23 22:52	5.50	0.30		74/10/23 17:52 74/10/24 1:52	8.00	0.0457
9	74/11/ 3 6:28 74/11/ 3 13:28	7.00	0.58		74/11/ 3 7:58 74/11/ 3 13:58	6.00	0.1199
10	74/11/19 22:59 74/11/19 23:59	1.00	0.04		74/11/19 22:59 74/11/20 0:59	2.00	0.0074

WEST LAFAYETTE,INDIANA,ROSS ADE(UPPER),IN0101

STATISTICAL SUMMARY

	00310 BOD 5 DAY MG/L	00530 RESIDUE TOT NFLT MG/L
MEAN	59.558	104.738
STD. DEVIATION	89.704	52.044
PARAMETER RANGE		
MIN	2.000	3.000
MAX	433.000	254.000
NO. OF EVENTS	8	8
TOT. MASS LOAD(LBS)	260.227	457.630
TOT. FLOW VOL.(IN)	0.6649	0.6649
CONC.(LBS/AC-IN)	13.4967	23.7351

Table X-42. Event and Quality Summaries, Greenfield, MA, Maple Brook Catchment (MA0101).

GREENFIELD,MASS.,MAPLE BROOK,MA0101

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MCN,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	76/ 6/ 1 18:40 76/ 6/ 2 1:10	6.50	0.22	14.00	76/ 6/ 1 18:45 76/ 6/ 2 3:50	9.08	0.0212
2	76/ 7/11 20:50 76/ 7/12 1: 0	4.17	0.43	12.00	76/ 7/11 21:25 76/ 7/12 2:55	5.50	0.0588
3	76/ 9/17 8:15 76/ 9/17 12:40	4.42	0.36	19.00	76/ 9/17 9: 5 76/ 9/17 13: 0	3.92	0.0547
4	77/ 4/ 4 23: 0 77/ 4/ 5 14: 0	15.00	1.02	2.00	77/ 4/ 4 23:45 77/ 4/ 5 14: 0	14.25	0.1845
5	77/ 4/23 5:30 77/ 4/23 10:30	5.00	0.26	20.00	77/ 4/23 6:30 77/ 4/23 10:30	4.00	0.0141

GREENFIELD,MASS.,MAPLE BROOK,MA0101

STATISTICAL SUMMARY

	00400 PH SU	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00665 PHOS-P P-WET MG/L	00680 T CRG C C MG/L	00940 CHLORIDE CL MG/L	01051 LEAD PB.TOT UG/L	01092 ZINC ZN.TOT UG/L
MEAN	6.970	11.618	58.097	147.445	18.674	1.478	22.402	24.964	178.005	195.615
STD. DEVIATION	0.013	7.169	16.806	112.151	10.645	0.404	3.600	6.520	200.067	32.703
PARAMETER RANGE										
MIN	6.450	4.000	23.700	8.500	9.000	0.220	15.800	15.600	8.900	52.000
MAX	7.700	37.000	149.000	540.000	77.000	3.040	41.200	63.500	799.000	574.000
NO. OF EVENTS	2	4	2	5	2	3	2	3	4	5
TOT. MASS LOAD(LBS)	*********	556.697	1860.578	8942.805	629.075	39.335	717.425	862.946	9.791	11.542
TOT. FLOW VOL.(IN)	0.1420	0.2085	0.1394	0.2639	0.1466	0.1158	0.1394	0.1504	0.2394	0.2568
CONC.(LBS/AC-IN)	********	2.6329	13.1657	33.4132	4.2319	0.3350	5.0766	5.6572	0.0403	0.0443

Table X-43. Event and Quality Summaries, Northampton, MA, Market Street Brook Catchment (MA0201).

NORTHAMPTON,MASS.,MARKET STREET,MA0201

SUMMARY OF EVENTS

EVENT #	RAINFALL DATE(START-END) (YR,MON,D,HR,MIN)	RAINFALL DURATION (HRS)	RAINFALL VOLUME (INCH)	PRECEDING DRY DAYS	FLOW DATE(START-END) (YR,MON,D,HR,MIN)	FLOW DURATION (HRS)	FLOW VOLUME (INCH)
1	77/ 6/ 6 18: 0 77/ 6/ 6 21:50	3.83	0.17	5.00	77/ 6/ 6 18: 0 77/ 6/ 6 23:35	5.58	0.0430
2	77/ 6/21 19:15 77/ 6/21 19:55	0.67	0.05	1.00	77/ 6/21 19:12 77/ 6/21 23: 0	3.80	0.0198
3	77/ 6/29 12:45 77/ 6/29 13:45	1.00	0.26	3.00	77/ 6/29 12:45 77/ 6/29 17: 0	4.25	0.0732
4	77/ 7/12 0:15 77/ 7/12 3:55	3.67	0.65	5.00	77/ 7/12 0:15 77/ 7/12 6:30	6.25	0.1257
5	77/ 7/12 10:40 77/ 7/12 13:50	3.17	0.85		77/ 7/12 10:40 77/ 7/12 23: 0	12.33	0.1917
6	77/ 7/21 16:35 77/ 7/21 17: 0	0.42	0.17	8.00	77/ 7/21 16:35 77/ 7/21 18:55	2.33	0.0261

NORTHAMPTON,MASS.,MARKET STREET,MA0201

STATISTICAL SUMMARY

	00400 PH SU	00310 BOD 5 DAY MG/L	00340 COD HI LEVEL MG/L	00530 RESIDUE TOT NFLT MG/L	00535 RESIDUE VOL NFLT MG/L	00660 ORTHOPO4 PO4 MG/L	00665 PHOS-P P-WET MG/L	00680 T ORG C C MG/L	00940 CHLORIDE CL MG/L	01051 LEAD PB,TOT UG/L	01092 ZINC ZN,TOT UG/L
MEAN	6.413	30.127	93.965	149.248	41.914	0.269	0.529	30.270	9.142	86.883	101.827
STD. DEVIATION	0.180	19.445	68.019	55.019	14.511	0.091	0.162	12.818	9.078	130.707	85.124
PARAMETER RANGE											
MIN	3.000	2.600	7.600	4.500	2.500	0.130	0.190	3.360	0.490	1.000	9.900
MAX	7.100	102.000	755.700	347.000	121.000	1.090	2.570	99.110	74.210	514.600	388.700
NO. OF EVENTS	3	3	6	6	6	6	6	6	6	6	6
TOT. MASS LOAD(LBS)	*********	453.189	3314.868	5265.125	1478.631	9.413	18.534	1067.854	322.183	3.046	3.581
TOT. FLOW VOL.(IN)	0.1747	0.1747	0.4097	0.4097	0.4097	0.4057	0.4071	0.4097	0.4093	0.4071	0.4083
CONC.(LBS/AC-IN)	********	6.8271	21.2937	33.8216	9.4983	0.0611	0.1198	6.8596	2.0716	0.0197	0.0231

SECTION XI

REFERENCES

1. Brandstetter, A. "Assessment of Mathematical Models for Storm and Combined Sewer Management," EPA Report EPA-600/2-76-175a, August 1976.

2. Huber, W.C. "Modeling for Storm Water Strategies," APWA Reporter, Vol. 42, No. 5, pp. 10-14, May 1975.

3. U.S. National Weather Service, Substation Observations. Observers Handbook, No. 2, 1970, rev. 1972.

4. World Meteorological Organization. Guide to Hydrometeorological Practices, 2nd ed., WMO No. 168, Tech. Paper 82, Geneva, 1970.

5. Linsley, R.K., Kohler, M.A. and Paulhus, J.L.H. Hydrology for Engineers, Second Edition, McGraw-Hill, 1975.

6. Eagleson, P.S. and Shack, W.J. "Some Criteria for the Measurement of Rainfall and Runoff," Water Resources Research, Vol. 2, No. 3., pp.427-436, 1966.

7. Hydrologic Engineering Center, Corps of Engineers. "Storage, Treatment, Overflow and Runoff Model, STORM," Users Manual, Generalized Computer Program 723-58-L7520, Davis, California, July 1976.

8. Smith, G.F. "Adaptation of the EPA Storm Water Management Model for Use in Preliminary Planning for Control of Urban Storm Runoff," M.E. Thesis, Dept. of Environmental Engineering Sciences, University of Florida, Gainesville, 1975.

9. National Weather Service. Local Climatological Data plus supplements, U.S. Dept. of Commerce. Published monthly for each state with additional data available from National Climatic Center, Asheville, North Carolina.

10. Eagleson, P.S. "Optimum Density of Rainfall Networks," Water Resources Research, Vol. 3, No. 4., pp. 1021-1033, 1967.

11. Rodriguez-Iturbe, I. and Mejia, J.M. "The Design of Rainfall Networks in Time and Space," Water Resource Research, Vol. 10, No. 4, pp. 713-728, August 1974.

12. Rodriguez-Iturbe, I. and Mejia, J.M. "On the Transformation of Point Rainfall to Areal Rainfall," Water Resources Research, Vol. 10, No. 4, pp. 729-736, August 1974.

13. U.S. Geological Survey, "Recommended Methods for Water-Data Acquisition," Preliminary Report of the Federal Interagency Work Group on Designation of Standards for Water Data Acquisition, 1972.

14. Buchanan, T.J. and Somers, W.P, "Stage measurement at gaging stations," USGS Techniques of Water-Resources Inv., Book 3, Chap. A7, 1968.

15. Buchanan, T.J. and Somers, W.P, "Discharge measurements at gaging stations," USGS Techniques of Water-Resources Inv., Book 3, Chap. A8, 1969.

16. Kilpatrick, F.A, "Use of flumes in measuring discharge at gaging stations," USGS Surface-Water Techniques, Book 1, Chap. 16, 1965.

17. Carter, R.W. and Davidian, J, "Discharge ratings at gaging stations," USGS Surface-Water Techniques, Book 1, Chap. 12, 1965.

18. Gray, D.M., ed. Handbook on the Principles of Hydrology, Water Information Center, 1973.

19. Chow, V.T. Open-Channel Hydraulics, McGraw-Hill, 1959.

20. Knapp, J.W., Schaake, J.C. and Viessman, W. Jr. "Measuring Rainfall and Runoff at Storm-Water Inlets," J. Hyd. Div., Proc. ASCE, Vol. 89, No. HY5, pp. 99-115, September 1963.

21. Wenzel, H.G. Jr. "A Critical Review of Methods of Measuring Discharge Within a Sewer Pipe," ASCE Urban Water Resources Research Program, Tech. Memo. No. 4, NTIS-PB 182 789, September 1968.

22. Shelley, P.E. and Kirkpatrick, G.A. "Sewer Flow Measurement--A State of the Art Assessment," EPA Report EPA-600/2-75-027, NTIS-PB 250 371, November 1975.

23. Wullschleger, R.E., Zanoni, A.E. and Hansen, C.A. "Methodology for the Study of Urban Storm Generated Pollution and Control," EPA Report EPA-600/2-76-145, August 1976.

24. Parshall, R.L. "The Improved Venturi Flume," Transactions ASCE, Vol. 89, pp. 841-851, 1926.

25. Diskin, M.H. "Temporary Flow Measurements in Sewers and Drains," J. Hyd. Div., Proc. ASCE, Vol. 89, No. HY4, pp. 141-159, July 1963.

26. Smoot, G.G., Davidian, J. and Billings, R.H. "Urban Storm Rainfall-Runoff-Quality Instrumentation," IASH Publ. No. 112, p. 44, 1974.

27. Shelley, P.E. and Kirkpatrick, G.A. "Assessment of Automatic Sewer Flow Samplers--1975," EPA Report EPA-600/2-75-065, NTIS-PB 250 987, December 1975.

28. Shelley, P.E. "Design and Testing of a Prototype Automatic Sewer Sampling System," EPA Report EPA-600/2-76-006, NTIS-PB 252 613, March 1976.

29. American Public Health Assn., American Public Works Assn., Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater, 14th Edition, American Public Health Assn., Washington, D.C., 1975.

30. Environmental Protection Agency. "Water Quality Control Information System (STORET) Handbook," Washington,D.C., 1965 with updates.

31. Lager, J.A. and Smith, W.G. "Urban Stormwater Management and Technology: An Assessment," EPA Report EPA-670/2-74-040, NTIS-PB 240 687, December 1974.

32. Milwaukee, City of, Department of Public Works Milwaukee. "Detention Tank for Combined Sewer Overflow--Milwaukee, Wisconsin, Demonstration Project." EPA Report EPA-600/2-75-071, NTIS-PB 250 427, December 1975.

33. Municipality of Metropolitan Seattle (METRO) and River Basin Coordinating Committee. "Environmental Management for the Metropolitan Area, Part II Urban Drainage, Appendix C Storm Water Monitoring Program," Seattle, October 1974.

34. Engineering-Science, Inc. "Characterization and Treatment of Combined Sewer Overflows," Final Report to City and County of San Francisco, EPA Report EPA-670/2-75-054, NTIS-PB 241 299, April 1975.

35. Engineering-Science, Inc. "Dissolved Air Flotation, Appendix A, Phase 1--Pre-Construction Studies on Quality and Quantity Relationships of Combined Sewage Flows and Receiving Water Studies at Outer Marina Beach," City and County of San Francisco report for EPA, July 1971.

36. Tucker, L.S. "Northwood Gaging Installation, Baltimore--Instrumentation and Data," ASCE Urban Water Resources Research Program, Tech. Memo. No. 1 , NTIS-PB 182 786, August 1968.

37. Tucker, L.S. "Oakdale Gaging Installation, Chicago--Instrumentation and Data," ASCE Urban Water Resources Research Program, Tech. Memo No. 2, NTIS-PB 182 787, August 1968.

38. Tucker, L.S. "Raingage Networks in the Largest Cities," ASCE Urban Water Resources Research Program, Tech. Memo No. 9, NTIS-PB 184 704, March 1969.

39. Tucker, L.S. "Non-Metropolitan Dense Raingage Networks," ASCE Urban Water Resources Research Program, Tech. Memo No. 11, NTIS-PB 191 709, January 1970.

40. Tucker, L.S. "Availability of Rainfall-Runoff Data for Sewered Catchments," ASCE Urban Water Resources Research Program, Tech. Memo No. 8, NTIS-PB 184 703, March 1969.

41. Tucker, L.S. "Sewered Drainage Catchments in Major Cities," ASCE Urban Water Resources Research Program, Tech. Memo No. 10, NTIS-PB 184 705, March 1969.

42. Tucker, L.S. "Availability of Rainfall-Runoff Data for Partly Sewered Urban Drainage Catchments," ASCE Urban Water Resources Research Program, Tech. Memo No. 13, NTIS-PB-191 755, March 1970.

43. Roesner, L.A., Nichandros, H.M., Shubinski, R.P., Feldman, A.D., Abbot, J.W. and Friedland, A.O. "A Model for Evaluating Runoff-Quality in Metropolitan Master Planning," ASCE Urban Water Resources Research Program, Tech. Memo No. 23, NTIS-PB 234 312, April 1974.

44. McPherson, M.B. and Mangan, G.F. Jr. "ASCE Urban Water Resources Research Program," J. Hyd. Div. Proc. ASCE, Vol 101, No. HY7, pp.847-355, July 1975.

45. McPherson, M.B. "Urban Hydrological Modeling and Catchment Research in the U.S.A.," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-1, NTIS-PB 260 685, November 1975.

46 Aitken, A.P. "Urban Hydrological Modeling and Catchment Research in Australia," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-2, NTIS-PB 260 686 , May 1976.

47. Marsalek, J. "Urban Hydrological Modeling and Catchment Research in Canada," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-3, NTIS-PB 262 068, June 1976.

48. Lowing, M.J. "Urban Hydrological Modeling and Catchment Research in the United Kingdom," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-4, NTIS-PB 262 069, July 1976.

49. Stall, J.B. and Terstriep, M.L. "Storm Sewer Design--An Evaluation of the RRL Method," EPA Report EPA-R2-72-068, NTIS-PB 214 134, October 1972.

50. Terstriep, M.L. and Stall, J.B. "The Illinois Urban Drainage Area Simulator, ILLUDAS," State of Illinois, Illinois State Water Survey, Bulletin 58, Urbana, 1974.

51. U.S. Geological Survey. "Catalog of Information on Water Data," Edition 1974, Separate volumes for each of 21 regions.

52. Schneider, W.J. "Water Data for Metropolitan Areas," USGS Water Supply Paper 1871, 1968.

53. Water Resources Scientific Information Center. "Catalog of USGS Publications Related to Urban Water Resources 1968--November 1974," Report for USGS, 1974.

54. U.S. Geological Survey. "WATSTORE Users Guide," Water Resources Division, Reston, Va., 1975.

55. Edwards, M.D. "Status of the National Water Data Exchange (NAWDEX)--September 1976," USGS Open File Report 76-719, Reston, Va., 1976.

56. Anderson, D.R. "Water Quality Models for Urban and Suburban Areas," Completion Report, OWRT Project No. A-025NEB, University of Nebraska, Lincoln, NTIS-PB 238 622, August 1974.

57. Heaney, J.P., Huber, W.C., Medina, M.A., Nix, S.J., Murphy, M.P. and Hasan, S. "Nationwide Evaluation of Combined Sewer Overflows and Stormwater Discharges: Vol. II Cost Assessment and Impacts," EPA Report 600/2-77-064b, March 1977.

58. Burford, J.B. and Clark, J.M. "Hydrologic Data for Experimental Agricultural Watersheds in the United States, 1967," Agricultural Research Service, Misc. Publ. No. 1262, GPO No. 0100-02802, July 1973.

59. NOAA, Environmental Data Service, "Users Guide to ENDEX/OASIS, Environmental Data Index and the Oceanic and Atmospheric Scientific Information System," Key to Oceanic and Atmospheric Information Sources No.1, Washington D.C., January 1976.

60. U.S. National Committee for the International Hydrological Decade. "International Hydrological Decade Representative and Experimental Basins in the United States, Catalog of Available Data and Results, 1965-1972," Report NAS/IHD-74/01 for National Academy of Sciences, NTIS-PB 237 002, July 1974.

61. National Technical Information Service. "Directory of Computerized Data Files and Related Software Available from Federal Agencies," NTIS-SR-74-01, March 1974.

62. Proctor and Redfern Ltd. and James F. MacLaren Ltd. "Storm Water Management Model Study, Vol. I," COA Research Report 47, Environmental Protection Service, Ottawa, Ontario, K1A OH3, September 1976.

63. Proctor and Redfern Ltd. and James F. MacLaren Ltd. "Storm Water Management Model Study, Vol. II," COA Research Report 48, Environmental Protection Service, Ottawa, Ontario, K1A OH3, September 1976.

64. Black, Crow and Eidsness, Inc. "Storm and Combined Sewer Pollution Sources and Abatement, Atlanta, Ga," EPA Report EPA-11024ELB01/71, NTIS-PB 201 725, January 1971.

65. Holbrook, R.F., Perez, A.I., Turner, B.G. and Miller, H.I. "Stormwater Studies and Alternatives in Atlanta," J. Env. Eng. Div.,Proc. ASCE, Vol. 102, No. EE6, pp. 1263-1277, December 1976.

66. Marsalek, J. "Malvern Urban Test Catchment," Progress Report No. 1, Project 73-3-12, Canada Centre for Inland Waters, Burlington, Ont. L7R 4A6, April 1976.

67. Marsalek, J. Canada Centre for Inland Waters, "Storm Water Quality in the Malvern Catchment," Paper presented at SWMM Users Group Meeting, Toronto, October 1976.

68. Cincinnati, University of. "Urban Runoff Characteristics," EPA Report EPA-11024DQU10/70, NTIS-PB 202 865, October 1970.

69. Weibel, S.R., Anderson, R.J. and Woodward, R.L. "Urban Land Runoff as a Factor in Stream Pollution," JWPCF, Vol. 36, No. 7, pp. 914-924, July 1964.

70. Havens and Emerson, Ltd. "Master Plan for Pollution Control, Report to City of Cleveland," 1967.

71. Urban Drainage and Flood Control District. "Denver Region Urban Hydrology Report," Technical Series, Denver, undated.

72. Ducret, G.L. Jr. and Hodges, H.E. "Rainfall-Runoff Data from Small Watersheds in Colorado, June 1968 through September 1971," USGS, Urban Drainage and Flood Control Dis. and Colo. Dept. of Highways, Colorado Water Resources Basic-Data Release No. 27, Colorado Water Conservation Board, Denver, 1972.

73. Davis, P.L. and Borchardt, F.A. "Combined Sewer Overflow Abatement Plan, Des Moines, Iowa," EPA Report EPA-R2-73-170, April 1974.

74. Jewell, T.K., Mangarella, P.A. and DiGiano, F.A, University of Massachusetts, "Application and Testing of the EPA Stormwater Management Model to Greenfield Massachusetts," presented at National Symposium on Urban Rainfall and Runoff and Sediment Control, University of Kentucky, Lexington, Ky., July 1974.

75. Waller, D.H. "Pollution Attributable to Surface Runoff and Overflows from Combined Sewerage Systems," Central Mortgage and Housing Corporation, Ottawa, Ontario , April 1971.

76. Bhatia, I. "Mass Discharge Rates and Variations in Composition of Surface Runoff from two Urban Areas," M.E. Thesis, Dept. of Civil Engineering, Nova Scotia Technical College, Halifax, 1973.

77. Waller, D.H., Coulter, W.A., Carson, W.M., and Bishop, D.G. "Urban Drainage Model Comparison for a Catchment in Halifax, Nova Scotia," COA Research Report No. 43, Environmental Protection Service, Ottawa,

Ontario, K1A OH3, 1976.

78. Waller, D.H. and Coulter, W.A. "Winter Runoff from an Urban Catchment," COA Research Report No. 41, Environmental Protection Service, Ottawa, Ontario, K1A OH3, 1976.

79. Eicher, C.W., Gore and Storrie Ltd. "Description of an Urban Test Catchment in Hamilton Ontario," Presented at SWMM Users Group Meeting, Toronto, April 1976.

80. Characklis, W.G., Gaudet, F.J., and Roe, R.L. "Maximum Utilization of Water Resources in a Planned Community," Rice Univ., Report to Edison Water Quality Research Laboratory, EPA, Edison, N.J., June 1976.

81. James F. MacLaren, Ltd. "Review of Canadian Storm Sewer Design Practice and Comparison of Urban Hydrologic Models," COA Research Report No. 26, Environmental Protection Service, Ottawa, Ontario, K1A OH3, 1975.

82. Kidd, C.H.R. "The Development of an Urban Runoff Model," MS. Thesis, Dept. of Civil Engineering, Queen's University, Kingston, Ontario, 1972.

83. Eagleson, P.S. "Unit Hydrograph Characteristics for Sewered Areas," J. Hyd. Div., Proc. ASCE, Vol. 88, No. HY2, pp. 1-25, March 1962.

84. Corps of Engineers. "Report of Sewer Runoff Investigation for Louisville, Kentucky," Louisville District, Louisville, Ky, 1949.

85. Wells, D.M., Anderson, J.F., Sweazy, R.M. and Claborn, B.J. "Variation of Urban Runoff Quality with Duration and Intensity of Storms--Phase II," OWRT Completion Report, Project OWRR B-104-TEX, Texas Tech University, Lubbock, NTIS-PB 223 930, August 1973.

86. Grizzard, T.J., Hartigan, J.P., Randall, C.W. and Kim, J.I. Virginia Polytechnic Institute, "Assessment of Runoff Pollution Impacts in Urbanizing Watershed: A Case Study of Northern Virginia's Occoquan Watershed," Presented at the EPA Region III Urban Runoff Seminar, Philadelphia, November 1976.

87. Wanielista, M.P. "Nonpoint Source Effects," Florida Technological University, Orlando, Report No. ESEI-76-1 to State Dept. of Environmental Regulation, Tallahassee, January 1976.

88. Wanielista, M.P. "Nonpoint Source Effects, Appendices," Florida Technological University, Orlando, Report No. ESEI-76-2, to State Dept. of Environmental Regulation, Tallahassee, January 1976.

89. Wanielista, M.P., ed. "Nonpoint Source Workshop," Florida Technological University, Orlando, Report No. ESEI-76-3, to State Dept. of Environmental Regulation, Tallahassee, February 1976.

90. Turner, R.R., Harriss, R.C., Burton, T.M. and Laws, E.A. "The Effect of Land Use on Nutrient Fluxes in North Florida Watersheds," Dept. of Oceanography, Florida State Univ., Tallahassee, 1975.

91. Proctor and Redfern Ltd. and James F. MacLaren Ltd. "Storm Water Management Model Study, Volume III," COA Research Report, Environmental Protection Service, Ottawa, Ontario, K1A OH3, September 1976.

92. James F. MacLaren Ltd. "Report on the Brucewood Monitoring Programme, Feb. 15, 1974-December, 1974," Report and Addendum to Canada Centre for Inland Waters, Burlington, Ontario, L7R 4A6, September 1975.

93. James F. MacLaren Ltd. "Brucewood Monitoring Programme, January 1, 1975, to May 15, 1975," Report to Canada Centre for Inland Waters, Burlington, Ontario, L7R 4A6, December 1975.

94. Larsen, E., M.M. Dillon Ltd. "Instrumentation of an Urban Catchment in Metropolitan Toronto," Presented at SWMM Users Group Meeting, Toronto, April 1976.

95. James F. MacLaren Ltd. "A Study of Environmental Problems at Toronto International Airport," Prepared for the Environmental Protection Service, Ontario Region, July 1975.

96. Resnick, S.D. and DeCook, K.J. "Hydrological and Environmental Controls on Water Management in an Arid Urban Area," Symp. on Urbanization in the Arid Lands, Dec., 1970, ISASALS Publ. 75-1, Texas Tech University, Lubbock, 1974.

97. Blackwood, K.R. "Runoff Water Quality of Three Tucson Watersheds," Research Report, Dept. of Civil Eng., Univ. of Arizona, Tucson, 1974.

98. Dharmadhikari, V.V. "Quality of Runoff from Diversified Urban Watersheds," MS. Thesis, Dept. of Civil Eng., Univ. of Arizona, Tucson, 1970.

99. Mische, E.F. "The Potential of Urban Runoff Area Water Resource," PhD Dissertation, Dept. of Civil Eng., Univ. of Arizona, Tucson, 1971.

100. Weston, R.F. "Conceptual Engineering Report--Kingman Lake Project," EPA Report EPA-11023FIX08/70, NTIS-PB 197 598, August 1970.

101. Metcalf & Eddy Engineers, University of Florida and Water Resources Engineers. "Storm Water Management Model, Vol. 1, Final Report," EPA Report EPA-11024DOC07/71, NTIS-PB 203 289, July 1971.

102. Metcalf & Eddy Engineers, University of Florida and Water Resources Engineers. "Storm Water Management Model, Vol. II, Verification and Testing," EPA Report EPA-11024DOC08/71, NTIS-PB 203 290, August 1971.

103. Huber, W.C., Heaney, J.P., Medina, M.A., Peltz, W.A., Sheikh, H. and Smith, G.F. "Storm Water Management Model: User's Manual--Version II," EPA Report EPA-670/2-75-017, March 1975.

104. Sherwood, C.B. and Mattraw, H.C. Jr. "Quantity and Quality of Runoff from a Residential Area Near Pompano Beach, Florida," in Proceedings, Storm-Water Management Workshop, M.P. Wanielista, ed., Florida Technological University, Orlando, February 1975.

105. Mattraw, H.C. Jr. and Sherwood, C.B. "Quality of Storm-Water from a Residential Area, Broward County, Florida," Journal of Research of the U.S. Geological Survey, Vol. 5, No. 6, pp. 823-834, Nov.-Dec. 1977.

106. Heaney, J.P., Huber, W.C., Sheikh, H., Medina, M.A., Doyle, J.R., Peltz, W.A. and Darling, J.E. "Urban Stormwater Management Modeling and Decision-Making," EPA Report EPA-670/2-75-022, NTIS-PB 242 290, May 1975.

107. Hergert, S.L. "Urban Runoff Quality and Modeling Study," MS. Thesis, Dept. of Civil Engineering, University of Nebraska, Lincoln, NTIS-PB 237 141, December 1972.

108. Clark, M.J., Gruber, D.A., Meinholz, T.L., Moser, J.H., Race, R.A. and Hansen, C.A. "Screening/Dissolved-Air Flotation Treatment as an Alternative to Combined Sewer Separation," EPA Report in preparation, 1977.

109. Corps of Engineers. "Environmental Management for the Metropolitan Area Cedar-Green River Basins, Washington, Part II Urban Drainage, Appendix B Urban Storm Drainage Simulation Models," Report for River Basin Coordinating Committee by Kramer, Chin and Mayo; Water Resources Engineers and Yoder, Trotter Orlob and Assoc., Seattle, December 1974.

110. Droste, R.L. "Pollution Loadings of Urban Storm Runoff," M. Appl. Sc. Thesis, Dept. of Civil Engineering, University of Windsor, Windsor, Ontario, July 1974.

111. Singh, M.M. "Urban Storm Runoff, A Qualitative and Quantitative Study," M. Appl. Sc. Thesis, Dept. of Civil Engineering, University of Windsor, Windsor, Ontario, March 1972.

112. Chen, C.W. and Shubinski, R.P. "Computer Simulation of Urban Storm Water Runoff," J. Hyd. Div., Proc. ASCE, Vol. 97, No. HY2, pp. 289-301, February 1971.

113. Terstriep, M.L. and Stall, J.B. "Urban Runoff by Road Research Laboratory Method," J. Hyd. Div., Proc. ASCE, Vol. 95, No. HY6, pp. 1809-1834, November 1969.

114. Miller, C.R. "Runoff Yields from Small Urban Watersheds," MS. Thesis, Dept. of Civil Engineering, University of Nebraska, Lincoln, January 1971.

115. Miller, C.R. and Viessman, W. Jr. "Runoff Volumes from Small Urban Watersheds," Water Resources Research, Vol. 8, No. 2, pp. 429-434, April 1972.

116. Schaake, J.C. Jr., Leclerc, G. and Harley, B.M. "Evaluation and Control of Urban Runoff," ASCE Annual and National Environmental Engineering Meeting, New York, Preprint 2103, October 1973.

117. Surkan, A.J. and Kelton, P. "Binary Tree Model Simulation of the Behavior of Urban Hydrologic Systems," Int. J. Systems Science, Vol. 5, No. 7, pp. 639-654, July 1974.

118. Shubinski, R.P. and Roesner, L.A. Water Resources Engineers, "Linked Process Routing Models," Presented at Symposium on Models for Urban Hydrology, Spring Meeting, American Geophysical Union, Washington, D.C., April 1973.

119. Marsalek, J., Dick, T.M., Wisner, P.E. and Clarke, W.G. "Comparative Evaluation of Three Urban Runoff Models," Water Resources Bulletin, Vol. 11, No. 2, pp. 306-328, April 1975.

120. Viessman, W. Jr. and Geyer, J.C. "Characteristics of the Inlet Hydrograph," J. Hyd. Div., Proc. ASCE, Vol. 88, No. HY5, pp. 245-267, September 1962.

121. Willeke, G.E. "Time in Urban Hydrology," J. Hyd. Div.,Proc. ASCE, Vol. 92, No. HY1, pp. 13-29, January 1966.

122. Schaake, J.C. Jr., Geyer, J.C. and Knapp, J.W. "Experimental Examination of the Rational Method," J. Hyd. Div., Proc. ASCE, Vol. 93, No. HY6, pp. 353-370, November 1967.

123. Grace, R.A. and Eagleson, P.S. "Scale Model of Urban Runoff from Storm Rainfall," J. Hyd. Div., Proc. ASCE, Vol. 93, No. HY3, pp. 161-176, May 1967.

124. Grace, R.A. and Eagleson, P.S. "The Modeling of Overland Flow," Water Resources Research, Vol. 2, No. 3, pp. 393-403, 1966.

125. Harley, B.M., Perkins, F.E. and Eagleson, P.S. "A Modular Distributed Model of Catchment Dynamics," MIT Parsons Lab Report No. 133, December 1970.

126. Klym, H., Koniger, W., Mevius, F. and Vogel, G. Dorsch Consult, "Urban Hydrological Processes, Computer Simulation," Presented at the Seminar or Computer Methods in Hydraulics, Swiss Federal Institute, Zurich, February 1972.

127. Colyer, P.J. and Pethick, R.W. "Storm Drainage Design Methods, a Literature Review," Report No. INT 154, Hydraulics Research Station, Wallingford, Oxfordshire, England, March 1976.

128. Chow, V.T., and Yen, B.C. "Urban Stormwater Runoff--Determination of Volumes and Flowrates," EPA Report EPA-600/2-76-116, NTIS-PB 253 410, May 1976.

129. Papadakis, C.N. and Preul, H.C. "Testing of Methods for Determination of Urban Runoff," J. Hyd. Div., Proc. ASCE, Vol. 99, No. HY9, pp. 1319-1335, September 1973.

130. Brown, J.W. and Suhre, D. "Sewer Monitoring and Remote Control--Detroit," ASCE Annual and Environmental Meeting, Chicago, Preprint No. 1035, October 1969.

131. Stall, J.B., Terstriep, M.L. and Huff, F.A. "Some Effects of Urbanization on Floods," ASCE National Water Resources Engineering Meeting, Memphis, Preprint No. 1130, January 1970.

132. Burgess and Niple, Ltd. "Stream Pollution and Abatement from Combined Sewer Overflows, Bucyrus, Ohio," EPA Report EPA 11024FKN11/69, NTIS-PB 195 162, November 1969.

133. Bryan, E.H. "Quality of Stormwater Drainage from Urban Land Areas in North Carolina," Report No. 37, Water Resources Research Institute, University of North Carolina, Raleigh, 1970.

134. Bryan, E.H. "Quality of Stormwater Drainage from Urban Land," Water Resources Bulletin, Vol. 8, No. 3, pp. 578-588, June 1972.

135. Smith, R. and Eilers, R.G. "Control Schemes for the Activated-Sludge Process," EPA Report EPA-670/2-74-069, NTIS-PB 236 086, December 1974.

136. Wilson, K.V. "A Preliminary Study of the Effect of Urbanization on Floods in Jackson, Mississippi," USGS Professional Paper 575-D, pp. 259-261, 1968.

137. Seaburn, G.E. "Preliminary Results of Hydrologic Studies at Two Recharge Basins on Long Island, New York," USGS Professional Paper 627-C, 1970.

138. Seaburn, G.E. "Method of Rating Flow in a Storm Sewer," USGS Professional Paper 750-D, pp. D219-D223, 1971.

139. Seaburn, G.E. "Effects of Urban Development on Direct Runoff to East Meadow Brook, Nassau County, Long Island, New York," USGS Professional Paper 627-B, 1969.

140. Guarino, C.F., Radziul, J.V. and Greene, W.L. "Combined Sewer Considerations by Philadelphia," J. San. Eng. Div., Proc. ASCE, Vol. 96, No. SA1, pp. 1-14, February 1970.

141. Hagarman, J.A., and Dressler, F.R. "Storm Water Management Model: Dissemination and User Assistance," EPA Report EPA-670/2-75-041,

NTIS-PB 242 544, May 1975.

142. Crawford, N.H. "Studies on the Application of Digital Simulation to Urban Hydrology," Hydrocomp International, Palo Alto, California, NTIS-PB 206 715, September 1971.

143. DiGiano, F.A. and Mangarella, P.A. "Short Course Proceedings: Applications of Stormwater Management Models," EPA Report EPA-670/2-75-065, NTIS-PB 247 163, June 1975.

144. Huber, W.C., Russell, L.W. and Pyatt, E.E. "Routing Model for Combined Sewage," ASCE National Water Resources Engineering Meeting, Memphis, Preprint 1108, January 1970.

145. Roesner, L.A., Kibler, D.F. and Monser, J.R. "Use of Storm Drainage Models in Urban Planning," Proceedings, National Symposium on Watersheds in Transition, Colorado State University, American Water Resources Assn., Urbana, Illinois, pp. 400-405, 1973.

146. Duff, H.W. and Hsieh, G.C.C. "Seattle Rain-gaging Program and Rainstorm Data," ASCE National Water Resources Engineering Meeting, Memphis, Preprint 1089, January 1970.

147. Lager, J.A., Didriksson, T. and Otte, G.B. "Development and Application of a Simplified Stormwater Management Model," EPA Report EPA-600/2-76-218, NTIS-PB 258 074, August 1976.

148. Massing, H. "Urban Hydrology Studies and Mathematical Modeling in the Federal Republic of Germany," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-6, NTIS-PB 267364 , September 1976.

149. Lindh, G. "Urban Hydrological Modeling and Catchment Research in Sweden," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-7, NTIS-PB 267523 , October 1976.

150. Desbordes, M. and Normand, D. "Urban Hydrological Modeling and Catchment Research in France," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-8, NTIS-PB 267524 , November 1976.

151. Selthun, N.R. "Urban Hydrological Modeling and Catchment Research in Norway," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-9, NTIS-PB 267365 , December 1976.

152. Urban Drainage Subcommittee. "Report of the Urban Drainage Subcommittee Program, Urban Drainage Subcommittee, Canada-Ontario Agreement, Describing Projects Conducted Between 1972 and 1976," Training and Technology Transfer Division (Water), Environmental Protection Service, Ottawa, Ontario K1A 0H3, 1976.

153. Heeps, D.P. and Mein, R.G. "Independent Comparison of Three Urban Runoff Models," J. Hyd. Div., Proc. ASCE, Vol. 100, No. HY7, pp. 995-1009, July 1974.

154. Cordery, I. "Quality Characteristics of Urban Storm Water in Sydney, Australia," Water Resources Research, Vol. 13, No. 1, pp. 197-202, February 1977.

155. Coyne and Bellier. "Measurements and Evaluation of Pollutant Loads from a Combined Sewer Overflow," (in English), Coyne and Bellier, Consulting Engineers, 5, rue d'Héliopolis, 75017 Paris, March 1974.

156. Brunner, P.G. "The Pollution of Storm Water Runoff in Separate Systems: Studies with Special Reference to Precipitaiton Conditions in the Lower Alp Region," Water Resources and Sanitary Engineering Dept. Report No. 9, Munich Technical University, 1975. (English translation available from EPA Cincinnati NERC Library).

157. Arnell, V. and Lyngfelt, S. "Beräkningsmodell för simulering av Dagrattenflöde inom Bebyggda Områden," ("Computational Model for Simulating Daily Floods in Urban Areas"), in Swedish, Chalmers University of Technology, Dept. of Hydraulics Report No. 12, Götegorg, Sweden, 1975.

158. Arnell, V. and Lyngfelt, S. "Nederbörds-Avrinningsmätningar 1 Bergsjön, Göteborg 1973-1974," ("Downstream Runoff Measurements of Runoff at Lake Bergsjön, Göteborg 1973-1974"), in Swedish, Chalmers University of Technology, Dept. of Hydraulics, Report No. 13, Götegorg, Sweden, 1975.

159. Fletcher, J.E. and Chen, C.L. "Urban Storm Runoff Inlet Hydrograph Study: Vol. 3. Hydrologic Data for Two Urban Highway Watersheds in the Salt Lake City Area, Utah," FHWA Report No. FHWA-RD-76-118, NTIS-PB 263987, March 1976.

160. Hydrologic Engineering Center. "Annual Report on the Quality of Urban Storm Runoff Entering the San Francisco Bay," Four Reports for Fiscal Years 1972-75, HEC, Corps of Engineers, Davis, California.

161. McElroy, F.T.R., III, Mattox, C.F., Hartman, D.W., Bell, J.M. "Sampling and Analysis of Stormwater Runoff from Urban and Semi-Urban/Rural Watersheds," Purdue University, Water Resources Research Center, Tech. Rept. No. 64, West Lafayette, Indiana, September 1976.

162. Harper and Owes, Assoc. "Preliminary Water Quality Report for the Milwaukee Combined Sewer Overflow Study," Report for the Milwaukee Metropolitan Sewerage District of the County of Milwaukee, in preparation, 1977.

163. O'Neel, W.G., Davis, A.L., and VanDusen, K.W. "Wastewater Collection System Analysis Model, User's Manual," Report for City of Portland by Cornell, Howland, Hayes, Merryfield-Hill, Corvallis, Oregon, March 1976.

164. Johnson, S.L. and Smith, R.E. "Urban Hydrology of the Houston, Texas Metropolitan Area, Compilation of Basic Data, April 1964 to September 1965," Open File Report, U.S. Geological Survey, Water Resources Division, Federal Bldg., 300 E. 8th St., Austin, Texas 78701, 1965.

165. Ranzau, C.E. Jr. "Hydrologic Data for Urban Studies in the Houston, Texas Metropolitan Area, 1974," Open File Report, U.S. Geological Survey, Water Resources Division, Federal Bldg., 300 E. 8th St., Austin, Texas 78701, June 1976.

166. Johnson, S.L. and Sayre, D.M. "Effects of Urbanization on Floods in the Houston, Texas, Metropolitan Area," Water-Resources Investigations 3-73, U.S. Geological Survey, Water Resources Division, Federal Bldg., 300 E. 8th St., Austin, Texas 78701, April 1973.

167. Espey, W.H. Jr. and Winslow, D.E. "Urban Flood Frequency Characteristics," J. Hyd. Div., Proc. ASCE, Vol. 100, No. HY2, pp. 279-293, February 1974.

168. Brater, E.F. and Sherrill, J.D. "Rainfall-Runoff Relations on Urban and Rural Areas," EPA Report EPA-670/2-75-046, NTIS-PB 224 420, May 1975.

169. Everhart, R.C. "New Town Planned Around Environmental Aspects," Civil Engineering, Vol. 43, No. 9, pp. 69-73, September 1973.

170. Watt, T.R., Skrentner, R.G. and Davanzo, A.C. "Sewerage System Monitoring and Remote Control," EPA Report EPA-670/2-75-020, NTIS-PB 242 107, May 1975.

171. Tracor, Inc. "Statistical Analysis of Hydrograph Characteristics for Small Urban Watersheds," Final Report to OWRT, Contract No. 14-13-0001-3737, NTIS-PB 228 131, October 1973.

172. Jennings, M.E. and Mattraw, H.C., Jr. "Comparison of Predictive Accuracy of Models of Urban Flow and Water Quality Processes," Proc. of National Symposium on Urban Hydrology, Hydraulics and Sediment Control, University of Kentucky, Lexington, pp. 239-243, July 1976.

173. Geiger, W.F., LaBella, S.A. and McDonald, G.C. "Overflow Abatement Alternatives Selected by Combining Continuous and Single Event Simulations," Proc. of National Symposium on Urban Hydrology, Hydraulics and Sediment Control, University of Kentucky, Lexington, pp. 1-9, July 1976.

174. Geiger, W.F. "Urban Runoff Pollution Derived from Long-Time Simulation," Proc. of National Symposium on Urban Hydrology, Hydraulics and Sediment Control, University of Kentucky, Lexington, pp. 259-270, July 1975.

175. Eckhoff, D.W., Friedland, A.O. and Ludwig, H.F. "Characterization and Control of Combined Sewer Overflows, San Francisco," Water Research, Vol. 3, pp. 531-543, 1969.

176. Putnam, A.L. "Effect of Urban Development on Floods in the Piedmont Province of North Carolina," USGS Open File Report, Water Resources Division, Raleigh, North Carolina, 1972.

177. Anderson, D.G. "Effects of Urban Developemnt on Floods in Northern Virginia," USGS Water Supply Paper 2001-C, 1970.

178. Water Resources Engineers and The Hydrologic Engineering Center "Management of Urban Storm Runoff," ASCE Urban Water Resources Research Program, Tech. Memo No. 24, NTIS-PB 234 316, May 1974.

179. James, I.C. "Flood Runoff from Partially Urbanized Areas, Wichita, Kansas," USGS Open File Report, District Office, USGS, 1950 Avenue A, Campus West, Lawrence, Kansas 66045, June 1967.

180. Zuidema, F.C. "Urban Hydrological Modeling and Catchment Research in The Netherlands," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-10, NTIS-PB 267587 , January 1977.

181. Blaszczyk, P. "Urban Runoff Research in Poland," ASCE Urban Water Resources Research Program, Tech. Memo No. IHP-11, NTIS-PB 267871 , February 1977.

182. Sarma, P.B.S., Delleur, J.W. and Rao, A.R., "A Program in Urban Hydrology. Part II: An Evaluation of Rainfall-Runoff Models for Small Watersheds and the Effects of Urbanization on Runoff", Technical report No. 9, (NTIS PB-189 043), Purdue University Water Resources Research Center, Lafayette, In., October 1969.

183. Nunno, T.J., "Application and Testing of Stormwater Modeling Technology," Unpublished master of science project report, Dept. of Civil Engineering, University of Massachusetts, Amherst, Undated.

184. Nunno, T.J. et al., "Stormwater Management Modeling: Greenfield and Northampton, Massachusetts," Report No. Env. E 61-78-4, Environmental Engineering Program, Dept.of Civil Engineering, University of Massachusetts, Amherst, 1978.

185. Jewell, T.K., Nunno, T.J. and Adrian, D.D., "Methodology for Calibrating Stormwater Models," J. Hyd. Div., Proc. ASCE, Vol. 104, No. EE3, pp. 485-501, June 1978.

186. Jewell, T.K., "Application and Testing of the U.S. Environmental Protection Agency Storm Water Management Model to Greenfield, Massachusetts," Unpublished master of science project report, Dept. of Civil Engineering, University of Massachusetts, Amherst, 1974.

187. Jewell, T.K., and Gaboury, D.R., "Environmental Protection Agency Storm Water Management Model Input/Output Data Handbook," Report prepared for short course on Applications of Storm Water Management Models, Dept. of Civil Engineering, University of Massachusetts, Amherst, August 1974.

188. DiGiano, F.A., Coler, R.A., Dahiya, R. and Berger, B.B., "Characterization of Urban Runoff - Greenfield Massachusetts Phase II," Publication No. 84, Special Report, Water Resources Research Center, University of Massachusetts, Amherst, August 1976.

189. McAloon T.J., "Northampton Urban Runoff Characterization, Storage Treatment and Costs," Master of Env. Eng. Thesis, Dept. of Civil Engineering, University of Massachusetts, Amherst, January 1978.

190. Mattraw, H.C., Jr., Hardee, J. and Miller, R.A., "Urban Stormwater Runoff Data for a Residential Area, Pompano Beach, Florida," USGS Open File Report 78-324, Tallahassee, FL, 1978.

191. Hardee, J., Miller, R.A. and Mattraw, H.C., Jr., "Stormwater-Runoff Data for a Highway Area, Broward County, Florida," USGS Open File Report 78-612, Tallahassee, FL, June 1978.

192. Miller, R.A., Mattraw, H.C., Jr., and Hardee, J., "Stormwater-Runoff Data for a Commercial Area, Broward County, Florida," USGS Open File Report (in press), Tallahassee, FL, 1979.

193. Wilson, L.D., Miller, R.A. and Doyle, W.H., Jr., "Urban Storm-Water Data Management System, Broward County, Florida," Proc. of International Symposium on Urban Storm Water Management, University of Kentucky, Lexington, 6 pp., July 1978.

194. Hardee, J., "Instrumentation of Urban Hydrology Monitoring Sites in Southeast Florida," USGS Report of Water Resources Investigations 79-37, Tallahassee, FL, 1979.

195. Mattraw, J.C., Jr., "Quality and Quantity of Storm Water Runoff from three Land-Use Areas, Broward County, Florida," Proc. of International Symposium on Urban Storm Water Management, University of Kentucky, Lexington, pp. 253-257, July 1978.

196. Miller, R.A., "The Hydraulically Effective Impervious Area of an Urban Basin, Broward County, Florida," Proc. of International Symposium on Urban Storm Water Management, University of Kentucky, Lexington, pp. 259-261, July 1978.

197. Jennings, M.E. and Doyle, W.H., Jr., "Deterministic Modeling of Urban Storm Water Processes, Broward County, Florida," Proc. of International Symposium on Urban Storm Water Management, University of Kentucky, Lexington, pp. 275-281, July 1978.

198. Miller, R.A., Mattraw, H.C., Jr., and Jennings, M.E., "Statistical Modeling of Urban Storm Water Processes, Broward County, Florida," Proc. of International Symposium on Urban Storm Water Management, University of Kentucky, Lexington, pp. 269-273, July 1978.

199. Miller, R.A., "Characteristics of Four Urban Basins in South Florida," USGS Report of Water Resources Investigations (in press), Tallahassee, FL, 1979.

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

1. REPORT NO. EPA-600/8-79-004	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE URBAN RAINFALL-RUNOFF-QUALITY DATA BASE Update With Statistical Analysis		5. REPORT DATE August 1979 (Issuing Date) 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Wayne C. Huber, James P. Heaney, Kevin J. Smolenyak and Demetrios A. Aggidis		8. PERFORMING ORGANIZATION REPORT NO.
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Environmental Engineering Sciences University of Florida Gainesville, Florida 32611		10. PROGRAM ELEMENT NO. 1BC822, SOS #1, Task 30 11. CONTRACT/GRANT NO. 68-03-0496
12. SPONSORING AGENCY NAME AND ADDRESS Municipal Environmental Research Laboratory Office of Research and Development US Environmental Protection Agency Cincinnati, Ohio 45268		13. TYPE OF REPORT AND PERIOD COVERED 6/74-11/78 14. SPONSORING AGENCY CODE EPA/600/14

15. SUPPLEMENTARY NOTES

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16. ABSTRACT

Urban rainfall-runoff-quality data gathered by others have been assembled on a storm event basis for 25 catchments in the following eleven cities: San Francisco, CA; Broward County, FL; Lincoln, NB; Durham, NC; Windsor, ONT; Lancaster, PA; Seattle, WA; Racine, WI; West Lafayette, IN; Greenfield, MA; and Northampton, MA. Rainfall-runoff data have been assembled for 22 more catchments in an additional 14 cities: Baltimore, MD; Chicago, IL; Champaign-Urbana, IL; Bucyrus, OH; Falls Church, VA; Los Angeles, CA; Portland, OR; Houston, TX; and Salt Lake City, UT. The 25 cities contain data for a total of 47 catchments. Descriptions of the catchments, parameters and sampling procedures are provided in this report. Actual data have been placed on a magnetic tape and are also being placed on the EPA STORET data retrieval system. Additional data for the above cities and data for other cities will be included in the form of addenda to this report. This report also includes a statistical analysis of data from all catchments that include quality sampling. For each storm event (as defined by the sampling agency) the clock times, duration and volume of rainfall and runoff are given. For quality parameters, ranges, flow weighted means, standard deviations and loadings (i.e., pounds per acre-inch of runoff) are provided on an average basis across all events. The same statistics are available for individual storm events in the form of voluminous computer output.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Hydrology, Precipitation, Water pollution, surveys, Documentation, Data storage, Data retrieval, Combined sewers, Mathematical models *Storm sewers, Surface water runoff Storms, Rainfall, Runoff, Statistical analysis	Rainfall runoff, Water quality data, Rainfall data, Data collection, Urban runoff, Urban runoff characteristics, Combined sewer overflows, Hydrology data, Storm runoff.	13B

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
RELEASE TO PUBLIC	UNCLASSIFIED	282
	20. SECURITY CLASS *(This page)*	22. PRICE
	UNCLASSIFIED	