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Cincinnati OH 45268

Office of Water Enforcement and Permits
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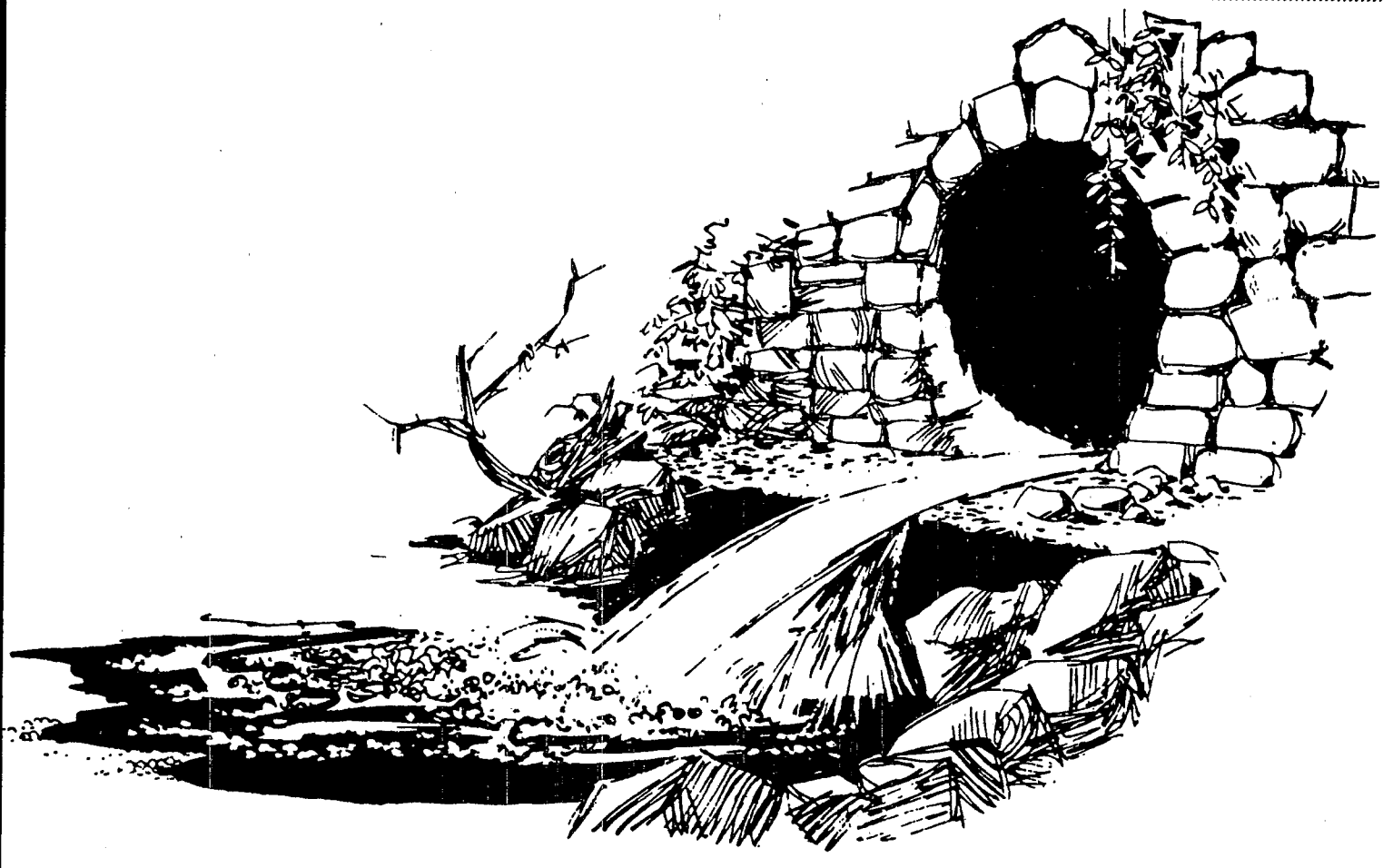
EPA

Research and Development EPA/600/9-91/012 May 1991

Storm and Combined Sewer Pollution Control

A Compilation of Significant References



EPA/600/9-91/012
May 1991

STORM AND COMBINED SEWER POLLUTION CONTROL
A Compilation of Significant References

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FOREWORD

Today's rapidly developing and changing technologies and industrial products and practices frequently carry with them the increased generation of materials that, if improperly dealt with, can threaten both public health and the environment. The U.S. Environmental Protection Agency is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. These laws direct the EPA to perform research to define our environmental problems, measure the impacts, and search for solutions.

The Risk Reduction Engineering Laboratory is responsible for the planning, implementing, and managing of research, development, and demonstration programs to provide an authoritative, defensible engineering basis in support of the policies, programs, and regulations of the EPA with respect to drinking water, wastewater, pesticides, toxic substances, solid and hazardous wastes, and Superfund-related activities. This publication is one of the products of that research and provides a vital communication link between the researcher and the user community.

This report represents an overview of the Storm & Combined Sewer Pollution Control Research Program (SCSP). These selected abstracts comprise a fraction of the research performed over a 20-year period, beginning with the mid-1960s. These descriptions serve as a guide for using the collection. A matrix is provided (centerfold) which targets subject content for each report or reprint, and serves as a handy locator.

As controls to reduce water pollution from traditional point sources have been implemented, it became more evident that diffuse sources of pollutants, including discharges from separate storm drainage systems and combined sewer overflows (CSO), are major causes of water quality problems. In response to this situation, Congress required the U.S. Environmental Protection Agency (EPA), by adding Section 402(p) to the Clean Water Act (CWA) in 1987, to regulate stormwater discharges to protect water quality by establishing comprehensive programs for permit applications, guidance, and management and treatment requirements. In addition, Section 319 was added to the CWA requiring states to develop nonpoint source assessment and management programs. The EPA has also recently implemented a "National CSO Control Strategy" to ensure that CSO meet the technology and water quality-based requirements of the CWA.

These documents are handy references for the user community faced with the challenges and mandates to combat urban wet-weather-induced water pollution. They cover the gamut of engineering requirements, from pollution problem assessment and associated tools, to management and control planning and design.

Those publications which are available from the Center for Environmental Research Information are listed on the order form in the back of this report. Indicate your choice by circling the appropriate number(s). There is no charge for these.

Those publications which are not available through this office, may be ordered through the following:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
(703) 487-4650

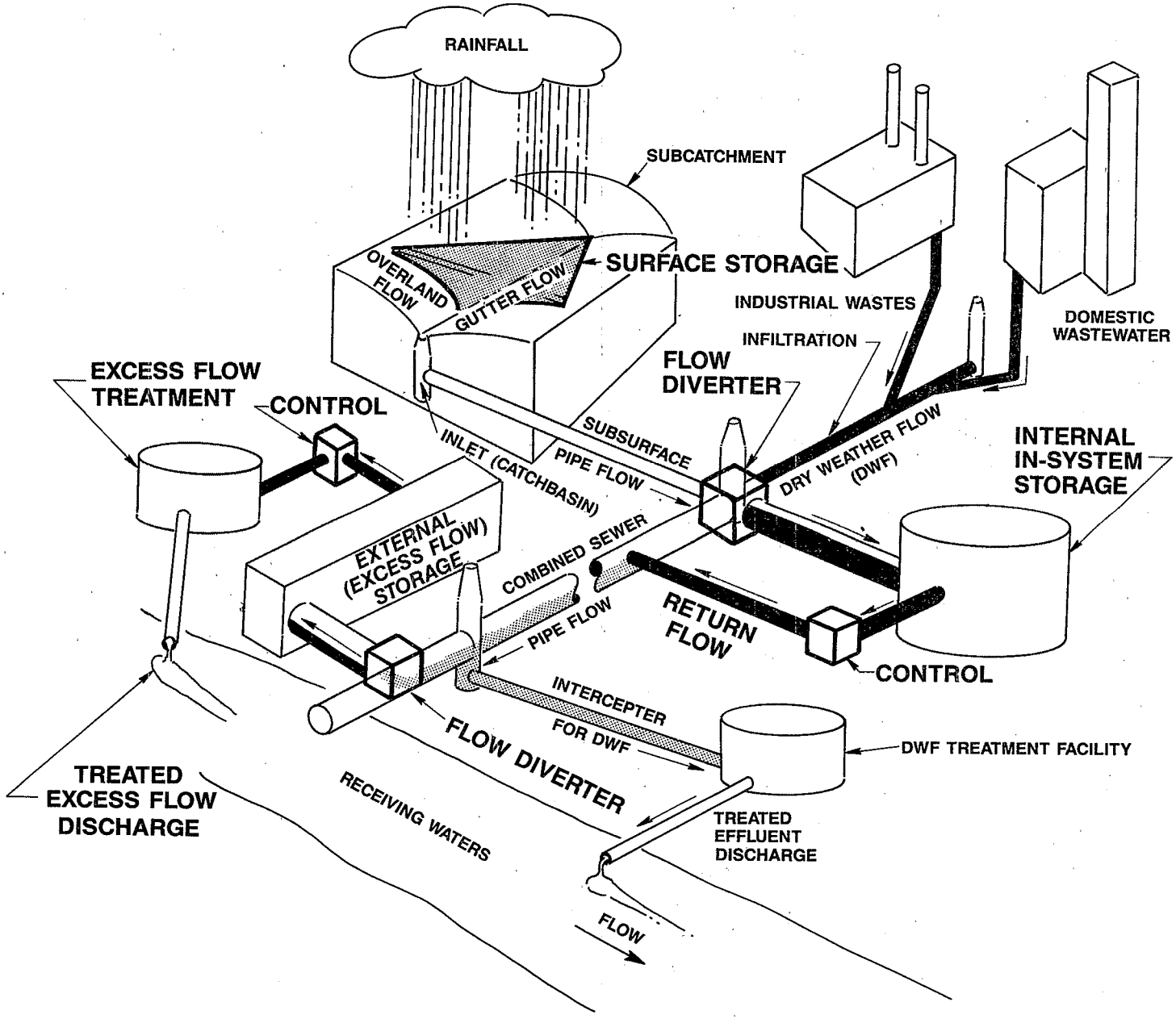
E. Timothy Oppelt, Director
Risk Reduction Engineering Laboratory

ACKNOWLEDGMENTS

This Laboratory is grateful to the principal compiler, Richard Field, for his long-term efforts and devotion to the SCSP. This has resulted in more than three hundred reference documents, many of which are internationally recognized. The significant references are cited in this publication.

The Laboratory would also like to acknowledge Foster Wheeler Enviresponse, Inc. especially Francine Everson, Technical Information Specialist, and Hugh Masters, the EPA Project Officer of the overall contract, for their contributions to this report.

URBAN RUNOFF CONTROL



ABSTRACTS

1967
EPA NO: 11020---12/67
NTIS NO: PB-214469

PROBLEMS OF COMBINED SEWER FACILITIES AND OVERFLOWS - 1967

The effects and means of correcting combined sewer overflows and separate storm and sanitary sewer discharges were inventoried on a national basis in 1967 and compiled in this report. On-site personal interviews with the public officials of approximately 900 communities in the United States collected over 250,000 pieces of data which have been analysed and grouped by state, river basin, and population group to define the problems of combined sewer facilities and overflows. Nationwide projections were made for major items of interest, including area and population served by combined sewers, overflow locations, type and number of regulators, associated land and water uses, estimates of costs for sewer separation by states, alternate control and/or treatment methods and consideration of other aspects of the overall problem. Findings, conclusions and recommendations are presented in summary form.

1969
EPA NO: 11030DNS01/69
NTIS NO: PB-215532

WATER POLLUTION ASPECTS OF URBAN RUNOFF

A study was conducted to determine the factors in the urban environment which contribute to the pollution of urban stormwater runoff and to determine methods to limit this source of water pollution. It was found that street refuse/litter could be a significant factor when the nature of the shock discharge of the pollution is considered.

An evaluation was made of the efficiency of street cleaning methods and limitations of commonly used equipment explored.

Catch basins in conjunction with street inlets to the stormwater disposal system were also determined to be a potential major source of pollution as large quantities of septic liquid are released during periods of stormwater runoff.

Other potential sources of pollution considered included air pollution, roof discharges, and chemicals used in the urban environment. Surveys were made to determine national patterns. A comprehensive set of "typical" ordinances governing a wide sampling of possible sources of urban stormwater runoff pollution were compiled and are included in the report.

Findings and recommendations are included in summary form.

1970
EPA NO: 11024---06/70
NTIS NO: PB-193939

COMBINED SEWER OVERFLOW ABATEMENT TECHNOLOGY

This compilation of papers entitled "Combined Sewer Overflow Abatement Technology" has been prepared and made available to you so that you can benefit from the current demonstration grants and contracts that are being supported by the FWQA.

During a two-day Storm and Combined Sewer Overflow Symposium, several demonstration projects were discussed. Material from these projects include: (1) alternatives to storm and combined sewer pollution in a small urban area; (2) screening and air floatation for solids removal; (3) underflow deep tunnel system concept; (4) urban erosion and sediment control; (5) sewer monitoring and remote control; (6) combined sewer overflow regulators; (7) use of fine mesh screens; and (8) land use and urban runoff pollution.

1970
EPA NO: 11022DMU07/70
NTIS NO: PB-215902

COMBINED SEWER REGULATOR OVERFLOW FACILITIES REPORT

Current design, operation and maintenance practices used by local jurisdictions in the United States and Canada were determined by personal interviews and compiled in this report. Particular attention was given to the performance of various types of regulators, the use of tide gates, new designs, European practices and the systems concept of combined sewer regulation. Thirty-seven drawings and photographs of regulators are included. Seventeen recommendations are made, the adoption of which would upgrade regulator facilities and tend to reduce receiving water pollution from combined sewer overflows.

ABSTRACTS

1970
EPA NO: 11022DMU08/70
NTIS NO: PB-195676

COMBINED SEWER REGULATION AND MANAGEMENT A MANUAL OF PRACTICE

Design application, operation and maintenance of combined sewer overflow regulator facilities are detailed in this Manual of Practice, developed in conjunction with a report prepared on combined sewer overflow regulators.

Design calculations are given for various types of regulators and tide gates. A sample regulator facility control program is given to illustrate the development of a control system. Operation and maintenance guidelines are also given. Thirty-eight sketches and photographs are included.

1970
EPA NO: 11022EFF12/70
NTIS NO: PB-200827

CONTROL OF INFILTRATION AND INFLOW INTO SEWER SYSTEMS

Two hundred and twelve public jurisdictions in the United States and Canada were contacted, and 26 communities were visited. Practices of consulting engineers and state and provincial water pollution control agencies were also surveyed.

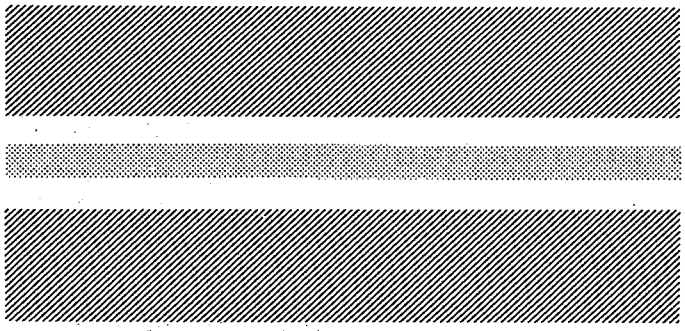
The surveys indicated that infiltration and inflow are widespread problems.

Reduction of infiltration should be stressed in both new and old systems. For new sewers a construction allowance of no more than 200 gallons per day per inch of diameter per mile of pipe is recommended. Existing systems must be extensively investigated to determine the extent and location of infiltration. Reduction of inflow waters can be accomplished after sources of such flows have been identified, alternate methods of disposal identified, and the backing of public and governing bodies secured.

Twenty recommendations are given indicating the need for extensive investigation of the extent of the infiltration/inflow problem before relief sewers are constructed or wastewater treatment plants built or enlarged.

The report includes 43 tables, an extensive review of reports concerning local infiltration studies, and a bibliography of 135 references.

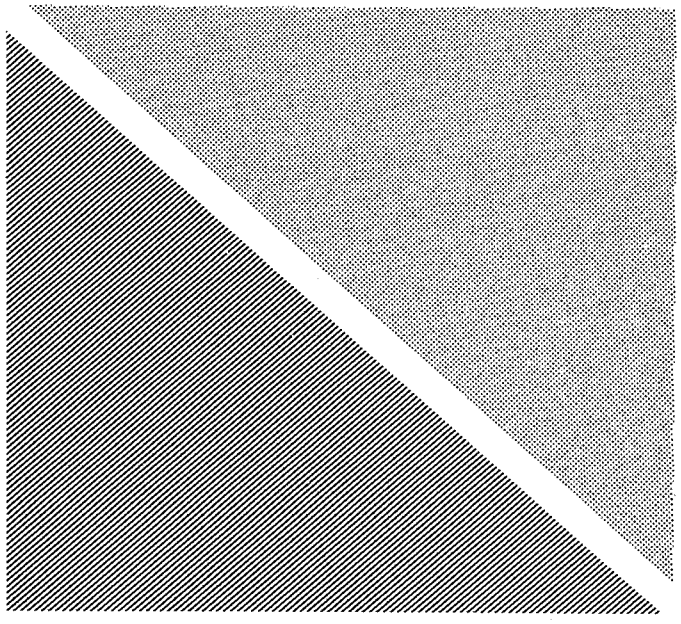
A companion document, "Manual of Practice, Prevention and Correction of Excessive Infiltration and Inflow into Sewer Systems," EPA No. 11022EFF01/71, was also prepared.



1971
EPA NO: 11022EFF01/71
NTIS NO: PB-203208

PREVENTION AND CORRECTION OF EXCESSIVE INFILTRATION AND INFLOW INTO SEWER SYSTEMS A MANUAL OF PRACTICE

As a result of a national study of the sources and prevention of infiltration and inflow, a Manual of Practice was proposed. The Manual is intended to serve as a guide to local officials in evaluating their construction practices, conducting surveys to determine the extent and location of infiltration and inflow, the making of economic analyses of the cost of excessive infiltration/inflow waters, and instituting corrective action.



ABSTRACTS

1971
EPA NO: 11020FAL03/71
NTIS NO: PB-202236

EVALUATION OF STORM STANDBY TANKS COLUMBUS, OHIO

The Whittier Street Storm Standby Tanks, completed in 1932, were designed to provide partial treatment to combined sewer overflows. By 1965 complaints from nearby residents about odor resulting from accumulation and removal of sludge in the tanks became numerous. To overcome this problem, the City modified the tanks in 1967 and 1968. The main modifications consisted of moving scrapers and sludge pumps to carry sludge from sumps in the tanks to the O.S.I.S. downstream of the Whittier Street Plant.

Samples of influent and effluent were obtained, and laboratory tests made for 24 storm periods consisting of 67 composite samples between May 1968 and June 1969, to evaluate the effectiveness of the modified storm standby tanks.

Reductions in concentrations of total suspended solids from 15 to 45 percent can be expected with the detention time being from 20 to 180 minutes. The expected effluent concentrations range from 50 to 230 mg/ℓ.

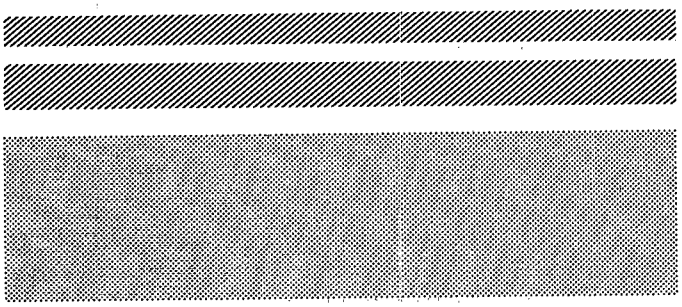
Similar reductions can be expected for settleable solids, the ranges being from 20 to over 80 percent with the detention time being between 20 and 180 minutes. The effluent values vary from 0.3 to 1.55 ml/ℓ.

The expected reductions in BOD concentrations range from 15 to 35 percent with the detention time varying from 20 to 180 minutes. The expected effluent values are between 35 and 100 mg/ℓ.

The expected improvement of dissolved oxygen ranges from 8 percent with an influent value of 70 percent saturation to 200 percent with an influent value of 10 percent saturation.

Inasmuch as the tanks do not operate during dry-weather flow periods when stream pollution problems are greatest, they cannot be considered as making a major contribution to pollution abatement. However, the tanks do significantly improve the quality of the storm flow passing through the tanks but this usually occurs when stream flows are decidedly greater than the dry-weather flow and when the quality of the stream flows are not particularly bad.

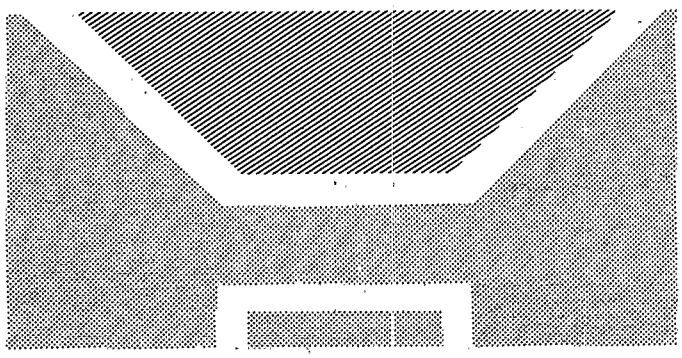
As known, indirect benefits from the long term usage of the system would exist in the reduced amount of load applied to the stream, even at a time when the stream could handle such load. However, the scope of this study was not intended to evaluate this obvious benefit.



1971
EPA NO: 11040GKK06/71
NTIS NO: PB-203493

ENVIRONMENTAL IMPACT OF HIGHWAY DEICING

Deicing agents for removal of ice and snow from highways and streets are essential to wintertime road maintenance in most areas of the U.S. Due to the ever-increasing use of highway deicing materials, there has been growing concern as to environmental effects resulting from these practices. This state-of-the-art report critically reviews the available information on methods, equipment and materials used for snow and ice removal; chlorides found in rainfall and municipal sewage during the winter; salt runoff from streets and highways; deicing compounds found in surface streams, public water supplies, groundwater, farm ponds and lakes; special additives incorporated into deicing agents; vehicular corrosion and deterioration of highway structures and pavements; and effects on roadside soils, vegetation and trees. It is concluded that highway deicing can cause injury and damage across a wide environmental spectrum. Recommendations describe future research, development and demonstration efforts necessary to assess and reduce the adverse impact of highway deicing. This report was prepared by the Storm and Combined Sewer Pollution Control Section, Edison Water Quality Laboratory, Water Quality Office (presently The Storm & Combined Sewer Pollution Control Program, Risk Reduction Engineering Laboratory) of the Environmental Protection Agency.



ABSTRACTS

1973
EPA NO: EPA-R2-73-257
NTIS NO: PB-222795/7BA

WATER POLLUTION AND ASSOCIATED EFFECTS FROM STREET SALTING

This report comprises a state-of-the-art review of highway deicing practices and associated environmental effects.

The bare pavement policy has resulted in a great increase in the use of deicing salts, in many cases replacing the abrasives previously used. However, no conclusive evidence has been found to substantiate that salt usage makes winter travel safer.

Besides chemical melting, various methods for anti-icing/deicing are available or have been conceived (external and in-slab thermal melting systems; mobile thermal "snow melters;" compressed air or high speed fluid streams in conjunction with snowplow blades or sweepers; snow/ice adhesion reducing [hydrophobic/icephobic] substances; improved vehicular and/or tire design) which may become more prominent in the future especially when communities realize that a price must be paid to alleviate the environmental effects of wintertime salting.

Salt storage facilities often become a major contributing source of local groundwater and surface water contamination and vegetation damage. Coverage and proper drainage of salt piles is becoming more prevalent, but there has not been an adequate acceptance of approved practices and a proper recognition of pollution problems associated with this material storage. Types of enclosed structures are illustrated, and cost considerations given.

High chloride concentration levels have been found in roadway runoff. The special additives in deicing salts may create more severe pollution problems than the chloride salts. Many roadside wells, due to contamination by salt laden runoff, have had to be replaced in such snow belt states as New Hampshire, Maine, and Massachusetts. Widespread damage of roadside soils and vegetation has been observed in areas of liberal salt usage.

Areas of future research are also indicated in this report.

1973
EPA NO: EPA-670/2-73-077
NTIS NO: PB-231836

COMBINED SEWER OVERFLOW SEMINAR PAPERS

The U.S. Environmental Protection Agency in conjunction with the New York State Department of Environmental Conservation conducted three one-day seminars on the problem of wet-weather flow pollution abatement. Many facets of the problem were considered including a brief overview of its magnitude and what the federal government is doing to manage and control this source of pollution. Various management, control and treatment techniques were described and the most up-to-date information on design and economics was presented. The audience consisted of consulting and municipal engineers from all areas of New York State.

This is a compilation of technical papers and discussions presented at these seminars.

1974
EPA NO: EPA-670/2-74-033
NTIS NO: PB-236152

MANUAL FOR DEICING CHEMICALS: STORAGE AND HANDLING

This report contains the results of a study conducted for the U.S. Environmental Protection Agency to minimize the loss to the environment of chemicals used in controlling snow and ice on highways. Based on the best current practices for highway maintenance as observed during two years of study, practical guidelines are presented for good practice in the storage and handling of deicing chemicals.

1. Covered storage of salt and other deicing chemicals is strongly recommended; permanent structures for this purpose are preferable. Guidelines are given for site selection and for design of foundations, paved working area, and site drainage. Existing storage facilities are presented that represent a range of costs, designs, construction materials and storage capacities.

2. For the handling of salt and other deicing chemicals, general precautions and good housekeeping practices are defined.

3. Environmental responsibilities are discussed for personnel who administer and supervise highway maintenance.

ABSTRACTS

1974
EPA NO: EPA-670/2-74-040
NTIS NO: PB-240687

URBAN STORMWATER MANAGEMENT AND TECHNOLOGY AN ASSESSMENT

A comprehensive investigation and assessment of promising, completed, and ongoing urban stormwater projects, representative of the state-of-the-art in abatement theory and technology, has been accomplished. The results, presented in textbook format, provide a compendium of project information on management and technology alternatives within a framework of problem identification, evaluation procedures, and program assessment and selection.

Essentially every metropolitan area of the United States has a stormwater problem, whether served by a combined sewer system (approximately 29 percent of the total sewered population) or a separate sewer system. However, the tools for reducing stormwater pollution, in the form of demonstrated processes and devices, do exist providing many-faceted approach techniques to individual situations. These tools are constantly being increased in number and improved upon as a part of a continuing nationwide research and development effort. The most promising approaches to date involve the integrated use of control and treatment systems with an areawide, multidisciplinary perspective.

1974
EPA NO: EPA-670/2-74-045
NTIS NO: PB-239694

MANUAL FOR DEICING CHEMICALS: APPLICATION PRACTICES

This report contains the results of a study conducted for the U.S. Environmental Protection Agency to minimize the loss to the environment of chemicals used in controlling snow and ice on highways. Based on the best current practices for highway maintenance as observed during two years of study, practical guidelines are presented for the use of deicing chemicals.

1. Supervisory aspects of proper chemical usage are defined, including organization and personnel training.

2. Efficient snow and ice control requires good judgement and appropriate action. Elements of proper decision-making are discussed, including weather forecasting, setting chemical application rates, and accounting for chemical usage.

3. The backbone of winter road maintenance is equipment. General requirements and major equipment classes are described, including recent improvements and advantages or disadvantages. Methods are given for accurate spreader calibrations.

4. Means are described for developing and enlisting the support of citizens and drivers for winter road maintenance policies.

5. Legal requirements for and constraints on snow and ice control are described.

1974
EPA NO: EPA-670/2-74-049
NTIS NO: PB-235771

MICROSTRAINING AND DISINFECTION OF COMBINED SEWER OVERFLOWS - PHASE III

A microstrainer with a stainless steel screen having openings of 23 microns reduced the suspended solids (SS) of the combined sewer overflow from 50 to 300 mg/ℓ to 40 to 60 mg/ℓ operating at an average rate of 38.4 m/hr (16 gpm/sq ft). The addition of polyelectrolyte improved the overall performance of the microstrainer. The effluent SS was reduced to an average of 23 mg/ℓ and the flow rates increased to an average of 87.5 m/hr (36 gpm/sq ft).

The combined sewer served a residential area in Philadelphia comprised of 4.5 hectares (11.2 acres). The average dry-weather flow was 91 cu m/day (24000 gpd). The average overflow rates encountered were about 70 times the average dry-weather flow.

An extensive coagulation study revealed that moderately charged, high molecular weight, cationic polyelectrolytes were the most suitable for this particular application. The concentrations applied ranged from 0.25 to 1.5 mg/ℓ.

Coliform reductions across the microstrainer were observed. It was also found that microstrained effluent could be more easily disinfected than the raw combined sewer overflow. Chlorine and ozone were used for disinfection at low contact time periods.

The capital cost of a microstrainer installation (based on 8.2 cu m/min hectare [1.96 cfs/acre]) followed by a high rate chlorine contact chamber is reported as $60,660/hectare ($24,480/acre). When polyelectrolyte addition equipment is included, the capital cost is $37,250/hectare ($15,030/acre). Costs are in 1973 dollars.

ABSTRACTS

1974
EPA NO: EPA-670/2-74-090
NTIS NO: PB-240498

COUNTERMEASURES FOR POLLUTION FROM OVERFLOWS THE STATE OF THE ART

Control and/or treatment of stormwater discharges and combined sewage overflows from urban areas are problems of increasing importance in the field of water quality management. Over the past decade much research effort has been expended and a large amount of data has been generated, primarily through the actions and support of the EPA's Storm and Combined Sewer Research and Development Program. Presented in this text are selected results of a comprehensive investigation and assessment of promising, completed and ongoing projects, representative of the state-of-the-art in abatement theory and technology; a look at recent legislation; and the identification of program needs and emphasis.

Combined sewer overflows are major sources of water pollution problems, but even discharges of stormwater alone can seriously affect water quality. Current approaches involve control of overflows, treatment and combinations of the two. Control may involve maximizing treatment with existing facilities, control of infiltration and extraneous inflows, surface sanitation and management, as well as flow regulation and storage. A number of treatment methods have been evaluated including high rate screening and microstraining, ultra high rate filtration, dissolved air flotation, physical/chemical treatment, and modified biological processes. A swirl flow regulator/solids separator of anular shape construction with no moving parts has been developed. High rate disinfection methods, including new disinfectants, have been applied.

Promising approaches involve integrated use of controls and treatment. The most disappointing have generally lacked flexibility in their operation and design. Mathematical models have been developed and successfully applied at multiple levels of sophistication and complexity.

1974
EPA NO: EPA-670/9-74-004
NTIS NO: PB-273440/8

EXCERPTS FROM CONTROL OF INFILTRATION AND INFLOW INTO SEWER SYSTEMS *AND* PREVENTION AND CORRECTION OF EXCESSIVE INFILTRATION AND INFLOW INTO SEWER SYSTEMS: A MANUAL OF PRACTICE

This is a brief report providing excerpts from two complete reports, that are extensive state-of-the-art and manual-of-practice documents, respectively, on the control of infiltration and inflow into sewer systems.

Refer to EPA Nos. 11022EFF12/70 and 11022EFF01/71 for the complete abstracts.

1975
EPA NO: EPA-600/2-75-027
NTIS NO: PB-250371

SEWER FLOW MEASUREMENT A STATE-OF-THE-ART ASSESSMENT

A brief review of the characteristics of storm and combined sewer flows is given, followed by a general discussion of the need for such flow measurement, the types of flow data required, and the time element in flow data. A discussion of desirable flow measuring equipment characteristics presents both equipment requirements as well as desirable features and includes an equipment evaluation sheet that can be used for a particular application.

A compendium of over 70 different generic types of primary flow measurement devices, arranged according to the fundamental physical principles involved, is presented along with evaluations as to their suitability for measurement of storm or combined sewer flows. To illustrate the implementation of the physical principles, a number of commercially available devices for flow measurement are briefly described.

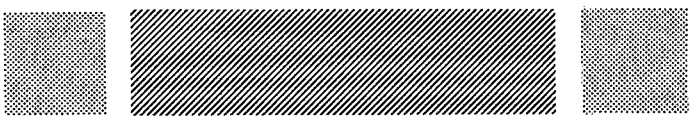
1975
EPA NO: EPA-600/2-75-065
NTIS NO: PB-250987

AN ASSESSMENT OF AUTOMATIC SEWER FLOW SAMPLERS - 1975

A brief review of the characteristics of storm and combined sewer flows is given followed by a general discussion of the purposes for and requirements of a sampling program. The desirable characteristics of automatic sampling equipment are set forth and problem areas are outlined.

A compendium of 82 model classes covering over 200 models of commercially available and custom designed automatic samplers is given with descriptions and characterizations of each unit presented along with an evaluation of its suitability for a storm and/or combined sewer application.

A review of field experience with automatic sampling equipment is given covering problems encountered and lessons learned. A technical assessment of the state-of-the-art in automatic sampler technology is presented, and design guides for development of a new, improved automatic sampler for use in storm and combined sewers are given.



ABSTRACTS

1975
EPA NO: EPA-670/2-75-011
NTIS NO: PB-242001

PHYSICAL AND SETTLING CHARACTERISTICS OF PARTICULATES IN STORM AND SANITARY WASTEWATERS

An investigation was conducted, as part of model studies utilizing a swirl concentrator as a primary separator, helical combined sewer overflow regulator, and related studies, to characterize the properties of solids in sanitary sewage, combined sewer overflows, and stormwater runoff. To effectuate this study, material suitable for monitoring removal efficiencies in hydraulic models of the swirl concentrator unit has been developed.

The approach taken in the simulation sewage studies was to match as closely as possible the settling characteristics of solids in three types of sewage and/or urban runoff with a well-defined, uniform artificial test material. An Amberlite anion exchange resin (IRA-93), when ground and sieved to between 74 and 149 microns, was found to closely simulate the settling characteristics of domestic sewage. This material is of uniform density and appears to react according to Stokes' law for spherical particles at this size range. Arizona Road Dust, between 10 and 20 microns, was found to exhibit a similar settling velocity distribution.

Importantly, as background information for the selection of synthesized solids, the settling characteristics (including size and specific gravity distribution) of a few samples of sanitary sewage, combined sewer overflow, and stormwater were determined. These values will be useful for future determinations of physical treatment process design and associated treatability.

This report on these studies recommends that either or both of these materials be used in the scale-model efficiency trials.

1976
EPA NO: EPA-600/2-76-006
NTIS NO: PB-252613

DESIGN AND TESTING OF A PROTOTYPE AUTOMATIC SEWER SAMPLING SYSTEM

A brief review of the characteristics of storm and combined sewer flows is given, followed by a discussion of the requirements for equipment to sample them, noting features that are desirable in such equipment and problem areas. When considered from a systems viewpoint, there are five functional subsystems. Design considerations for each of these are discussed, followed by a description of the design implementation used for each subsystem in the fabrication and assembly of a prototype automatic sewer sampling system intended for storm and combined sewer application and other adverse sewer flow conditions.

The prototype sampler is described from an installation and operation viewpoint, and the results of preliminary field testing are discussed. The device was also tested under controlled laboratory conditions and found to be capable of gathering reasonably representative samples (i.e., within 10%) over a fairly wide range of flow characteristics, even for particles somewhat outside the regime of Stokes' law. Four different commercially available samplers were tested under the same flow conditions in a side by side fashion. Their behavior was rather erratic, and they were not able to gather representative samples consistently. None of them was capable of good performance when appreciable bed load was present. Results from these commercial units ranged from an overall understatement of pollutant loading by 25% or more, to overstatements of 200% and more.

1976
EPA NO: EPA-600/2-76-095
NTIS NO: PB-252223

URBAN RUNOFF POLLUTION CONTROL PROGRAM OVERVIEW: FY'76

FY'76 review of EPA's Urban Runoff Pollution Control Research, Development, and Demonstration Program – The review describes the basic problems associated with urban runoff (both technical and administrative) and the approach that EPA's R&D program has and is taking to combat these problems. Information is presented on flood control, erosion control and the basic pollution problems created by wet-weather flows. Nationwide cost requirements for abating urban runoff pollution and available abatement technology along with ongoing and perceived developments are discussed. Of overlying importance is the presentation of EPA's research direction and desired goals oriented toward a truer concept of solution methodology.

Details in summary and abstract form are presented covering the gamut of technologic advancements resulting from some 150 R&D projects. Stormwater management is broken down into the categories of: problem definition, user assistance tools, land management, collection system control, storage, treatment, sludge/solids, integrated systems, and technical assistance/technology transfer.

General cost comparisons for urban runoff pollution control/treatment are given along with a specific example of a cost-effective solution for urban runoff pollution control by in-line storage in Seattle, Washington, and a simplified hypothetical plan for wet-weather flow pollution abatement for the Des Moines, Iowa area.

ABSTRACTS

1976
EPA NO: EPA-600/2-76-145
NTIS NO: PB-258743

METHODOLOGY FOR THE STUDY OF URBAN STORM GENERATED POLLUTION AND CONTROL

This report contains recommendations for standard procedures to be followed in the conduct of projects dealing with pollution assessment and abatement of storm generated discharges. The purpose of this project was to develop standard procedures needed to insure that all discharges and treatment processes could be evaluated by the same means. The procedures chosen were those found to be the most applicable and optimum for the field of storm and combined sewer overflow pollution control.

The project efforts were devoted to the major areas listed below.

1. Recommended methods for sampling and sample preservation.
2. Appropriate monitoring instrumentation available.
3. The choice of quality parameters to be utilized.
4. The analytical procedures to be followed.
5. The methods for evaluating storm generated discharge pollution.
6. The standard procedures for evaluating treatment processes treating storm generated flows.

Choice of the recommended procedures was based upon the EPA research and demonstration project reports in this and associated fields, other published literature, ongoing EPA funded projects, and the contractor's experience in the field of stormwater pollution control.

1976
EPA NO: EPA-600/2-76-218
NTIS NO: PB-258074

DEVELOPMENT AND APPLICATION OF A SIMPLIFIED STORMWATER MANAGEMENT MODEL

A simplified stormwater management model has been created to provide an inexpensive, flexible tool for planning and preliminary sizing of stormwater facilities.

The model delineates a methodology to be used in the management of stormwater and consists of a series of interrelated tasks that combine small computer programs and hand computations. The model successfully introduces time and probability into stormwater analysis, promotes total system consciousness on the part of the user, and assists in establishing size-effectiveness relationships for facilities.

Throughout this report, data from the City of Rochester, New York, is presented and analysed as a working example.

1976
EPA NO: EPA-600/2-76-244
NTIS NO: PB-263030

PROCEEDINGS OF WORKSHOP ON MICROORGANISMS IN URBAN STORMWATER

This workshop was held on March 29, 1975 at Edison, New Jersey. The aim was to exchange information obtained from EPA Office of Research and Development, Storm and Combined Sewer Program sponsored projects so as to foster a better understanding of microorganisms in urban storm runoff and combined sewer overflow.

Workshop emphasis was placed on the following aspects:

a. Procedures for pathogenic microorganism assays
b. Relationship between pathogenic and coliform group microorganisms
c. Disinfection and aftergrowth of microorganisms
d. Viruses in stormwater

1976
EPA NO: EPA-600/2-76-275
NTIS NO: PB-259916

STORM WATER MANAGEMENT MODEL LEVEL I PRELIMINARY SCREENING PROCEDURES

The original EPA Storm Water Management Model (SWMM) provides a detailed simulation of the quantity and quality of storm water during a specified precipitation event lasting a few hours. This model is widely used. However, it is too detailed for many users. Indeed, there is a need for a wide range of evaluation techniques ranging from simple to complex procedures. In particular, urban planning efforts need simplified procedures to permit preliminary screening of alternatives.

In response to this need, four levels of stormwater management models have been prepared and are being released this year. This initial volume presents a "desktop" procedure which was developed to do a nationwide assessment of stormwater pollution control costs. The next three models will be computer based and provide increasing amounts of detail.

The desktop procedure permits the user to estimate the quantity and quality of urban runoff in the combined, storm, and unsewered portions of each urban area in his jurisdiction. Using generalized results from the nationwide assessment, the optimal mix of storage and treatment and its associated costs may be estimated. Also, comparisons between tertiary treatment and stormwater management are presented. Lastly, possible savings due to integrated management of domestic wastewater, stormwater quality, and stormwater quantity are evaluated.

ABSTRACTS

1976
EPA NO: EPA-600/2-76-286
NTIS NO: PB-266359

COST ESTIMATING MANUAL
COMBINED SEWER OVERFLOW STORAGE AND TREATMENT

Data for estimating average construction costs and operation and maintenance requirements are presented for combined sewer overflow treatment plants ranging from about 5 to 200 million gallons per day in capacity, and storage facilities ranging in size from 1 to 240 million gallons. Estimating data are included for 14 separate process functions associated with combined sewer overflow treatment plants and storage facilities. An example of the use of the data is given.

Estimated average construction costs and operation and maintenance requirements are related graphically to appropriate single parameters for respective plant components. In addition, cost components of the process functions are presented to enable inflating cost-related materials and wages.

The data presented provides means of estimating costs and operating and maintenance requirements for a variety of facilities on an average basis, but do not supplant the need for detailed study of local conditions or recognition of changing design requirements in preparing estimates for specific applications.

1976
VOL. I
EPA NO: EPA-600/9-76/014-1
NTIS NO: PB-271864/1
VOL. 2
EPA NO: EPA-600/9-76/014-2
NTIS NO: PB-271865/8
VOL. 3
EPA NO: EPA-600/9-76/014-3
NTIS NO: PB-271866/6
SET
NTIS NO: PB—271863

AREAWIDE ASSESSMENT PROCEDURES MANUAL
VOLUME I, VOLUME II, VOLUME III

This manual summarizes and presents in condensed form a range of available procedures and methodologies that are available for identifying and estimating pollutant load generation and transport from major sources within water quality management planning areas. Although an annotated chapter is provided for the assessment of non-urban pollutant loads, the major emphasis of the manual is directed toward the assessment of problems and selection of alternatives in urban areas, with particular concern for stormwater related problems. Also included in the manual are methodologies for assessing the present and future water quality impacts from major sources as well as summaries of available information and techniques for analysis and selection of structural and non-structural control alternatives.

This manual is structured to present problem assessment and impact analysis approaches for several levels of planning sophistication. Simple procedures are recommended for initial analysis to develop the insight and problem understanding to guide the application of more complex techniques where required.

1977
EPA NO: EPA-600/2-77-017d
NTIS NO: PB-279248

SEWER SYSTEM EVALUATION, REHABILITATION AND NEW CONSTRUCTION
A MANUAL OF PRACTICE

This Manual of Practice has been prepared for use by local authorities and consulting engineers for the investigation of sewer systems for infiltration/inflow. This Manual discusses three areas: sewer system evaluation, sewer rehabilitation, and design of new systems to minimize infiltration/inflow.

Procedures for conducting the System Analysis and Sewer System Evaluation Study (SSES) are described in detail.

Sewer cleaning equipment and methods of sewer inspection are discussed in detail. Factors which govern the cost of conducting work are given. Rehabilitation techniques are described and an analysis of factors to be considered for each method described.

Establishment of infiltration limits for new construction is recommended at a rate not to exceed 200 gal/in.-diam/mi/day (185.2 ℓ/cm-diam/km/day). Methods of testing are explained in detail.

1977
EPA NO: EPA-600/2-77-047
NTIS NO: PB-264452

URBAN RUNOFF POLLUTION CONTROL TECHNOLOGY OVERVIEW

This Overview describes the major elements of the Urban Runoff Pollution Control Program. Problem definition, user assistance tools, management alternatives and technology transfer are covered, including some of the highlights of the Program's future direction and products from over 150 of its research projects. References are cited for completed Program reports, ongoing Program projects, and in-house documents.

Capital cost comparisons for storm and combined sewer control/treatment are given, along with a specific example of cost-effect solution for urban runoff pollution control by in-line storage in Seattle. In a study done in Des Moines, using a simplified receiving water model, four control alternatives were compared, considering cost and effectiveness in terms of a frequency of D.O. standard violations.

ABSTRACTS

1977
EPA NO: EPA-600/2-77-051
NTIS NO: PB-270092

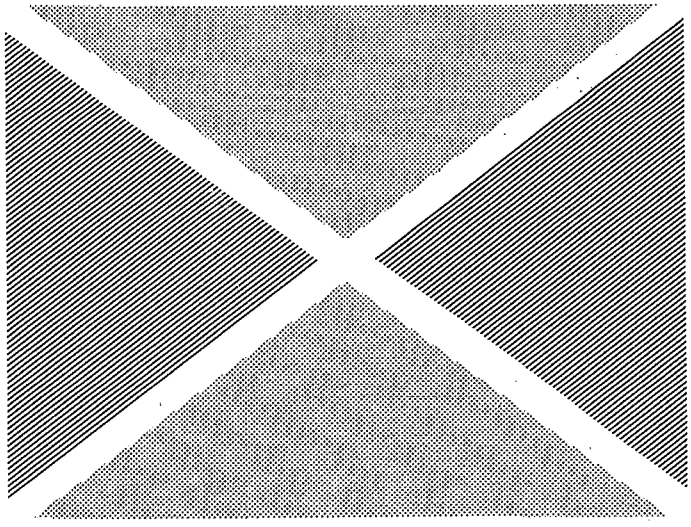
CATCHBASIN TECHNOLOGY OVERVIEW AND ASSESSMENT

An overview and assessment of current catchbasin technology has been prepared to provide engineers and municipal managers with technical and economic information on catchbasins and some alternatives so that they can make intelligent, informed decisions on runoff collection systems in light of pollution control legislation, the municipality's financial status, and its particular stormwater runoff characteristics.

Various catchbasin configurations and sizes were evaluated for hydraulic and pollutant removal efficiencies using hydraulic modeling analyses.

Detailed study findings are presented in sections dealing with (1) a state-of-the-art review; (2) a review of variables affecting catchbasin efficiency, (3) hydraulic modeling analyses, (4) an assessment of the role of catchbasins, (5) an economic evaluation of alternative storm and combined sewer designs, and (6) a review of recent developments and continuing program needs. Detailed example problems of the evaluation of catchbasin performance and economics are included.

A recommended catchbasin design configuration based upon hydraulic performance and sediment capture efficiency is presented.



1977
EPA NO: EPA-600/2-77-053a
NTIS NO: PB-270212

HANDLING AND DISPOSAL OF SLUDGES FROM COMBINED SEWER OVERFLOW TREATMENT PHASE I - CHARACTERIZATION

This report summarizes the results of a characterization and treatment test program undertaken to develop optimum means of handling and disposal of residual sludges from combined sewer overflow (CSO) treatment systems. Desk top engineering reviews were also conducted to gather, analyse and evaluate pertinent information relating to pump/bleedback of the treatment residuals to the dry-weather sludge handling/treatment and disposal facilities.

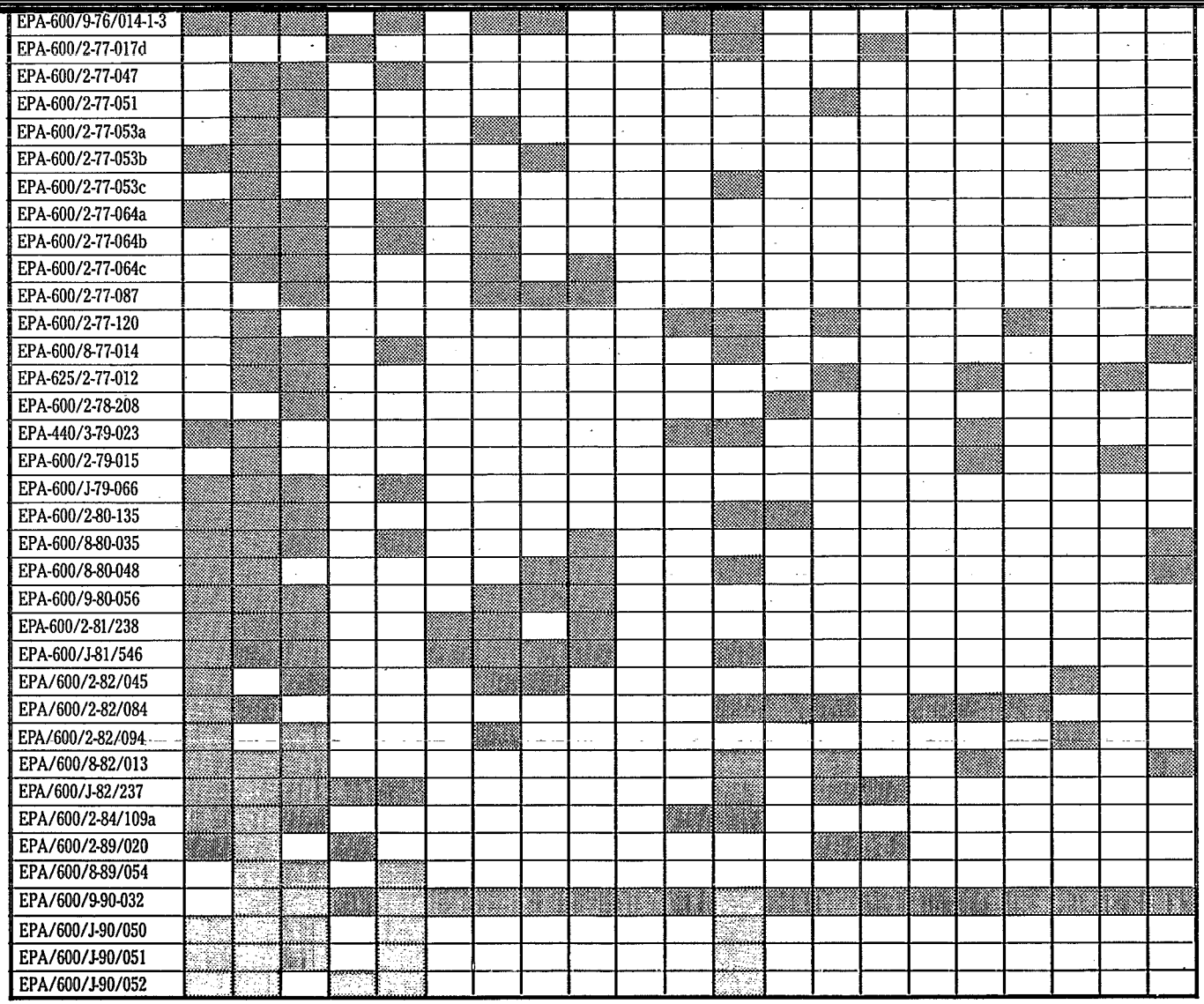
The results indicate that the volumes and characteristics of the residuals produced from CSO treatment vary widely. For the residuals evaluated in this study, the volumes ranged from less than 1% to 6% of the raw volume treated and contained 0.12% to 11% suspended solids. The volatile content of these sludges varied between 25% and 63% with biological treatment residuals showing the highest volatile content and fuel values. The heavy metal and pesticide concentrations of the various sludges were observed to be significant and are presented.

It was concluded that the pump/bleedback of CSO treatment residuals may not be practical for an entire city because of the possibility of hydraulic and/or solids overloading of the dry-weather treatment facilities and other adverse effects. However, controlled pump/bleedback on a selective basis may be feasible. For low solids content residuals (storage, screen backwash, waste activated sludge, etc.), gravity or flotation thickening were concluded to be the optimum steps for the removal of the major water portion while centrifugation and vacuum filtration were concluded to be the optimum dewatering techniques for the high solids content residuals (settled storage treatment sludge, flotation scum and other thickened sludges) prior to their ultimate disposal by incineration or landfill. As a result of the findings and conclusions of this initial study, the EPA conducted a followup study (see EPA-600/2-77-053c) to:

1. Evaluate on a pilot scale basis the process treatment systems of thickening followed by centrifugation or vacuum filtration for handling and disposing of CSO treatment sludges, as well as stabilization methods such as anaerobic digestion.

2. Develop capital and operating costs for the above mentioned treatment systems.

3. Evaluate alternative methods for ultimate disposal of storm generated residuals and assess the potential impacts of such handling and disposal.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EPA-600/2-77-064b
EPA-600/2-77-064c
EPA-600/2-77-087
EPA-600/2-77-120
EPA-600/8-77-014
EPA-625/2-77-012
EPA-600/2-78-208
EPA-440/3-79-023
EPA-600/2-79-015
EPA-600/J-79-066
EPA-600/2-80-135
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EPA-600/8-80-048
EPA-600/9-80-056
EPA-600/2-81/238
EPA-600/J-81/546
EPA/600/2-82/045
EPA/600/2-82/084
EPA/600/2-82/094
EPA/600/8-82/013
EPA/600/J-82/237
EPA/600/2-84/109a
EPA/600/2-89/020
EPA/600/8-89/054
EPA/600/9-90-032
EPA/600/J-90/050
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USEPA REPORT NUMBER		
11020- - -12/67	AVAILABLE FROM NTIS ONLY	
11030DNS01/69	COMBINED SEWER OVERFLOW	FLOW/ DISCHARGE TYPE
11024- - -06/70	STORMWATER	FLOW/ DISCHARGE TYPE
11022DMU07/70	INFILTRATION/INFLOW	FLOW/ DISCHARGE TYPE
11022DMU08/70	GENERAL / OVERVIEW	
11022EFF12/70	MONITORING / ANALYSIS	POLLUTION PROBLEM ASSESSMENT
11022EFF01/71	CHARACTERIZATION	POLLUTION PROBLEM ASSESSMENT
11020FAL03/71	RECEIVING WATER / ECOLOGICAL IMPACTS	POLLUTION PROBLEM ASSESSMENT
11040GKK06/71	CASE STUDIES	POLLUTION PROBLEM ASSESSMENT
EPA-R2-73-257	MONITORING INSTRUMENTATION	USER ASSISTANCE TOOLS
EPA-670/2-73-077	MODELING	USER ASSISTANCE TOOLS
EPA-670/2-74-033	DESIGN/SOLUTION METHODOLOGY	
EPA-670/2-74-040	LAND MANAGEMENT	MANAGEMENT / CONTROL ALTERNATIVES
EPA-670/2-74-045	COLLECTION SYSTEM CONTROL	MANAGEMENT / CONTROL ALTERNATIVES
EPA-670/2-74-049	INFILTRATION/INFLOW CONTROL	MANAGEMENT / CONTROL ALTERNATIVES
EPA-670/2-74-090	STORAGE	MANAGEMENT / CONTROL ALTERNATIVES
EPA-670/9-74-004	TREATMENT	MANAGEMENT / CONTROL ALTERNATIVES
EPA-600/2-75-027	DISINFECTION	MANAGEMENT / CONTROL ALTERNATIVES
EPA-600/2-75-065	SLUDGE / SOLIDS HANDLING	MANAGEMENT / CONTROL ALTERNATIVES
EPA-670/2-75-011	INTEGRATED SYSTEMS	MANAGEMENT / CONTROL ALTERNATIVES
EPA-600/2-76-006	CASE STUDIES	MANAGEMENT / CONTROL ALTERNATIVES
EPA-600/2-76-095		
EPA-600/2-76-145		
EPA-600/2-76-218		

ABSTRACTS

1977
EPA NO: EPA-600/2-77-053b
NTIS NO: PB-280309

HANDLING AND DISPOSAL OF SLUDGES FROM COMBINED SEWER OVERFLOW TREATMENT
PHASE II - IMPACT ASSESSMENT

This report documents the results of an assessment of the effort that the United States will have to exert in the area of sludge handling and disposal if, in fact, full-scale treatment of combined sewer overflows (CSO) is to become a reality. The results indicate that nationwide an average yearly sludge volume of 156 x 10^6 cu m (41.5 x 10^9 gal.) could be expected from CSO if complete CSO treatment were achieved. This compares to a raw primary sludge volume of 60.9 x 10^6 cu m (16.1 x 10^9 gal.). However, the average solids concentration in CSO sludge is about 1% compared to 2-7% in raw primary sludges. This is due to the high volume, low solids residuals generated by treatment processes employing screens. The sludge volume generated and the reported characteristics of the sludge vary widely, depending on the type of treatment process used. The most notable differences from raw primary sludge were the high grit and low volatile solids content in CSO residuals plus their intermittent generation.

Evaluation of the effect of bleed/pump-back of CSO sludge on the hydraulic, solids and/or organic loadings to the dry-weather plant indicated that overloading would occur in most instances. Disregarding grit accumulation in sewers plus other transport problems, it was established that solids loadings to the secondary clarifier were limiting and required 8-22 day bleed/pump-back periods. There may also be a toxic danger to dry-weather treatment plant biological processes.

The most promising treatment trains were found to include possible grit removal, lime stabilization, optional gravity thickening, optional dewatering and land application or landfill. Land application systems can be considered as viable alternatives for CSO treatment and disposal. The cost of the collection-transportation and/or equalization system may be the crucial factor in disallowing the alternative of direct application of raw CSO. If CSO treatment is employed by a city, land spreading of CSO sludges should be evaluated. Public health concerns dictate sludge stabilization before disposal and pollutant loading limitations based on nitrogen and heavy metal concentrations. An environmentally safe rate of application was determined as 19.0 metric tons/ha/yr (8.5 tons/ac/yr).

Preliminary economic evaluation indicated that lime stabilization, storage, gravity thickening, and land application was the most cost-effective treatment sytem. Costs for overall CSO sludge handling depend on the type of CSO treatment process, volume and characteristics of the sludge and the size of the CSO area, among other considerations. Estimates indicate that first investment capital costs range from $447-10,173/ha ($181-4129/ac) with annual costs of $139-1630/ha ($56-660/ac). It is recommended that the use of grit removal, lime stabilization and gravity thickening, plus dewatering, be further investigated to establish specific design criteria related to CSO sludge.

1977
EPA NO: EPA-600/2-77-053c
NTIS NO: PB-281006

HANDLING AND DISPOSAL OF SLUDGES FROM COMBINED SEWER OVERFLOW TREATMENT
PHASE III - TREATABILITY STUDIES

This report documents the results of a project initiated to evaluate the handling and disposal of combined sewer overflow (CSO) treatment residuals. Bench scale thickening and pilot and full-scale centrifugation dewatering tests were performed at dry-weather and CSO treatment sites in Kenosha, Racine, and Milwaukee, Wisconsin. CSO sludge at Kenosha is biologically generated; that at Milwaukee is physical in nature; and the Racine CSO residuals are of physical-chemical origin. In addition, bench scale anaerobic digestion studies were conducted to determine the effect of CSO sludges on the anaerobic digestion stabilization process.

The results obtained from this project indicated that the dewatering of CSO sludges appears feasible when the sludges are first degritted, where required, and thickened prior to centrifugation. Under optimum centrifuge operating conditions, thickened sludges were dewatered to cake concentrations varying from 14.0% to 32% solids with solids recoveries ranging from 80% to 99%. Similarly, the dry-weather sludges for the test sites were dewatered to haulable cakes. Moreover, at Kenosha, the dewatering characteristics of wet-dry weather sludge mixtures were similar to those for CSO sludge alone. The bench scale anaerobic digestion studies showed that no significant adverse effect was realized by adding CSO generated sludges to dry-weather digesters at feed rates similar to that expected from a typical storm event.

Preliminary economic estimates indicate that first investment capital costs for thickening-centrifigation of CSO sludges ranged from 0.31 to 2.92 million dollars with annual costs of $49,500 to $659,300 per year when handling 4.0 to 36.5 tons dry sludge per day. These cost ranges were developed respectively, for the cities of Racine, WI (population - 90,700; CSO area - 702 acres), and Milwaukee, WI (population - 670,000, CSO area - 16,800 acres).

The report recommends that a full-scale CSO sludge dewatering facility employing degritting, thickening, and centrifugation should be developed as a demonstration site for a further evaluation of the treatment of CSO residuals.

ABSTRACTS

1977
EPA NO: EPA-600/2-77-064a
NTIS NO: PB-273133

NATIONWIDE EVALUATION OF COMBINED SEWER OVERFLOWS AND URBAN STORMWATER DISCHARGES
VOLUME I: EXECUTIVE SUMMARY

A study was conducted by the American Public Works Association and the University of Florida to determine: the cost of abating pollution from combined sewer overflows and urban stormwater, the impact of such pollutional discharges on receiving waters, and the pollution potential of such discharges. The study was based upon the availability of existing data and prediction models.

Continuous simulation runs using one year of hourly data were made to determine the attainable level of pollution control with a specified availability of storage volume and treatment rate in five cities: Atlanta, Denver, Minneapolis, San Francisco, and Washington, D.C. This procedure was used to derive generalized equations relating pollution control to storage and treatment. These results were combined into a simple optimization model which determined the optimal mix of storage and treatment for any feasible level of control for any city. Then the nationwide assessment is presented. The results indicate annual costs ranging from $297 million for 25 percent pollution control to $5,029 million for 85 percent pollution control. The corresponding initial capital investment ranges from $2,476 million for 25 percent control to $41,900 million for 85 percent control. These costs can be reduced significantly if stormwater pollution control is integrated with best management practices and integrated into a multi-purpose program.

The balance of the study analysed existing published and unpublished information to characterize the pollution potential of urban runoff and to estimate the impact of such runoff on receiving waters. It was found that there appears to be direct connections between many parameters such as BOD and suspended solids with the amount of street refuse. However, some parameters appear to be related to more site specific factors. As a practical matter it was found necessary to relate pollution abatement to BOD and suspended solids, even though there are many other pollutants in large concentrations such as heavy metals and phosphorus.

1977
EPA NO: EPA-600/2-77-064b
NTIS NO: PB-266005/8

NATIONWIDE EVALUATION OF COMBINED SEWER OVERFLOWS AND URBAN STORMWATER DISCHARGES
VOLUME II: COST ASSESSMENT AND IMPACTS

A nationwide assessment has been made of the quantity and quality of urban storm flow emanating from combined sewers, storm sewers, and unsewered portions of all 248 urbanized areas and other urban areas in the United States. Available control alternatives and their associated costs were also determined. Continuous simulation runs using one year of hourly data were made to determine the attainable level of pollution control with a specified availability of storage volume and treatment rate in five cities: Atlanta, Denver, Minneapolis, San Francisco, and Washington, D.C. This procedure was used to derive generalized equations relating pollution control to storage and treatment. These results were combined into a simple optimization model which determined the optimal mix of storage and treatment for any feasible level of control for any city. Then the nationwide assessment is presented. The results indicate annual costs ranging from $297 million for 25 percent pollution control to $5,029 million for 85 percent control. These costs can be reduced significantly if stormwater pollution control is integrated with best management practices and integrated into a multi-purpose program.

The entire results from this project are contained in the three volumes: EPA-600/2-77-064a, EPA-600/2-77-064b, and EPA-600/2-77- 064c.

ABSTRACTS

1977
EPA NO: EPA-600/2-77-064c
NTIS NO: PB-272107

NATIONWIDE EVALUATION OF COMBINED SEWER OVERFLOWS AND URBAN STORMWATER DISCHARGES VOLUME III: CHARACTERIZATION OF DISCHARGES

An analysis was made of existing data to characterize the pollutional strength of urban stormwater runoff and combined sewer overflows. Published and unpublished data were evaluated.

Extensive evaluation was made of census track data to develop data concerning land use and population densities in urban areas to assist modeling of urban stormwater discharge.

Utilizing the developed data, an analysis of receiving water impacts was made.

It was found that much of the available data was developed without consideration of the quantity of flow at the time quality was being considered. A wide variety of methods used to sample flows further complicates the use of much reported data.

The estimated runoff pollutional contributions were found to exceed any contributions of treated sanitary flows at the time of a storm event. Thus, runoff pollution can govern the quality of receiving water due to the shock effect and long-term buildup of solids.

1977
EPA NO: EPA-600/2-77-087
NTIS NO: PB-272245

MICROORGANISMS IN URBAN STORMWATER

Microbiological quantitative assays of Baltimore City urban runoff were conducted throughout a 12 month period to show the relationships to several factors such as separate or combined sewer flow, urban characteristics of drainage area, rainfall, and quantity of flow during and between rain storms. In general, there was a consistently high recovery of both pathogenic and indicator organisms throughout the study except for *Shigella* sp. which is believed to have been present but could not be isolated due to interferences during the culture procedure. There appeared to be little relationship between pathogen recovery and season of the year, amount of rainfall, period of the antecedent rainfall, and stream flow. The most concentrated pathogens were *Pseudomonas aeruginosa* and *Staphylococcus aureus* at levels ranging from 10^3 to 10^5 and from 10^0 to 10^3/100mℓ, respectively. *Salmonella* and enteroviruses, though frequently isolated, were found at levels of only 10^0 to 10^1/10 ℓ of urban runoff. The background samples (sewage, urban streams and reservoirs) between storms gave good positive correlation between indicators and pathogens at a 95% to 99% level of confidence, whereas, the stormwater had no or poor correlation. The ratios of indicators, such as FC/FS, gave some indications of pollution by human sewage, but it was the presence of enteroviruses that definitely showed the mixing of sewage with rain water, whether in a storm sewer or in the combined sewer overflow. The logical solution would point to the removal of sanitary sewage overflows rather than the disinfection of all urban runoff for removing the health hazard and improving the quality of urban runoff.

1977
EPA NO: EPA-600/2-77-120
NTIS NO: PB-270695

PROCEDURES FOR ESTIMATING DRY WEATHER POLLUTANT DEPOSITION IN SEWERAGE SYSTEMS

A set of generalized procedures for estimating pollutant loadings associated with dry-weather sewage solids deposition in combined sewer systems has been prepared to provide planners, engineers and municipal managers with technical information so that they can make intelligent informed decisions on potential sewer flushing programs in combination with other combined sewer management controls.

The predictive equations relate the total daily mass of pollutant deposition accumulations within a collection system to physical characteristics of collection systems such as per capita waste rate, service area, total pipe length, average pipe slope, average diameter and other more complicated parameters that derive from analysis of pipe slope characteristics. Several alternative predictive models are presented reflecting anticipated differences in the availability of data and user resources. Pollutant parameters include suspended solids, volative suspended solids, biochemical oxygen demand, chemical oxygen demand, total organic nitrogen and total phosphorous. Sewer system age and degree of maintenance was also considered. Factors are presented for estimating the increase in collection system deposition resulting from improper maintenance. A user's guide has been presented to establish the necessary data input to utilize the predictive procedures.

ABSTRACTS

1977
EPA NO: EPA-600/8-77-014
NTIS NO: PB-275654

URBAN STORMWATER MANAGEMENT AND TECHNOLOGY
UPDATE AND USERS' GUIDE

A continuation and reexamination of the state-of-the-art of storm and combined sewer overflow technology is presented. Essential areas of progress of the stormwater research and development program are keyed to the approach methodology and user assistance tools available, stormwater characterization, and evaluation of control measures. Results of the program are visible through current and ongoing master planning efforts.

Assessment of urban runoff pollution is referenced to the developing national data base, localized through selective monitoring and analysis, and quantified as to potential source and magnitude using techniques ranging from simplified desktop procedures to complex simulation models. Stormwater pollutants are characterized by (1) source potential, (2) discharge characteristics, (3) residual products, and (4) receiving water impacts.

Control and corrective measures are separated into nonstructural, termed Best Management Practices (BMPs), and structural alternatives. Best Management Practices focus on source abatement, whereas structural alternates roughly parallel conventional wastewater treatment practices of end-of-the-pipe correction. Structural alternatives may include storage (volume sensitive) and treatment (rate sensitive) options and balances. Multipurpose and integrated (dry-wet) facilities have been the most successful with process simplicity and operational control flexibility prime considerations.

Best Management Practices have decided benefits over structural alternatives – including lower cost, earlier results, and an improved and cleaner neighborhood environment -- but lack quantified action-impact relationships. For combined sewer overflow abatement, increasing degrees of structural control are necessary.

Successful program implementation is illustrated for several selected case histories.

1977
EPA NO: EPA-625/2-77-012
NTIS NO: PB91-133264

SWIRL DEVICE FOR REGULATING AND TREATING COMBINED SEWER OVERFLOWS
EPA TECHNOLOGY TRANSFER CAPSULE REPORT

An intensive study to develop a new type of combined sewer overflow regulator device, called swirl, was conducted under the general supervision of the EPA's Storm & Combined Sewer Overflow Pollution Control Program, Office of Research & Development, Edison, New Jersey. The design of this device was based on hydraulic and mathematical modeling to optimize its configuration. This Capsule Report briefly describes the results of a full-scale prototype swirl unit that controlled real overflows in the city of Syracuse, New York and discusses other areas of swirl application including its use as a grit separator, primary separator, erosion control device, and an urban stormwater runoff pollution control device.

1978
EPA NO: EPA-600/2-78-208
NTIS NO: PB-292491

DEMONSTRATION OF EROSION AND SEDIMENT CONTROL TECHNOLOGY
LAKE TAHOE REGION OF CALIFORNIA

A three-year project was conducted by the California State Water Resources Control Board to determine methods of preventing and correcting erosion problems which severely affect the quality of the waters of the State of California. Two project sites were chosen in the vicinity of the Lake Tahoe basin in California. One project site, Northstar-at-Tahoe, is a well planned and constructed residential-recreational development constructed in the early 1970s. The cost of extensive predeveloped planning and erosion control at Northstar is currently less than $400 per developed unit or residential lot. With ultimate planned build-out, costs are expected to be reduced to $220 per developed unit. The other project site, Rubicon Properties - Unit No. 2, is an extremely poorly planned and constructed residential subdivision development constructed in the late 1950s and early 1960s. The cost of complete corrective erosion control at Rubicon Properties would range from $1,000 to $3,000 or more per residential lot.

At both project sites, extensive hydrologic and water quality monitoring programs were conducted to determine erosion rates and their impact upon aquatic ecosystems. Monitored parameters included precipitation, snow depth, stream flow, suspended sediment and concentration, and benthic macroinvertebrate communities. Postdevelopment erosion rates at Northstar are estimated to be 100 percent above predevelopment levels, resulting in only minor perturbations of the benthic macroinvertebrate community of West Martis Creek. Postdevelopment erosion rates within Rubicon Properties are estimated to be over 10,000 percent above predevelopment levels, resulting in up to 99 percent destruction of the benthic macroinvertebrate community in Lonely Gulch Creek. At both project sites, extensive demonstrations were made of predevelopment planning concepts, construction techniques, and corrective measures which may be used to substantially reduce erosion and sedimentation problems associated with developments which are typical to the subalpine to alpine Lake Tahoe region of California. Analyses were made to determine cost and effectiveness of the various erosion control techniques which were demonstrated at the project sites.

ABSTRACTS

1979
EPA NO: EPA-440/3-79-023
NTIS NO: PB-299185/9

A STATISTICAL METHOD FOR THE ASSESSMENT OF URBAN STORMWATER LOADS - IMPACTS - CONTROLS

This manual describes a simplified methodology which can be used to assess the impact of urban stormloads on the quality of receiving waters, and to evaluate the cost and effectiveness of control measures for reducing these pollutant loads. The methodology is particularly appropriate for use at the planning level where preliminary assessments are made to define problems, establish the relative significance of contributing sources, assess feasibility of control, and determine the need for and focus of additional evaluations. It can also be used effectively in conjunction with detailed studies, by providing a cost-effective screening of an array of alternatives, so that the more detailed and sophisticated techniques can examine only the more attractive alternatives.

The methodology is based on the determination of certain statistical properties of the rainfall history of an area. From these statistics, the desired information on loads, performance of controls, and receiving water impacts is generated directly. Procedures are quite simple to apply, using charts and graphs which facilitate screening alternate types or levels of control, testing sensitivity to assumptions concerning drainage area characteristics, stormwater contaminant levels and similar variable factors.

1979
EPA NO: EPA-600/2-79-015
NTIS NO: PB-296626/5

DUAL PROCESS HIGH-RATE FILTRATION OF RAW SANITARY SEWAGE AND COMBINED SEWER OVERFLOWS

Pilot plant studies were conducted in New York City's Newtown Creek Water Pollution Control Plant from 1975-1977 to investigate the suspended solids (SS) removal capabilities of the deep-bed, high-rate gravity filtration process on raw sewage and combined sewer overflows.

The treatment system was composed of a rotating screen equipped with a 40 mesh (420 micron) screen followed by a dual-media, high-rate filter containing 48 in. (122 cm) or 60 in. (152 cm) of No. 3 anthracite (effective size 3.85 mm) over 30 in. (76 cm) of No. 612 sand (effective size 2 mm).

A continuous series of tests on dry-weather (raw sewage) flows demonstrated SS removals across the filter averaging 67 percent at a flux range of 8-12 gpm/ft^2 (20-30 m^3/hr/m^2) with an average effluent concentration of 44 mg/ℓ SS. BOD and COD removals were 39 percent and 34 percent, respectively.

Tests on combined sewer overflow showed an average removal of 61 percent SS across the filter and 66 percent across the system at a flux of 16 gpm/ft^2 (40 m^3/hr/m^2) and an average effluent of 62 mg/ℓ SS. BOD and COD removals across the filter were 32 percent and 42 percent, respectively. The addition of cationic polymer (1-2 mg/ℓ) in combination with alum (17-35 mg/ℓ) improved filter removals to an average 72 percent for SS, 40 percent for BOD and 50 percent for COD for two tests.

Capital costs (ENR-2520) for a high-rate filtration plant are estimated at $55,225 per mgd for a 200 mgd plant (757,000 m^3/day). Total annual treatment costs, including interest amortization, operation and maintenance charges, range from approximately $396,450 to $1,794,050 for dual treatment facilities in a 25 to 200 mgd (94,600 to 757,000 m^3/day) capacity range and $238,050 to $1,175,900 for the same capacity range of facilities treating only CSO.

Comparison with alternate treatment systems show that high rate filtration (HRF) is cost competitive with conventional sedimentation facilities for dual-process or CSO treatment yet HRF has only 5-7 percent the area requirements. For strict CSO treatment, HRF is competitive with dissolved air flotation and microstraining processes.

1979
EPA NO: EPA-600/J-79-066
NTIS NO: PB80-177033

URBAN RUNOFF AND COMBINED SEWER OVERFLOW

A general discussion of urban runoff pollution including the impact of urban runoff on water quality, and the control and handling of non-point source pollutants is presented. The importance of various planning and design considerations are stressed. Long range control planning, management strategies, runoff simulation and various computer models such as SWMM and STORM are discussed. The benefits of source and collection system controls are presented on a cost-effectiveness basis, and a review is made of innovative physical/chemical treatment processes. The information is presented in the form of a literature review.

ABSTRACTS

1980
EPA NO: EPA-600/2-80-135
NTIS NO: PB81-104796

POROUS PAVEMENT
PHASE I -- DESIGN AND OPERATIONAL CRITERIA

Design and operational criteria, utilization concepts, benefits and disadvantages, as well as other characteristics of porous pavements are presented in this report. Particular emphasis is placed on porous asphalt pavements, but the criteria and design approach are applicable to all other porous pavement types. The design considerations presented in this report include siting problems, load bearing design, and hydrologic design. A brief history of porous pavement development and previous experience with porous pavement by several designers, contractors, and operators are described. A computer model for hydrologic performance evaluation of existing or proposed porous pavement systems is also described in this report. Load bearing design criteria are based on previous work conducted for porous asphalt pavements. Appendices to this report include a sample set of specifications for porous asphalt construction and a list of soils and their permeability classes as prepared by the U.S. Soil Conservation Service.

1980
EPA NO: EPA-600/8-80-035
NTIS NO: PB81-107153

URBAN STORMWATER MANAGEMENT AND TECHNOLOGY
CASE HISTORIES

This report is the third in a series on urban stormwater and combined sewer overflow management. It presents 12 case histories representing most promising approaches to stormwater control. The case histories were developed by evaluating completed and operational facilities or ongoing demonstration projects that have significant information value for future guidance. Essential elements of the case history evaluations cover (1) approach methodology, (2) design considerations, (3) costs, (4) effectiveness, and (5) environmental and socioeconomic impacts.

Eight of the case histories assess Best Management Practices (BMPs) and expand the data base on source control methodology, focusing principally on planning and storage alternatives. Special considerations are given to flood and erosion control measures also having a dual benefit of stormwater control. The project sites evaluated are Bellevue, Washington; Montgomery County, Maryland; Lake Tahoe, California; The Woodlands, Texas; Orange County, Florida; San Jose, California; Middlesex County, Connecticut; and Boulder, Colorado.

The remaining four case histories evaluate the control of combined sewage overflows and document a systems approach in applying unit process alternatives. The effectiveness and unit costs of storage and treatment processes are presented, together with evaluations of areawide and systemwide integration of these technologies. Storage, the key element of an integrated approach, can involve storage/wet-weather treatment or storage/dry-weather treatment, or both. The project sites are Seattle, Washington; Saginaw, Michigan; Mount Clemens, Michigan; and Lancaster, Pennsylvania.

ABSTRACTS

1980
EPA NO: EPA-600/8-80-048
NTIS NO: PB81-141913

METHODOLOGY FOR EVALUATING THE IMPACT AND ABATEMENT OF COMBINED SEWER OVERFLOWS
A CASE STUDY OF ONONDAGA LAKE, NEW YORK

A general methodology is presented for the evaluation of the impact and abatement of combined sewer overflows (CSO's) on receiving waters. It was developed from experience with Onondaga Lake, an urban lake in Central New York that receives CSO's from the City of Syracuse via three tributary streams.

Field investigations of the combined sewer system and the receiving water must first be undertaken. The field work includes flow measurement and water-quality sampling of the sewer overflows and the receiving water during several different storms. Use of a computerized data bank has been found virtually essential for the storage and manipulation of the large quantity of data resulting from the sampling and analysis.

Mathematical modeling of the receiving water is undertaken to evaluate water quality as a function of pollutant load; the storm sewer system is modeled to determine the quantities of pollutants discharged during various storm conditions. Prior to the modeling effort, analysis of local rainfall records is necessary to develop the classical intensity-duration-frequency relationships. After assessing the water-quality impact of dry-weather pollutants from wastewater treatment plants and other sources, the results of the two models can be combined to express the reduction in stormwater pollutants needed to achieve a particular water-quality goal as a function of storm frequency or storm recurrence interval.

Abatement alternatives, and their respective costs, for the reduction of pollutants from wet-weather sources, particularly combined sewer overflows are next investigated. Using engineering judgment of the most effective and economic abatement measures, a relationship is then developed between abatement cost and storm condition for each of several water-quality criteria or goals. From the cost-benefit relationships thus developed, a graphical determination can be made of the "general optimum solution" (GOS) for reduction or treatment of combined sewer overflows.

It is recognized that the quality of the receiving water resulting from the GOS may not be acceptable to the general public or regulatory agencies. In that case, a decision to provide greater (or lesser) pollution abatement will be based upon social or political considerations, but the governmental body making the decision will be cognizant of its economic implications.

In the study for Onondaga County, New York, from which the methodology was developed, 35 overflows from the combined sewers of the City of Syracuse, which serve an area of about eight square miles, were monitored for a period of one year. Onondaga Lake, the principal receiving water, is approximately four and one-half square miles in surface area; it was sampled at ten surface locations, each at two distinct depths, for the period of influence of each of six storms. The Storm Water Management Model (SWMM) was applied to the City's sewer system. A 27-segment, three-dimensional, dynamic water-quality model of the lake, with capability of predicting enteric bacteria, dissolved oxygen, nutrients, and toxic materials, was developed.

From the models, it was determined that the impact of CSO's on dissolved-oxygen concentrations in Onondaga Lake will not be critical after tertiary treatment facilities for dry-weather wastewaters are placed in operation; a maximum DO deficit of 2.8 milligrams per liter was predicted for a 10-year, two-hour storm. Combined sewer overflow contributions of phosphorus will be negligible in comparison to those from other sources.

In an average rainfall year, 38 violations of the fecal coliform standard will occur in the area of the lake intended for contact recreation. If abatement of CSO pollution were to follow the "general optimum solution" of this methodology, there would still be 13 annual violations, ten of which would occur from June through September. Inasmuch as each violation persists for about three days, more extensive CSO abatement will be required if the projected recreational usage of Onondaga Lake is to be realized.

1979
EPA NO: EPA-600/9-80-056
NTIS NO: PB81-155426

URBAN STORMWATER AND COMBINED SEWER OVERFLOW IMPACT ON RECEIVING WATER BODIES
PROCEEDINGS OF THE NATIONAL CONFERENCE ORLANDO, FLORIDA NOVEMBER 26-28, 1979

The Conference on "Urban Stormwater and Combined Sewer Overflow Impact On Receiving Water Bodies" was held November 26-28, 1979 at Orlando, Florida.

The conference provided a forum for researchers, practitioners and others to receive an update on the state-of-the-art and to learn about research findings dealing with stormwater impact. It also served to stimulate dialogue among those who are interested in stormwater effects and control, regarding the implication and applications of current research results, particularly from those projects supported by the EPA's Municipal Environmental Research Laboratory's Storm and Combined Sewer Program.

The topical areas considered included: (a) combined sewer overflow control costs vs. benefits; (b) impacts on lakes, rivers and estuaries; (c) ecological response to stormwater and methodologies for stormwater impact assessment; (d) stormwater management through the use of receiving water quality models for planning and abatement methodology.

The proceedings include the contributions from the scheduled speakers and an edited transcription of the taped workshop conducted on practical applications of research findings and future research needs.

ABSTRACTS

1981
EPA NO: EPA-600/2-81/238
NTIS NO: PB82-221094

URBAN RAINFALL-RUNOFF-QUALITY DATA BASE

Urban rainfall-runoff-quality data gathered by others have been assembled on a storm event basis for 48 catchments in the following 16 cities: San Francisco, CA; Broward County, FL; Lincoln, NB; Durham, NC; Windsor, ON; Lancaster, PA; Seattle, WA; Racine, WI; West Lafayette, IN; Greenfield, MA; Northampton, MA; Burlington, ON; Chicago, IL; Denver, CO; Dade County, FL; and Toronto, ON. Rainfall-runoff data have been assembled for 25 more catchments in an additional 15 cities: Baltimore, MD; Chicago, IL; Champaign-Urbana, IL; Bucyrus, OH; Falls Church, VA; Los Angeles, CA; Portland, OR; Houston, TX; Salt Lake City, UT; and Denver, CO. The 25 cities contain data for a total of 73 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 on the EPA STORET data retrieval system. Both the raw data and statistical summaries are also available on magnetic tape from the authors.

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.

1981
EPA NO: EPA-600/J-81/546
NTIS NO: PB82-205915

URBAN RUNOFF RECEIVING WATER IMPACTS PROGRAM OVERVIEW

Receiving water impacts are a major national concern. We are spending billions of dollars on secondary treatment plants, meanwhile major contributors, such as stormwater and combined sewer overflows, are still uncontrolled. To attain the goals set forth in PL 92-500 and PL 95-217 in an economical and efficient manner, those analysing, planning, and designing controls must have an understanding of the impact of pollutants on receiving waters. Ties between receiving water quality and stormwater discharges must be clearly established and delineated. Therefore, several years ago, the Storm and Combined Sewer Program (SCSP) of the EPA Municipal Environmental Research Laboratory began a modest effort to fill this data void. A brief history of the SCSP's receiving water impact projects is presented, emphasizing an overview of ongoing and recently completed projects, including significant results. Also, Program needs and areas of anticipated effort are analysed.

1982
EPA NO: EPA/600/2-82/045
NTIS NO: PB82-230319

EVALUATION OF SECONDARY ENVIRONMENTAL IMPACTS OF URBAN RUNOFF POLLUTION CONTROL

This report presents a generalized evaluation of the impacts associated with different urban stormwater runoff pollution control techniques. The control techniques investigated included urban runoff (UR) treatment and street-sweeping practices.

The report addresses the definition of the problem, estimates the volume and characteristics of the UR and the sludges expected, evaluates six methods of UR sludge treatment, examines alternatives and impacts for UR treatment sludge handling such as bleed/pump-back to the dry-weather plant and land disposal and evaluates street-sweeping as a UR pollution control technique.

UR sludge volumes were estimated to range from 0.3 to 6.0 percent of the UR flow [2.9 x 10^9 m^3/year (7.7 x 10^5 M gal/year)] with total solids concentrations varying from 0.51 to 12 percent. For comparison, these national sludge characteristics were contrasted to those estimated for a portion of a calibrated drainage area in Milwaukee, Wisconsin. The extreme variation in UR typical suspended solids concentration (415 mg/ℓ on a national basis and 156 mg/ℓ on a site specific basis) was reflected in the sludge characteristics and associated handling costs. High grit contents and low volatile solids are anticipated in UR sludges. Nutrient levels are lower in UR sludges than either CSO or raw primary sludges.

Regarding bleed/pump-back of UR sludges, solids deposition in sewers and overload to the dry-weather facilities are anticipated to cause problems. Dry-weather sludge handling facilities would require 1.5 to 4.5 times additional capacity.

The most cost-effective sludge treatment alternative appeared to be lime stabilization followed by thickening, pressure filter dewatering and landfill disposal. Annual costs for UR sludge handling were shown to range from $126 to $252/ha ($51 to $102/acre) on a national basis. Secondary impacts in addition to costs included water quality, noise, energy consumption, air pollution and land area requirements.

ABSTRACTS

1982
EPA NO: EPA/600/2-82/084
NTIS NO: PB82-259235

A PLANNING AND DESIGN GUIDEBOOK FOR COMBINED SEWER OVERFLOW CONTROL AND TREATMENT

This report is a survey of control and treatment of combined sewer overflows (CSO), encompassing the Storm and Combined Sewer Section's research efforts over the last fifteen years.

The survey was prepared to assist federal, state, and municipal agencies, and private consultants, in 201 Facilities Planning and Design, Steps 1 and 2, respectively.

The discussions of control/treatment technologies, which consist mostly of downstream treatment, have been divided into seven chapters: (1) Source Control; (2) Collection System Control; (3) Storage; (4) Physical with/without Chemical Treatment; (5) Biological Treatment; (6) Advanced Treatment; (7) Disinfection.

Storage is the best documented CSO abatement measure currently practiced, and it must be considered at all times in system planning, because it allows for maximum use of existing dry-weather facilities. Physical with/without chemical treatment will generally be the minimum required to meet discharge or receiving water quality goals. If a higher degree of organics removal is needed, biological treatment should be examined. If maintaining a viable microorganism population is not feasible, but removal of dissolved and colloidal organics is desired, advanced treatment may be attractive.

General discussions of CSO control/treatment can be found in EPA-670/2-74-040, EPA-600/2-76-286, EPA-600/8-77-014, EPA-600/8-80-035, EPA/600/J-90/052, and EPA/600/J-90/050 which served as principal references for this report.

A comprehensive list of references appears at the end of each chapter.

1982
EPA NO: EPA/600/2-82/094
NTIS NO: PB83-133561

CHARACTERISTICS AND TREATABILITY OF URBAN RUNOFF RESIDUALS

Studies have been undertaken to determine the characteristics, treatability and cost of handling and disposal of wastewater treatment plant and combined sewer overflow (CSO) sludges, but few have considered urban stormwater runoff residuals. This study was undertaken to determine the characteristics of urban stormwater runoff residuals as well as handling and disposal techniques.

Samples of urban stormwater runoff residuals for this study were obtained from a field-assembled sedimentation basin in Racine, Wisconsin, swirl and helical bend solids separators in Boston, Massachusetts, and an in-line upsized storm conduit in Lansing, Michigan. The drainage basins at each site were primarily residential in character. The residuals samples from Racine and Boston were obtained from individual stormwater events while the sample obtained from Lansing represented an accumulation of residuals from runoff events occurring over a six month time period.

The characterization study included analyses for nine metals, eight pesticides and PCB's, solids, nutrients, and organics. The treatability study included bench-scale sedimentation tests, centrifugation tests, lime stabilization tests, and capillary suction time tests.

The total solids concentration of the residuals samples from Racine ranged from 233 mg/ℓ to 793 mg/ℓ (104 mg/ℓ to 155 mg/ℓ total volatile) while the residuals samples from Boston had a total solids concentration that ranged from 344 mg/ℓ to 1,140 mg/ℓ (107 mg/ℓ to 310 mg/ℓ total volatile). The residuals sample from Lansing, Michigan had a total solids concentration of 161,000 mg/ℓ (25,800 mg/ℓ volatile). The concentration of individual nutrients (total phosphorous, TKN, NH_3, NO_2, and NO_3) in the Boston and Racine samples never exceeded 5 mg/ℓ, while the concentrations in the Lansing sample were between 0.3 mg/ℓ and 2,250 mg/ℓ. Of the metals, iron was found in the highest concentration in all the samples (6.1 mg/ℓ to 2,970 mg/ℓ), with lead and zinc ranking second and third, respectively. PCB's were observed in measurable concentrations (0.19 μg/ℓ to 24.6 μg/ℓ) in all samples except the October, 1980, Boston samples. Of the eight pesticides surveyed, only three (DDT, DDD and Dieldrin) were observed in measurable concentrations. However, the pesticides were primarily soluble while the PCB's were more related to the suspended solids.

Treatability data indicated that gravity thickening is a very effective method for thickening stormwater residuals. Solids recovery in the thickened residuals ranged from 46 to 94 percent in the Boston, Racine, and Lansing samples during one hour thickening tests. The solids concentration of the gravity thickened residuals ranged from 9 to 37 percent. Centrifugation, as expected, was also found to be an effective method for thickening the stormwater runoff residuals. Solids recovery ranged from 77 to 99 percent. The quantity of lime required for stabilization of the stormwater runoff residuals varied from 1.2 to 6.6 g CaO/ℓ.

Based on the results of this study, the most cost-effective treatment for handling and disposal of urban stormwater runoff residuals is gravity thickening followed by lime stabilization and landspreading or direct landfilling. Total annual cost estimates for landfilling and landspreading of residuals generated from a hypothetical 50 hectare site range from $360 to $470 per hectare.

ABSTRACTS

1982
EPA NO: EPA/600/8-82/013
NTIS NO: PB82-266172

DESIGN MANUAL
SWIRL AND HELICAL BEND POLLUTION CONTROL DEVICES

Hydraulic and mathematical modeling have been used to develop several pollution control devices for specific applications, particularly for controlling and treating combined sewer overflows and stormwater discharges. Prototype testing of each unit has been accomplished by various researchers in the United States and other countries. This design manual brings together pertinent information concerning the design and operation of the units and thus, consolidates information from many reports. Inasmuch as the design has been evolutionary in nature, the design procedures contained in this manual replace that which has previously been published.

Two types of combined sewer overflow regulators are described: the swirl and the helical bend regulator/separator. Both units are static, that is, operate without moving parts and require no outside source of power. Both can remove up to 50 percent of the suspended solids. Both are also effective for treating separate stormwater discharges. Both serve a dual function - treatment and regulation of the flow.

The units treat waste flows by concentrating the solids in a small fraction of the total flow. This reduced volume becomes economical, or in effect, possible to treat in conventional wastewater treatment facilities.

The degritter unit is for use in removing from the underflow to treatment the solids concentrated by the combined sewer overflow regulators, or for use in conventional treatment facilities.

A primary treatment device and a sediment load polishing unit are also described. Both have special applications. In addition, several devices and applications which have been developed by others as a result of the basic information on the flow field characteristics and capabilities are described.

The design manual contains thorough descriptions of the design procedures, operating experience to date, and results obtained.

1982
EPA NO: EPA/600/J-82/237
NTIS NO: PB83-168245

OVERVIEW OF THE U.S. ENVIRONMENTAL PROTECTION AGENCY'S STORM AND COMBINED SEWER PROGRAM COLLECTION SYSTEM RESEARCH

A state-of-the-art and assessment of the EPA's Storm and Combined Sewer Program collection system research pertaining to management alternatives for wet- and dry-weather wastewater transport and interception is presented. These include: maintenance; catchbasins; new sewer design; sewer flushing; polymer injection; infiltration/inflow controls including inflow reduction, Insituform, impregnated concrete pipe and trenchless sewer; upstream storage/attenuation; flow routing and inpipe storage; new types of flow regulators, fluidic regulator and Hydrobrake; and a new rubber "duck-bill" tide gate.

1984
EPA NO: EPA/600/2-84/109a
NTIS NO: PB84-198423

STORM WATER MANAGEMENT MODEL USER'S MANUAL VERSION III

The EPA Storm Water Management Model (SWMM) is a comprehensive mathematical model for simulation of urban runoff quantity and quality in storm and combined sewer systems. All aspects of the urban hydrologic and quality cycles are simulated, including surface runoff, transport through the drainage network, storage and treatment, and receiving water effects. (The latter component is currently under revision by the EPA.) This volume applies to Version III of SWMM and is an update of two earlier User's Manuals issued in 1971 and 1975. It should be coupled with Addendum I in order to run the Extran Block (detailed hydraulic flow routing) developed by Camp, Dresser and McKee.

Detailed descriptions are provided herein for all blocks (except the Receiving Water Block): Runoff, Transport, Storage/Treatment, Combine, Statistics and Graph (part of the Executive Block). The latter three blocks are "service" blocks while the first three are the principal computational blocks. In addition, extensive documentation of new procedures is provided in the text and in several appendices.

ABSTRACTS

1989
EPA NO: EPA/600/2-89/020
NTIS NO: PB89-188379/AS

DEVELOPMENT AND EVALUATION OF A RUBBER "DUCK BILL" TIDE GATE

The inflow of tidal waters into combined sewer interceptor systems places a hydraulic loading on a treatment plant, and the salts contained in tidal water further aggravate treatment efficiency and accelerate sewerage system deterioration. Tide gates are installed in these systems to prevent tidal inflow. A prototype testing of an alternative tide gate design was accomplished in New York City to explore improvements to conventional flap gate design.

A unique 54-inch diameter rubber "duck bill" tide gate (RTG) was fabricated and installed in a typical NYC tide gate chamber. The operation of the gate was observed over two years. The RTG was very effective in preventing the inflow of tidal waters and generally showed equal or improved performance compared to a typical flap gate. Hydraulically, the RTG was supposed to open to release storm flows at a positive difference in upstream head of six inches and to remain closed preventing inflow at a downstream positive head up to eight feet during high tide. Only minor inflow was observed when debris was introduced into the RTG, however capability of self-cleaning was exhibited. Inflow would be significantly greater if similar size debris was lodged in the conventional flap-type gate. The maintenance crews observed no incident where the manual removal of debris was required. The existing chamber required minor modifications for the installation of the RTG. The method of adapting the RTG to an existing tide gate frame is critical to ensuring the reliability of the installation. The RTG was exposed on occasions to gale force winds and heavy rainfall during the two years of operation in New York City.

The design development and performance evaluation of the RTG are described in this report. The project also examined comparisons of hydraulic performance, capital and maintenance costs with traditional flap gates. Results of the project indicate that the RTG can provide low maintenance and reliable performance as a cost-effective alternative to conventional tide gates.

1989
EPA NO: EPA/600/8-89/054
NTIS NO: PB90-187006

STORM AND COMBINED SEWER OVERFLOW AN OVERVIEW OF EPA'S RESEARCH PROGRAM

The Storm and Combined Sewer Pollution Control Research, Development, and Demonstration Program was initiated back in 1964. Congress acknowledged the problem 23 years ago by authorizing funds under the Water Quality Act of 1965 for researching ways of stormwater pollution management. The research effort was directed by the Storm and Combined Sewer Technology Program (SCSP) located in Edison, New Jersey until 1983 when it was disestablished. About 300 projects totaling approximately $150 million have been awarded under the EPA's Research Program which resulted in approximately 350 final reports. More than 100 conference papers and over 100 articles and in-house reports have been presented and published, respectively by the Program. The goal has been user assistance with emphasis on planning and design oriented material.

Many in-house papers and reports have been published on Program overviews, state-of-the-art, and special topics. These are important management tools having been read and used internationally.

The Program has been involved in the development of a diverse technology including such things as CSO and stormwater control technology, instrumentation, problem assessments, best management practices (BMP's) development and evaluation, stormwater management models, sludge handling and disposal methods, infiltration/inflow control, erosion control, and many others. This paper will cover SCSP products and accomplishments in these areas, covering 18 years of efforts. The vastness of the Program does not allow complete coverage. Therefore SCSP outputs and developments are selectively emphasized.

ABSTRACTS

1990
EPA NO: EPA/600/9-90-032
NTIS NO: PB90-255670

BIBLIOGRAPHY OF STORM & COMBINED SEWER POLLUTION CONTROL R&D PROGRAM DOCUMENTS

A complete, chronological EPA Storm & Combined Sewer Pollution Control Research Program (SCSP) bibliography of approximately 320 publications.

1975
EPA NO: EPA/600/J-90/050
NTIS NO: PB90-221979/AS

URBAN RUNOFF POLLUTION CONTROL — STATE-OF-THE-ART

Combined sewer overflows are major sources of water pollution problems, but even discharges of stormwater alone can seriously affect water quality. Current approaches involve control of overflows, treatment, and combinations of the two. Control may involve maximizing treatment with existing facilities, control of infiltration and extraneous inflows, surface sanitation and management, as well as flow regulation and storage. A number of treatment methods have been evaluated including high rate screening and microstraining, ultra high rate filtration, dissolved air flotation, physical/chemical treatment, and modified biological processes. A swirl flow regulator/solids separator of annular shape construction with no moving parts has been highly developed. High rate disinfection methods including new disinfectants have been applied. Promising approaches involve integrated use of controls and treatment.

1980
EPA NO: EPA/600/J-90/051
NTIS NO: PB90-221997/AS

EPA RESEARCH IN URBAN STORMWATER POLLUTION CONTROL

Control and treatment of stormwater discharges and combined sewage overflows from urban areas are problems of increasing importance in the field of water quality management. Over the past decade much research effort has been expended and a large amount of data has been generated, primarily through the actions and support of the EPA's Storm and Combined Sewer Pollution Control Research and Development Program. This paper presents a state-of-the-art and overview of that program.

The purposes of the program were to quantify the urban storm and combined sewer overflow pollution problems and develop countermeasure controls. As a result of federal investment in the neighborhood of $100,000,000, an advanced technology or state-of-the-art has been developed, demonstrated, and disseminated.

Furthermore, these urban wet-weather pollution control advancements are and can be used by those municipal and consulting engineers and planners concerned with area-wide/city-wide pollution control plans, strategies, and facilities required by PL 92-500, Section 201 ("Waste Treatment Management Planning and Design"), Section 208 ("Area-wide Waste Treatment Management Planning"), and other directives relating to the management and control of urban runoff.

Because it is nearly impossible to segregate benefits and strategies of wet-weather flow pollution control from drainage, flood, and erosion control, multipurpose analyses and control are stressed.

There have been over 150 projects under the program so only a basic program direction and the more significant products, both completed and anticipated, will be highlighted. The products will be divided into the following areas, common to the major elements of combined sewer overflow pollution control, and sewered and unsewered runoff pollution control: (1) problem definition; (2) user assistance tools (instrumentation and computers); (3) land management; (4) collection system control; (5) storage; (6) treatment; (7) sludge and solids; (8) integrated systems; and (9) technical assistance and technology transfer.

1972
EPA NO: EPA/600/J-90/052
NTIS NO: PB90-221706/AS

MANAGEMENT AND CONTROL OF COMBINED SEWER OVERFLOWS

This paper will serve as a basic overview of the U.S. government's involvements in developing countermeasures for combined sewer overflow pollution.

The Storm and Combined Sewer Pollution Control Research, Development and Demonstration Program was initiated under the auspices of the U.S. Public Health Service, Department of Health, Education and Welfare (USPHS). The program is now part of the EPA's Office of Research and Development. Up to the time of this paper, over 100 grants and contracts totaling approximately $80 million have been awarded. The EPA's share is about $40 million.

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