REGIONAL STORMWATER MASTER PLAN

JANUARY 1992

VOLUME I

Prepared for

South Texas Water Authority
City of Corpus Christi
Nueces County, Texas

Prepared by

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CDM

environmental engineers, scientists, planners, & management consultants

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January 20, 1992

Mr. Bob Wear, P.E.
Texas Water Development Board
1700 N. Congress Avenue
Austin, TX 78711-3231

RE: Regional Stormwater Master Plan
Final Report Submittal

Dear Mr. Wear:

Please find enclosed twelve copies of the Regional Stormwater Master Plan for the City of Corpus Christi and portions of unincorporated Nueces County, Texas. This document contains approved revisions made to the draft document based on comments received from the Texas Water Development Board and the Texas Water Commission. An additional copy of the master plan has been transmitted directly to the South Texas Water Authority, the City of Corpus Christi, and Nueces County.

Should you have any questions or require additional information, please do not hesitate to contact me. It has been a pleasure working with you during the development of this master plan.

Sincerely,
CAMP DRESSER & MCKEE INC.

George E. Oswald

George E. Oswald, P.E.
Principal Engineer

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SOUTH TEXAS WATER AUTHORITY
REGIONAL STORMWATER MASTER PLAN

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EXECUTIVE SUMMARY

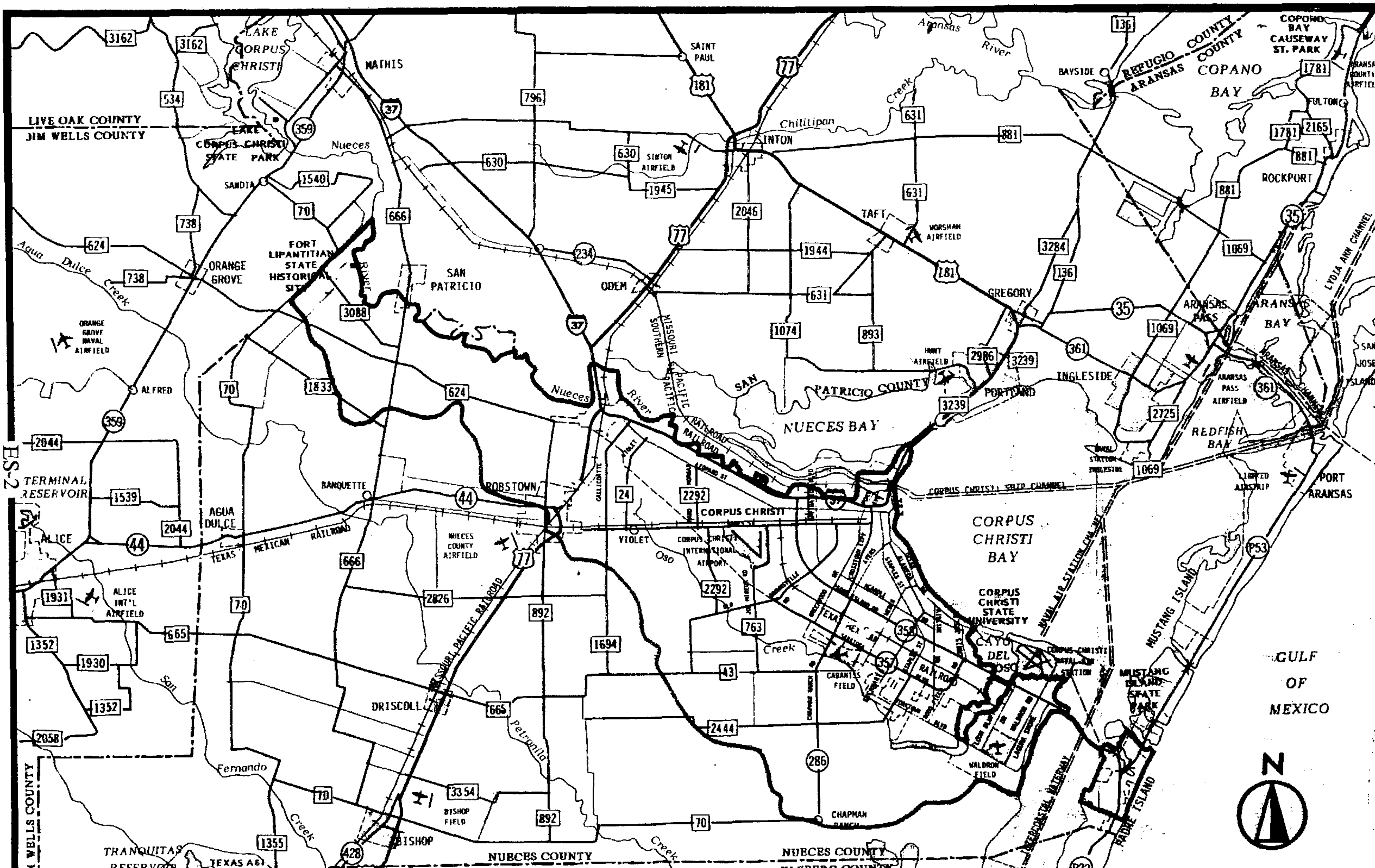
INTRODUCTION

In October 1990, the Texas Water Development Board (TWDB) and the South Texas Water Authority (STWA) entered into a joint funding agreement for the development of a comprehensive regional stormwater master plan for the City of Corpus Christi and portions of the unincorporated area of Nueces County (Figure 1). In joint sponsorship with the City and County, the STWA retained the services of Camp Dresser & McKee, Inc. in association with Archie Walker Engineering, Inc., Wood, Boykin & Wolter and Morehead, Dotts & LaPorte, Inc. for the development of a regionally integrated approach to stormwater management. During the past several months, the STWA, City, County and consulting team have worked together to develop this master plan document.

Historically, the City of Corpus Christi and Nueces County have developed stormwater master plans that only address flood control and drainage improvement issues. Little, if any, consideration has been given to controlling stormwater pollution or protecting water quality. With heightened public awareness and recent federal mandates, local government will be forced to address stormwater quality management. Acknowledging that floodwaters and stormwater pollution in local drainageways cross city and county boundaries, this is the first stormwater master plan that has addressed both <u>flood control</u> and <u>water quality management</u> on a regional, watershed specific basis.

This executive summary provides an overview of the regional stormwater master project and is organized as follows:

- Summary of Work
- Project Findings
- Recommendations
- Implementation Schedule



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REGIONAL STORMWATER MASTER PLAN STUDY AREA

FIGURE 1

SUMMARY OF WORK

The project scope of work required the evaluation of current and future stormwater management issues in the study area. A series of nineteen (19) individual task reports were produced which address the major elements of comprehensive stormwater management including:

- Storm Sewer System Characterization/Mapping
- Drainage Improvement/Flood Control
- Stormwater Quality Management
- Organization/Administration
- Program Financing
- Legal Considerations/Regulatory Compliance
- Public Education

These task reports may be summarized as follows:

TASK	DESCRIPTION
1	Regulatory Coordination - reviews federal, state and local regulatory issues associated with development and implementation of master plan recommendations.
2.I.A	Mapping Data Collection Plan - outlines an approach for the location and characterization of storm sewer outfalls discharging to major receiving waters in the study area.
2.I.B.(1)	Runoff Model Selection - reviews current methods and models for quantifying runoff as a basis for the subsequent characterization of stormwater pollutant loadings and development of a stormwater quality management program.

2.I.B.(2)(a)&(b) Nonpoint Source Model - provides an inventory of existing local receiving water quality and stormwater quality data. Also demonstrates the application of a nonpoint source pollution model to estimate pollutant loadings associated with stormwater runoff and optimize water quality management strategies.

2.I.B.(2)(c) Dry Weather Sampling Plan - outlines a plan for screening outfalls located in Task 2.I.A for dry weather flows which may be indicative of illicit connections or illegal dumping to the storm sewer system.

Wet Weather Sampling Plan - serves as a guide for the collection and analysis of stormwater samples to characterize land use impacts on the quality and quantity of stormwater runoff in the study area for subsequent use in developing a stormwater quality management plan.

2.I.C.(1)&(2) Digital Mapping - provides project maps and associated database in both hard copy and digital format compatible with the City's GIS computer system.

2.I.C.(3) Control Plan - identifies suspect outfalls that have potential for illicit connections or past illegal dumping and provides a plan for locating and removing illicit connections in the storm sewer system.

2.I.C.(4) Representative Outfalls - lists candidate sites chosen for wet weather discharge monitoring per Task 2.I.B.(2)(c).

2.II.A Population and Land Use Projections - presents the results of five, ten and twenty year population projections with resulting changes in land use and development which affect stormwater runoff and pollution generation rates.

2.II.B	Design Criteria - inventories and evaluates current City and County design criteria and policies related to stormwater management.
2.II.C & D	Hydraulic Modeling - presents results of hydraulic drainage analysis of Oso Creek, Kelly Ditch, Clarkwood Ditch, Salt Flat Drainageway and the Nueces River.
2.II.E & F	Structural/Nonstructural Improvements - evaluates necessary flood control and drainage improvements based on modeling performed in Task 2.II.C & D.
2.III.A	Existing Authorities - provides an inventory of legal authorities possessed by local government related to stormwater management.
2.III.B	Existing Jurisdictions - identifies local entities with stormwater management responsibilities and their jurisdictional boundaries.
2.III.C	Coordination Mechanisms - evaluates available mechanisms and current efforts among local government and jurisdictions to coordinate stormwater management.
2.III.D	Financing Options - evaluates alternative funding options available to support future stormwater management activities.
2.III.E	Implementation Plan - assesses existing City and County stormwater programs and provides an approach for the implementation of a comprehensive regional stormwater management program.
3	Public Education Plan - outlines a plan to educate the public about current and future stormwater management issues and their effect on the community.

PROJECT FINDINGS

STORM SEWER SYSTEM CHARACTERIZATION/MAPPING

Subsequent to the production of the Mapping Data Collection Plan, the City contracted with Corpus Christi State University (CCSU) to field locate points of stormwater discharge (outfalls) to significant receiving waters in the study area. Under the direction of Professor Allen Berkebile, a crew of two CCSU students walked along streambanks and shorelines locating and collecting field data for storm sewer system outfalls. Based on previous field notes and existing system maps, 110 major outfalls were known to exist before this effort. It was tentatively estimated that up to two hundred outfalls could exist in the study area.

After completion of field mapping, a total of 340 outfalls had been field located and characterized. The number of outfalls found per receiving water were as follows:

Receiving Water	Number of Outfalls
Oso Bay	54
Corpus Christi Bay	72
Inner Harbor	25
Nueces Bay	23
Oso Creek	88
West Oso Creek	11
Nueces River	41
Laguna Madre	26
Total	340

Along with these outfall locations, floodplain boundaries, watershed boundaries, and subwatershed areas, were input to digital computer maps. U.S. Geological Survey 7.5 minute quadrangle maps were used as base maps with additional data entered in DXF format. This information is compatible with the City's GIS system and will prove to be a valuable asset for future work efforts associated with stormwater management.

DRAINAGE IMPROVEMENT/FLOOD CONTROL

The drainage study portion of this project utilized the SCS TR-20 hydrologic model and the U.S. Corps of Engineers HEC-2 hydraulic model to predict existing and future flood elevations for the 25-year and 100-year storm events. The current study utilized detailed demographic information (land use, population) developed by the Corpus Christi City Planning and Urban Development Department especially for this project. Drainage problems were identified for main conveyances only. No local drainage or neighborhood systems were evaluated in this study.

In the drainage improvement recommendations, consideration was given to two basic solutions to flooding conditions as follows:

1) Phase I Projects - Local drainage problem areas where cost-effective conveyance improvements are possible; and

2) Phase II Projects - Methods to reduce the impact of ultimate development on the peak levels of Oso Creek for watershed-wide benefits.

The recommended Phase I improvements (Table 1) to alleviate drainage problems on Oso Creek are intended to eliminate areas of restrictions where the improvements will be of greatest benefit to land areas in close proximity to the improvements. These benefits will occur by reducing the frequency that the tributary drainageways, which are designed to convey a 25-year storm, will be inundated or made nonfunctional by backwater effects from the receiving stream, Oso Creek. The extent of the 100 year floodplain will also be reduced considerably. Phase II improvements, such as additional channel improvements, land use controls, as well as drainage area diversions and regional detention facilities were considered as methods to reducing the impact of ultimate development on Oso Creek flood levels throughout the watershed in the future. The recommended Phase II improvements are included as Table 2.

TABLE 1

PHASE I DRAINAGE IMPROVEMENTS

Project	COST: Construction	COST: Annual Maintenance
Texas-Mexican Railroad Trestle at Highway 44	$ 775,000	$ 500
Oso Creek Channel Improvements from Highway 44 to Violet Rd.	730,000	10,000
Kelly Ditch Channel Improvements from Saratoga to Old Brownsville Rd.	693,750	17,600
Kelly Ditch Channel Improvements from Old Brownsville Rd. to Bear Lane	407,500	13,680
Kelly Ditch Floodplain Clearing	120,000	13,500
Clarkwood Ditch Maintenance	--	28,500
Salt Flats Drainageway Box Culverts	732,750	--
Salt Flats Improvements	832,250	--
Coke Street Culverts	22,500	--
Total	$4,313,750	$ 83,780

TABLE 2

PHASE II DRAINAGE IMPROVEMENTS

	COST	
Project	Construction	Annual Maintenance
Oso Creek Channel Improvements from Violet Rd. to Highway 77	$ 936,250	$ 23,250
Oso Creek Improvements from Clarkwood Road to Highway 44	$ 2,285,000	37,500
Oso Creek Floodplain Clearing	$ 840,000	75,000
Regional Detention Facility	9,669,000	48,000
Total	$13,730,250	$ 183,750

STORMWATER QUALITY MANAGEMENT

A comprehensive water quality management program places an emphasis on the control of stormwater pollution to enhance and protect local water resources. This is the first stormwater master plan to take a pro-active approach to water quality protection.

Of the 340 outfalls located during this project, 55 outfalls exhibited dry weather flows. Dry weather flows may indicate illicit connections (of sanitary sewers or floor drains) or illegal dumping (of oils or other toxic materials) to the storm sewer system. While these potential pollution sources are not "stormwater" problems, they do present an immediate danger to the quality of the receiving water. By locating and disconnecting these point sources of pollution, an immediate benefit to local water quality will be realized. Task 2.I.C.(3) provides a Control Plan to address this problem.

To provide insight into impacts of stormwater pollution on local receiving waters, an inventory of existing water quality was conducted. While water quality is generally good in the Corpus Christi Bay system, existing data indicate some instances where state water quality criteria are not met. These occurrences are potentially attributable to stormwater pollution.

It must be understood that water quality in local bays and waterways is governed by a variety of factors: point source discharges for process waters, brine discharges and wastewater treatment plant effluents; nonpoint sources such as stormwater runoff and septic tank effluents; spills in or near the bays; and pollution entering the bay from outside the region. Temporary elevations in pollutant levels soon after a storm event have been identified in past studies. Analyses of bottom sediments where pollutants settle and accumulate also demonstrate a need to address water quality protection.

A wet weather discharge monitoring plan is recommended to provide needed data regarding stormwater runoff quality before it enters local receiving waters. By characterizing existing and projected stormwater pollutant loadings, a management framework can be developed to reduce and manage stormwater pollution.

This framework will utilize the monitoring results via stormwater pollution modeling to estimate existing pollution loadings to local streams and bays. Future loading projections will also be made in order to develop a watershed specific plan to control stormwater pollution through best management practices (BMP's). Available BMP's include dry and wet detention areas, erosion control measures and nonstructural controls.

ORGANIZATION/ADMINISTRATION

An assessment of the City and County stormwater management programs was conducted to identify program needs. Future program requirements based on federal and state regulations were considered for their impact on required staffing levels. Although a regional management approach promoting City-County cooperation is recommended, federal requirements will require the City to a place higher priority on stormwater quality management issues. Current federal regulations will require the City to develop a stormwater quality management program and obtain a discharge permit for the municipal separate storm sewer system. Both the City and County will be required to obtain permits for stormwater discharges associated with City and County owned industrial facilities. Additional staffing will be required to administer routine dry weather field monitoring of outfalls, enforcement activities, and wet weather monitoring. In regard to operation and maintenance of the local stormwater management system, work is currently performed on a complaint or as-needed basis. Additional staffing is recommended to provide both routine and remedial maintenance to the storm sewer system on a pro-active basis.

PROGRAM FINANCING

In Task 2.III.D., a review of available funding alternatives to support development of a comprehensive stormwater management program was performed. The financing options that were evaluated included the general fund, special funds, tax/assessment districts, permit and license fees, subdivision exactions, impact fees and user fee supported enterprise funds (stormwater utility). Based on the referenced evaluation, the stormwater utility alternative was determined as the most equitable and fair means of allocating stormwater management costs. Rates are based on actual runoff contribution from each property parcel. Additionally, a stormwater utility enterprise fund provides a stable funding source for the stormwater management program independent of other general governmental activities. It is recommended that the City evaluate an implementation plan for the utility concept in the Corpus Christi area.

LEGAL CONSIDERATIONS/REGULATORY COMPLIANCE

In November 1990, the U.S. Environmental Protection Agency (EPA) published National Pollutant Discharge Elimination System (NPDES) permit application requirements for stormwater discharges associated with industrial activity and discharges from municipal separate storm sewer systems serving a population of 100,000 or more. The two part NPDES permit application process for municipal (City only) permits requires the creation and compilation of maps, water quality data, land use information, soil data, and legal, institutional and financial information. Most importantly, the City will be required to develop a comprehensive stormwater quality management program which will be implemented over the permit term.

Once the Part 1 and 2 permit applications have been submitted to EPA, a final permit will be issued to the City. This permit will require renewal every five years. The final permit to be issued by EPA will contain specific permit compliance requirements addressing stormwater quality management.

Due to the amount of required data and information to be developed, it is recommended that the City begin immediately with the preparation of an NPDES Part 1 permit application for submittal to EPA by May 18, 1992 for its municipal storm sewer system. Within 90 days of the Part 1 application submittal, EPA will comment on the City's wet weather discharge characterization plan. The plan outlines an approach to collect storm event water quality data required by EPA for submission with the Part 2 permit application. The City is required to prepare and submit an NPDES Part 2 permit application before May 1993. Therefore, the City should start to develop plans for the implementation of a stormwater quality monitoring program. The data collected as part of this monitoring program (required by EPA) will provide the technical basis for the development of the City's stormwater quality management program.

Both the City and County must obtain additional NPDES stormwater permits for City and County-owned industrial facilities. Permit application submittal deadlines vary based on the type of stormwater permit coverage required:

Industrial Permit Coverage	Application Submittal Deadlines
Individual	November 16, 1991*
Group - Part 1	September 30, 1991
Group - Part 2	May 18, 1992
General	Rules under development

* Application submittal deadline may be changed to May 18, 1992.

It is recommended that the City and County proceed with the development of permit applications for each of its applicable facilities (such as landfills, treatment plants, and certain vehicle maintenance facilities which fall under the NPDES industrial facility classification) per the schedule listed above. Additionally, all capital improvement construction exceeding five acres in size must secure an industrial permit to address the control of construction site runoff.

PUBLIC EDUCATION

In Task 3, a public education plan was outlined to educate the public about current and future stormwater issues that affect the community and to solicit input on stormwater management needs. Various public information tactics such as newspaper, radio, TV and public presentation activities were considered. A Stormwater Advisory Committee met monthly with the project team to discuss project issues and findings. Committee input was solicited on how best to implement a Public Education Program regarding stormwater issues. It is recommended that a public education component be included in future stormwater management program budgets.

RECOMMENDATIONS

Based on the findings of the current master plan, a summary of recommendations to the City of Corpus Christi and Nueces County is presented for review. Recommendations have been organized by priority. Major recommendations represent those items or policy issues that warrant strong consideration or immediate action. Recommendations which apply only to the City have been shown separately. Additional recommendations are also listed which merit strong consideration in the future.

MAJOR STORMWATER RECOMMENDATIONS

- Continue to promote this regional approach to stormwater management.

- Implement the Phase I drainage improvements recommended in the master plan.

- Obtain NPDES permits for stormwater discharges for applicable City and County-owned facilities that are included in the NPDES industrial classification.

- Include a public education component in future stormwater management programs.

ADDITIONAL RECOMMENDATIONS FOR CITY ONLY

- Continue to develop a stormwater quality management program.

- Prepare an NPDES Part 1 permit application for stormwater discharges from the municipal separate storm sewer system.

- Conduct dry and wet weather sampling.

- Conduct study to evaluate the feasibility of implementing a stormwater utility in the City.

- Develop ordinances to adequately address NPDES requirements including erosion control for new developments.

FUTURE STORMWATER CONSIDERATIONS

- Coordinate stormwater management activities with local communities and drainage districts.

- Develop and implement long-term CIP program consistent with the Phase II drainage improvements recommended in this master plan.

- Expand City GIS maps and database to include stormwater system information developed in this master plan for subsequent use in planning, design, operation, maintenance and permitting activities.

- Develop standardized design criteria for the design of stormwater facilities in the City.

- Adopt a policy for the application of standardized design criteria for both new developments and extension of the storm sewer system.

- Implement control plan to locate and disconnect illicit connections and prevent illegal dumping to the storm sewer system.

IMPLEMENTATION SCHEDULE

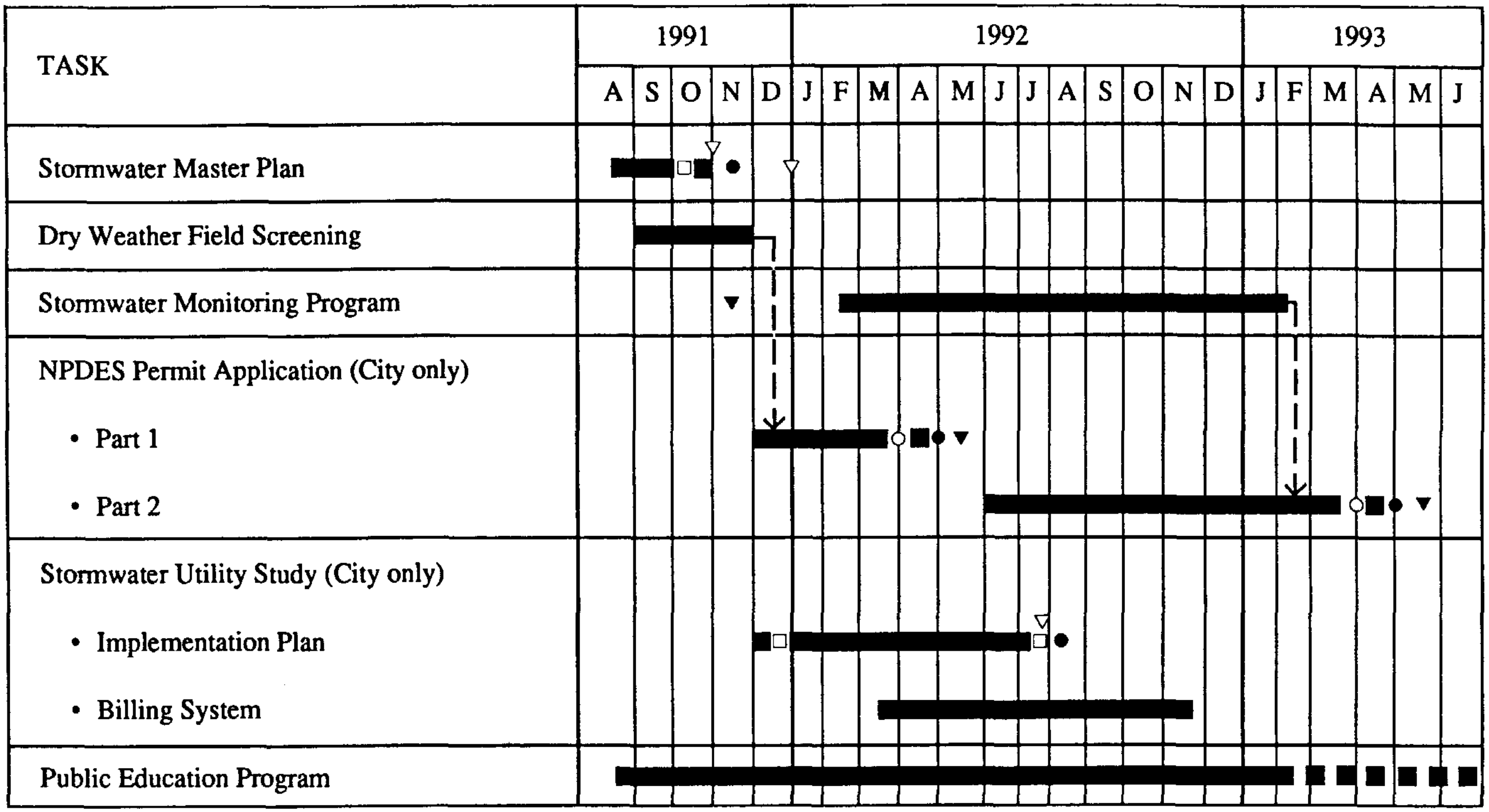
An implementation schedule (Figure 2) has been developed which addresses the preceding recommendations. Key dates for major activities are discussed below.

Dry Weather Field Screening - City staff is currently performing this task for all outfalls located in the study area to identify illicit connections and improper disposal to the stormwater system. Completion of this effort and compilation of field screening data is required for subsequent use in the NPDES Part 1 permit application process.

Stormwater Quality Monitoring Program - Wet weather monitoring of storm events is required in NPDES Part 2 permit application requirements to determine the impact of urban land uses on stormwater quality. All required monitoring data should be collected and compiled by early 1993 to incorporate into the Part 2 application. Before implementation of the monitoring program, a wet weather monitoring plan should be submitted to EPA for approval. This should proceed immediately to allow adequate time for the collection of the required data.

NPDES Permit Application - The deadline to submit the NPDES Part 1 permit application for discharges from the municipal separate storm sewer system is May 18, 1992. Due to the amount of detailed information required to complete a permit application, the City should begin to develop its Part 1 permit application no later than December 1991.

REGIONAL STORMWATER MASTER PLAN
IMPLEMENTATION SCHEDULE



Legend:
- ○ Staff Approval
- ● Council Approval
- ▽ Submittal to City
- ▼ Submittal to EPA
- □ Work Shops

FIGURE 2

Stormwater Utility Study - As recommended in Task 2.III.D, the development of a Citywide stormwater utility to support the City's stormwater management program should be considered. In addition to the determination of a user fee rate, detailed budget requirements, billing system alternatives, revenue scenarios, and draft ordinances should be evaluated and presented to the City Council for their consideration. A stormwater management funding mechanism must be identified per NPDES Part 2 permit application requirements before May 1993.

Public Education Plan - Many important stormwater issues impacting the residents of Corpus Christi and Nueces County have been presented in this master plan. Public support will be crucial to the success of future efforts to implement master plan recommendations. A public education campaign is necessary to inform the local community about current and future stormwater management issues. This campaign should be conducted concurrent with regional management program development and City NPDES permit application activities.

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1.0 INTRODUCTION

1.1 PURPOSE

The Regional Stormwater Master Plan addresses several issues subject to regulation by Federal, State or local agencies. The extent of regulation and type of activity being regulated differ with each of the various agencies who are charged with maintenance of water quality or protection from flood damage. Some of these regulated activities must be addressed in the Master Plan, while additional regulatory requirements will apply in the future as the Master Plan is implemented.

It is the purpose of this task to delineate the activities of the Master Plan which will be subject to regulation, and provide information on the recommended means for compliance with regulatory requirements.

The need for interaction of the Master Plan with the plans and policies of local drainage and water quality authorities will also be addressed by defining areas of overlapping jurisdiction. The scope of this jurisdiction review is limited to policies on Master Plan activities such as flood protection and drainage design criteria which are currently being employed. A complete review of legal jurisdictional authority will be accomplished by Task 2.III.(A & B) in subsequent sections of the Master Plan.

2.0 REGULATORY AGENCIES

2.1 FEDERAL - ENVIRONMENTAL PROTECTION AGENCY

During the past 20 years, national environmental priorities have been established to protect and enhance the quality of the nation's waters. The adoption of the Federal Water Pollution Control Act Amendments of 1972 and the Clean Water Act of 1977 established standards and goals to improve and maintain the nation's water quality.

The U.S. Environmental Protection Agency (EPA) has nation-wide authority to implement the Clean Water Act which regulates discharges into navigable waters of the United States. By this authority, the EPA requires permits of various types for discharges into jurisdictional waters in order to help attain water quality standards. The permit program is entitled National Pollutant Discharge Elimination System (NPDES). NPDES permitted facilities must comply with effluent limits and prohibitions on toxic pollutants. NPDES permits have long been required for wastewater treatment plant discharges. Recent EPA rules that took effect November 1990 require NPDES permits for discharges of stormwater runoff from municipal separate storm sewer systems and from certain industrial activities.

Section 405 of the Water Quality Act of 1987 added Section 402(P) of the Clean Water Act to require the Environmental Protection Agency (EPA) to establish regulations setting forth National Pollutant Discharge Elimination System (NPDES) permit application requirements for stormwater discharges associated with industrial activity and discharges from municipal separate storm sewer systems serving a population of 100,000 or more.

2.1.1 PERMIT APPLICATION REQUIREMENTS

Compliance with the NPDES regulations for stormwater discharge (Federal Register, Volume 55, No. 222, November 16, 1990) will require municipalities with populations of 100,000 or greater to complete a two-part permit application process for control of pollutants in discharges from the storm sewer system. Additionally, certain municipally owned facilities classified as "industrial" by the regulations will require individual permits independent of the permit for the City's storm sewer system. The municipal storm sewer permit application process has the following major requirements:

- Demonstration of adequate legal authority to control the discharge of pollutants into and from the storm sewer system.
- Inventory and mapping of the municipal drainage system to identify sources of storm water runoff and associated pollutants and discharge points to Waters of the United States.
- Characterization of pollutants in dry and wet weather discharges from the storm sewer system through water quality sampling and modeling.
- Development of a Comprehensive Stormwater Pollution Management Program.
- Demonstration that adequate long-term funding is available to support implementation and on-going operations of the Pollution Management Program.

2.1.2 FINAL PERMIT REQUIREMENTS

The final permit will specify a Comprehensive Stormwater Management Program to be implemented over the permit term of five years. The management program must address the control of stormwater pollution. Final permit requirements may include:

- Temporary treatment controls for construction sites;
- Control of discharges from existing and new industrial facilities;
- Detection and elimination of non-stormwater discharges and improper disposal to the storm sewer system;

- Adequate authority by ordinance to control the discharge of pollutants;

- Permanent structural treatment and non-structural controls (using BMP's) for areas of new commercial and residential land development;

- Maintenance programs for structural controls;

- Personnel and equipment resources to carry out the day-to-day planning, operations, and enforcement activities; and most importantly;

- Sufficient long-term funding to ensure that the management program can be implemented and sustained into the future.

2.1.3 PERMIT RENEWAL AND REVIEWS

Permits will be renewed every five years and performance of the Stormwater Pollution Management Program will be assessed through annual status reports presented by municipalities to the EPA and appropriate State regulatory agencies. The annual reports will summarize the City's progress in implementing the Pollution Management Program and the results of stormwater quality monitoring in determining the pollution control effectiveness of the management program. This information will be used by the regulatory agencies to refine permit renewal conditions to ensure that specified pollution control goals are achieved.

2.1.4 PERMIT APPLICATION PROCESS

The City of Corpus Christi will be included among the municipalities subject to the NPDES permit requirements. The City will have two and one-half years from the date of final rule promulgation to complete the two-part permit application process (May 1993). The County most likely will not be subject to the initial NPDES regulations for its storm sewer system. However, the EPA will make this judgment based on the degree of urbanization in the County and the large amount of hydraulic communication between County and City stormwater discharges. The criteria for this judgment have not been established.

The EPA has developed a two-part permit application process. Permits will be issued on a system- or jurisdiction-wide basis. In Texas, permitting will be administered by EPA Region VI. Part 1 of the permit application is intended to provide an adequate basis for identifying sources of pollutants, for identification of non-stormwater discharges to the storm sewer system via sampling and an analysis of dry weather discharges, and to formulate a strategy for comprehensive characterization of wet weather discharges from the storm sewer system. <u>The City's Part 1 application must be submitted to the EPA by May 18, 1992.</u>

Part 2, of the permit application is designed to supplement the characterization information provided in Part 1, through wet weather discharge sampling and analysis to characterize land use impacts on discharge quality, and to allow municipalities to develop a comprehensive stormwater pollution management program that will control the discharge of pollutants to the maximum extent practicable. Additionally, the source of funding that will support program implementation must be identified. <u>The Part 2 application must be submitted to the EPA by May 17, 1993.</u>

It is important to note that, in addition to requiring permitting of the City's storm sewer system, the NPDES regulations require permitting of stormwater discharges from certain City and County-owned facilities that fall into the industrial category. These include wastewater treatment plants, landfills, the airport, vehicle maintenance facilities, and large capital improvement construction sites. The permitting requirements for these facilities are similar to those for the municipal storm sewer system.

The NPDES Permit Application Regulations for Stormwater Discharges are published in 40 CFR, Parts 122, 123, and 124. Part 122, contains the specific permit application requirements. These are included herein as Appendix A in order to serve as reference information for future NPDES permitting activities. In addition, Appendix A describes the specific permit application requirements for municipal separate storm sewer discharges. The mapping and discharge characterization activities of the Master Plan are intended to comply with these requirements as discussed in detail in Section 3.4.

2.2 FEDERAL - FEDERAL EMERGENCY MANAGEMENT AGENCY

The National Flood Insurance Act of 1968 was enacted to provide previously unavailable flood insurance protection for property owners in flood-prone areas. The Federal Emergency Management Agency (FEMA) was designated to administer the implementation of the flood insurance program.

In order to establish equitable insurance rates which are proportional to the probability of flood damage, risk studies are performed in each community along major drainageways. These risk studies are based upon extensive hydrologic and hydraulic engineering analysis which determines the elevation of flood waters to be anticipated during the event of a 100 year frequency storm. Consideration is given to flood water levels from tropical storms as well as normal rainfall.

After flood profiles are established, floodways are determined to establish the maximum limit of encroachment allowable into the floodplain which will create no more than one foot rise in the 100 year flood elevations. By maintaining unobstructed floodways, land development activities should not adversely affect flood levels.

The City of Corpus Christi and Nueces County have each adopted a flood hazard protection code proposed by FEMA which gives the local entity the authority to control development in flood-prone areas. The statement of purpose of the ordinance and methods to be employed are contained in the following excerpt from Article 1 of the Flood Hazard Prevention Code.

(ARTICLE 1, FLOOD HAZARD PREVENTION CODE)
Section C. Statement of Purpose

"It is the purpose of this ordinance to promote the public health, safety and general welfare and to minimize public and private losses due to flood conditions in specific areas by provisions designed to:

(1) To protect human life and health;

(2) To minimize the need to spend public money for flood control projects;

(3) To minimize the need for rescue and relief efforts associated with flooding and undertaken at the expense of the general public;

(4) To minimize the prolonged business interruptions;

(5) To minimize damage to public facilities and utilities such as water and gas mains, electric, telephone, and sewer lines, streets and bridges located in flood plains;

(6) To provide for the sound use and development of flood-prone areas to minimize future flood blight areas; and

(7) To encourage the potential buyers be notified that property is in a flood area.

Section D. Methods of Reducing Flood Losses

In order to accomplish its purposes, this ordinance uses the following methods:

(1) Restrict or prohibit uses that are dangerous to health, safety or property in times of flood, or cause excessive increases in flood heights or velocities;

(2) Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;

(3) Control the alteration of natural flood plains, stream channels, and natural protective barriers, which are involved in the accommodation of flood waters;

(4) Control filling, grading, dredging and other development which may increase flood damage;

(5) Prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands."

Building permits are routinely denied for any above ground structure within the floodway unless an engineering study demonstrates that the construction will not have an adverse impact upon upstream water levels.

Procedures are included within the FEMA regulations for amending or revising the flood plain maps. Revisions can occur due to mapping errors, technical errors, or due to modification of drainageways which result in a change in water surface elevation or flood plain delineation. Appendix B is a reprint of the FEMA regulations specified in 44 CFR, Parts 59 through 79, which govern the activities of FEMA relating to the flood insurance program. Particularly, Parts 67-70 address the procedures to amend or modify the flood maps due to modifications of drainageways.

2.3 FEDERAL - U.S. ARMY CORPS OF ENGINEERS

The River & Harbor Act of 1899 contains several sections relevant to the regulation of work and structures in "navigable waters of the United States".

Section 13 (33 US Code 401) prohibits the discharges of refuse in navigable waters or their tributaries or onto their banks if the refuse is likely to be washed into a navigable water.

Section 10 (33 US Code 403) requires a permit for structures and works in navigable waters. Examples of activities requiring a permit are: piers, bulkheads, breakwaters, pipelines, dredging, filling, stream excavation, channelization, and similar works.

Section 404 (33 US Code 1344) of the Federal Water Pollution Control Act Amendments of 1977 authorizes the Corps of Engineers to regulate the discharge of dredged and fill material into waters of the United States. The broader jurisdiction under this law includes not only navigable waters, but most other waters of the country and wetlands adjacent to such waters.

The Corps of Engineers has issued a number of nationwide permits which allow certain activities that otherwise would require individual permits under the Corps' program. Examples of activities permitted are:

A. Discharge of dredged material into nontidal streams above the headwaters, defined as the point above which the average flow is less than 5 cubic feet per second.

B. Repair or replacement of a previously authorized structure such as an outfall structure and bulkhead. No deviation from the original plans is permitted.

Section 404(f)(1)(c) of the Federal Water Pollution Control Act provides for certain exemptions for drainage ditch maintenance. A Regulatory Guidance Letter (RGL) on this topic was issued August 17, 1987 by the Corps of Engineers. The RGL was a guidance statement prepared by EPA in cooperation with the Corps for implementation of the exemption for drainage ditches. Even though this RGL officially expired December 31, 1989, it has not been superceded and Corps of Engineers representatives say that this is still the policy in effect. But they also caution that all of their current policies are frequently reviewed and that those responsible for ditch maintenance with the city and county should frequently check with the Corps as to the permit requirements for certain activities.

Included as Appendix C is a copy of the Regulation Guidance Letter concerning Section 404(f)(1)(c), Statutory Exemption for Drainage Ditch Maintenance, which covers in detail the Corps of Engineers and EPA's current policy on ditch maintenance activities.

Maintenance work or shoreline repairs do not require individual permits if the activities comply with the guidelines of the nationwide permit or the RGL on drainage ditch exemptions. But, before beginning any work in waters or wetlands, it is advisable to contact the local Corps of Engineers office to obtain a written determination as to the necessity for an individual permit.

Major construction projects which will require permits from the Corps of Engineers will also be subject to the review of various other agencies which are concerned with wildlife habitat and water quality preservation. The agencies which are usually asked to comment on COE permit applications are the U.S. Fish & Wildlife Service, National Marine Fisheries Service, Texas Parks & Wildlife, General Land Office of Texas, the Environmental Protection Agency, and the Texas Water Commission.

Discussion of proposed permits with these agencies during the project formulation stage is advised. This procedure allows the permittee to submit a "pre-coordinated" application which, if it addresses the goals of the agencies, will typically reduce the permit processing time by 30 to 60 days.

2.4 STATE - TEXAS WATER COMMISSION

The Federal Clean Water Act is administered by the EPA. However, states may apply to EPA for authorization to administer various aspects of the Clean Water Acts program for permitting discharges into waterways. Texas has not been authorized by EPA to administer the CWA, but it does implement water quality control through the Texas Water Code.

The Texas Water Code provides for maintaining water quality to the highest standard possible with consideration for the many differing uses of water sources.
The current stormwater monitoring and enforcement activities of the local Texas Water Commission (TWC) is limited, partially due to manpower shortages.

The Commission does monitor Industrial Discharge Permittees for compliance, but their activities in the area of municipal stormwater is limited to point source pollution. This occurs when a report is received concerning obvious pollutants and TWC conducts an investigation.

In addition to the NPDES regulations, the Texas Water Commission (TWC) is developing water pollution control and abatement rules (Texas Water Code Section 26.177) which address stormwater discharges for municipalities having a population greater than 5,000. These proposed regulations are similar in intent and scope to the NPDES requirements. However, the regulations are currently in an initial draft stage and promulgation is not anticipated any earlier than mid-1992.

2.5 REGIONAL - COASTAL BEND COUNCIL OF GOVERNMENTS (CBCOG)

In 1976, Governor Dolf Briscoe designated the Coastal Bend Council of Governments as the local planning agency for the Corpus Christi designated planning area for water quality management planning activities. Population projections, designated local treatment and collection agency designation, and nonpoint source pollution management activities must be approved by CBCOG before projects can receive federal or state funding that has been capitalized with federal monies. The development of the Master Plan will include input from CBCOG representatives. The CBCOG should continue to be included in the implementation of future water quality efforts resulting from Master Plan recommendations, especially if federal or state funding is consider to finance such efforts.

3.0 AFFECTED MASTER PLAN ACTIVITIES

3.1 FLOOD PROTECTION

Flood protection has traditionally been the primary focus of stormwater master plans. These plans have provided the size and location of drainageways required to carry away flood waters from design storms. The current Master Plan determines the flood capacity of selected drainageways (Task 2.II.C and D), plus recommends structural and nonstructural measures (Task 2.II.E and F) which will address flood protection problem areas within the study area.

The activities proposed will frequently occur within the jurisdictional wetlands of the United States which will require coordination with the regulations of the U.S. Army Corps of Engineers (COE). New construction of outfalls through wetlands requires COE permits, particularly if there will be any disposition of excavated material within the wetlands. Maintenance of existing ditches is exempted under the Section 404(f)(i)(c) statute if excavated material is deposited and retained in upland areas. Vehicular traffic in wetland fringes must be controlled to provide minimal disturbance to vegetation. Temporary fill for access roads usually requires a permit. Coordination with COE representative, whether a permit is required or not, is advisable.

Flood protection improvements which are proposed within the federally regulated floodway as defined by FEMA will need to be reviewed by that agency to determine that there will not be an increase in upstream flood levels due to this activity. In the event that the flood protection improvements will significantly alter the flood plain, the City or County should submit the required applications for Map Amendments to FEMA for review and acceptance before undertaking construction of the proposed improvements.

3.2 FLOOD PLAIN DELINEATION

The flood plains depicted on the mapping output for the Regional Stormwater Master Plan represent the 100 year flooding zones established by FEMA as well as the 100 year flooding zones calculated by the effort of Task 2.II.C of this study. The significance of these flooding zones is that building construction is restricted to minimum elevations within these areas by the local authorities due to their participation in the Federal Flood Insurance Program. Within areas considered the floodway, construction is prohibited unless special engineering studies are performed. The establishment of minimum building elevations based upon the 100 year flood capacity of local drainageways insures that flood damage to property is minimized during extreme rainfall events, even when the drainage system is constructed to contain a design storm of much less magnitude.

The activities of this study could be affected by FEMA regulatory requirements if there are areas where the 100 year flood plain established by this study differs from the existing FEMA flood plain and elevations. This could occur due to more accurate cross-sectional data, previously completed improvements in the waterway which had not been documented by FEMA, or major changes in watershed development levels or hydrologic methodology which provides different runoff quantities from previous studies. If the change is significant, it should warrant an application by the city or county for a "Map Revision" by FEMA, based upon supporting technical data. These applications typically require at least 12 months for processing, technical review, and public comments.

3.3 DESIGN CRITERIA REVIEW

The City of Corpus Christi and Nueces County have adopted regulations concerning the design and construction of stormwater facilities within their respective jurisdictions. The implementation of these regulations directly affect flood control and water quality which are also the concerns of federal and state regulatory agencies discussed in Section 2.

For example, the design storm utilized (i.e., 5-year frequency, 25-year, or 100-year) determines the level of protection from flooding which the drainage system will provide. Design storms are generally established as policy by the local drainage authority responsible for constructing the drainage system and/or implementing the policies throughout its jurisdictional area. The selection of a design storm invariably involves the consideration of economics versus the public desire for protection. For example, in the hill country towns of Texas, it is practical to design 100 year flood capacity drainageways due to the abundant slope which is available for carrying away stormwater within economically sized storm sewer conduits. In coastal regions where the terrain lacks slope, the drainageways must be sized three to four times larger in order to carry the same 100 year frequency stormwater runoff. The considerable extra expense which the public would need to bear is weighed against the anticipated cost of flood damage and the inconvenience of periodically flooded streets when the design storm is adopted as policy. It is important that stormwater systems from interconnecting jurisdictions are based on similar design storms.

Structural design criteria will be reviewed for water quantity and quality aspects. The City's method for designing stormwater detention ponds has previously focused on controlling peak flood waters, but will also be reviewed for water quality maintenance. Another example of design criteria is inlet throat dimensions which are designed to convey trash debris without clogging. The result is that these pollutants end up in receiving waters which are protected by various regulatory agencies.

Task 2.II.B will review existing drainage design criteria of the City and County and propose changes. These changes will need to be consistent with the regulatory policies of EPA, FEMA, as well as others.

3.4 OUTFALL MAPPING, SOURCE IDENTIFICATION & DISCHARGE CHARACTERIZATION

A major task of the Master Plan is the inventory of stormwater outfalls within the study area. This effort will field locate, map, label, photograph, and describe the size, shape and condition of each outfall. In addition to the inventory, all observed discharges will be characterized and later sampled for possible pollutants.

The results of this survey will form a comprehensive database which can be used by the respective stormwater divisions of the City and County in maintaining their stormwater systems.

An additional purpose of the mapping, source identification, and discharge characterization will be the utilization of this data for the preparation of future applications for NPDES Stormwater Discharge Permits through EPA.

As described in Section 2.I.A, Outfall Data Collection and Mapping Plan, the activities of the mapping plan will follow current EPA guidelines for outfall identification. The location of receiving waters, the characterization of outfalls, the methodology of selecting sampling points and the mapping system being utilized are each derived from EPA guidelines. As these methodologies are being developed for the Master Plan, questions which arise are resolved through discussions with EPA officials of Region VI in Dallas.

4.0 LOCAL PLANS AND POLICIES

4.1 INTER-JURISDICTIONAL COORDINATION

Several local jurisdictions with the authority to establish stormwater management policies exist within the study area of the Master Plan. These jurisdictions include the City of Corpus Christi, Nueces County, City of Robstown, and the Nueces County Drainage District No. 2, which are interrelated in several ways.

First, the areas of jurisdiction frequently overlap, such as the City of Robstown being contained within the area of N.C.D.D. No. 2, while portions of N.C.D.D. No. 2 are also within the extra-territorial jurisdiction (ETJ) of Corpus Christi and entirely within Nueces County. Likewise, Nueces County includes jurisdiction within Corpus Christi city limits and the unincorporated area inside and outside of the ETJ. These jurisdictional overlaps affect the implementation of design criteria policies of different authorities in these areas.

Secondly, stormwater systems of different authorities are frequently interconnected as the stormwater drainageways follow natural topographic relief. For example, the stormwater generated and conveyed from parts of the western edge of the study area under county jurisdiction enters the N.C.D.D. No. 2 system, joins with City of Robstown stormwater runoff which discharges into the upper end of Oso Creek, and flows through the ETJ and city limits of Corpus Christi before entering Corpus Christi Bay. The intermingling of stormwater runoff demands inter-jurisdictional coordination and cooperation among those jurisdictions responsible for flood control and water quality management.

The need to coordinate the various local plans and policies is apparent in order to ensure a consistent level of design throughout the integrated drainage system and to cooperate on maintenance of water quality. Inter-jurisdictional coordination of flood protection activities is already taking place through policies established by ordinance and sometimes by cooperative efforts dependent upon communication between jurisdiction managers. For instance, when property is platted in the County's jurisdiction but outside Corpus Christi, the County Engineer regularly has the City Engineer review the proposed plat for compliance with the Master Plans of Corpus Christi. In the future, additional coordination and adoption of compatible ordinances may be necessary to help meet water quality standards.

4.2 CITY OF CORPUS CHRISTI

By authority of its platting ordinance (revised version adopted 1955 as Ordinance 4168), the City of Corpus Christi must approve the subdividing of land within its city limits and extraterritorial jurisdiction. The platting process, thus, ensures that certain standards are met which satisfy stormwater drainage requirements. For instance, road ROW's are set at minimum widths to contain proper drainage structures, and major easements are required to contain the ultimate width to both construct and maintain drainageways per the adopted Drainage Master Plans.

The platting ordinance, furthermore, requires the construction of improvements to meet design criteria standards for water and sewer service, roads, parks, grading and stormwater. These design standards are established within the platting ordinance and within the adoption of subsequent drainage master plans. The stormwater system constructed through the platting of individual tracts of land thus completes separate portions of the overall stormwater system.

The City's authority extends into its five mile ETJ in order to ensure that development, which someday will likely become part of the incorporated city, is constructed to City standards. Therefore, when a development is proposed within the City's incorporated limits, the City ensures that the storm drainage plan is consistent with the City's Master Plans before approval. If the development is proposed outside Corpus Christi city limits, but within its ETJ, then Nueces County and the City must both approve the stormwater plan before the plat is approved.

The City also administers the FEMA flood plain regulations within its city limits. These regulations are consistent across jurisdictional lines so very little inter-jurisdictional coordination is required for implementation.

4.3 NUECES COUNTY

The County has the authority to approve platting within its jurisdiction and to require drainage improvements which comply with the accepted design criteria for the County.

Within areas of the County which are outside the ETJ of Corpus Christi or Robstown, the County uses its own criteria. When the area is within the ETJ of one of these cities, the County combines its drainage authority with the local municipality and the tract is platted consistent with the City's platting process. Upon City approval, the County may add additional drainage requirements, but routinely accepts the plats as approved by the municipalities.

Differences in design criteria between the County and the cities are likely to create minor problems in the application of platting requirements. For instance, the County has adopted the design frequency of a 25-year rainfall as the basis for sizing all storm sewer systems. This sizing could prevail until the system enters the ETJ of Corpus Christi where the design of drainageways within a proposed subdivision changes to a five year frequency storm.

Problems with this particular conflict have been few due to the lack of development activity since this new criteria has taken place, but it does point out a situation which should be addressed.

FEMA flood plain regulations on the other hand are consistent across jurisdictions and, thus, are consistently applied as long as each jurisdiction monitors all activity within its area.

4.4 NUECES COUNTY DRAINAGE DISTRICT NO. 2 (ROBSTOWN)

The Nueces County Drainage District No. 2 surrounds Robstown and provides drainage system construction and maintenance for the major outfalls into which the Robstown storm sewer system drains.

The Drainage District basically accepts the drainage delivered from the Robstown system with no requirement as to the design frequency. The Drainage District does monitor the total capacity of its system and can limit the amount of water as well as location of connections into its system if the District feels that it does not have sufficient capacity to handle the proposed flows. Therefore, the Drainage District usually coordinates only with the City of Robstown on flows from its system.

4.5 PORT AUTHORITY, FEDERAL INSTALLATIONS & INDUSTRIAL FACILITIES

Major facilities such as the Port, Naval Air Station, and major industrial developments maintain their individual private stormwater systems. Where these systems outfall directly into the bays or harbors, the City does not review the design criteria for these systems.

EPA has recognized this situation and provided for separate permitting for these types of facilities. Occasionally these systems will outfall into City drainageways where the City must approve the connection.

4.6 NUECES RIVER AUTHORITY

Water quality in the Nueces River has long been a priority due to the river providing the entire potable water supply for the region. The Nueces River Authority makes recommendations which are implemented by the City of Corpus Christi that affect water quality in the Nueces River in the vicinity of the raw water intake for the Stevens Water Treatment Plant at Calallen.

For this reason, the City endeavors to limit, as a matter of policy, stormwater discharges into the river in order to minimize turbidity.

5.0 REFERENCES

Environmental Protection Agency, National Pollutant Discharge Elimination System Permit Application Regulations for Stormwater Discharges, 40 CFR, Parts 122, 123 and 124, Washington, D.C., 1989.

Federal Emergency Management Agency, Flood Insurance Study, City of Corpus Christi, Texas, January 1984.

Federal Emergency Management Agency, National Flood Insurance Program, 44 CFR, Parts 59 through 79, U.S. Governmental Printing Office, Washington, D.C., 1979.

U.S. Army Corps of Engineers, Corpus Christi Office, Paul Lazarine, Conversation concerning Procedures for Reporting Stormwater Activity, May 1991.

HDR Infrastructure Inc., Drainage Criteria & Design Manual, Nueces County, Texas, October 1986.

APPENDIX A

EPA NPDES PERMITTING REGULATIONS
(CFR 40, PART 122)

federal register

Friday
November 16, 1990

Part II

Environmental Protection Agency

40 CFR Parts 122, 123, and 124
National Pollutant Discharge Elimination System Permit Application Regulations for Storm Water Discharges; Final Rule

certify, pursuant to 5 U.S.C. 605(b), that these amendments do not, have a significant impact on a substantial number of small entities.

List of Subjects in 40 CFR Parts 122, 123, and 124

Administrative practice and procedure, Environmental protection, Reporting and recordkeeping requirements, Water pollution control.

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

Dated: October 31, 1990.

William K. Reilly,

Administrator.

For the reasons stated in the preamble, parts 122, 123, and 124 of title 40 of the Code of Federal Regulations are amended as follows:

PART 122—EPA ADMINISTERED PERMIT PROGRAMS; THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

Subpart B—Permit Application and Special NPDES Program Requirements

1. The authority citation for part 122 continues to read as follows:

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

2. Section 122.1 is amended by revising paragraph (b)(2)(iv) to read as follows:

§ 122.1 Purpose and scope.

* * * * *

(b) * * *

(2) * * *

(iv) Discharges of storm water as set forth in § 122.26; and

* * * * *

3. Section 122.21 is amended by revising paragraph (c)(1), by removing the last sentence of paragraph (f)(7), by removing paragraph (f)(9), by adding two sentences at the end of paragraph (g)(3), by revising paragraph (g)(7) introductory text, by removing and reserving paragraph (g)(10) and by revising the introductory text of paragraph (k) to read as follows:

§ 122.21 Application for a permit (applicable to State programs, see § 123.25).

* * * * *

(c) *Time to apply.* (1) Any person proposing a new discharge, shall submit an application at least 180 days before the date on which the discharge is to commence, unless permission for a later date has been granted by the Director. Facilities proposing a new discharge of storm water associated with industrial activity shall submit an application 180 days before that facility commences industrial activity which may result in a discharge of storm water associated with that industrial activity. Facilities described under § 122.26(b)(14)(x) shall submit applications at least 90 days before the date on which construction is to commence. Different submittal dates may be required under the terms of applicable general permits. Persons proposing a new discharge are encouraged to submit their applications well in advance of the 90 or 180 day requirements to avoid delay. See also paragraph (k) of this section and § 122.26 (c)(1)(i)(G) and (c)(1)(ii).

* * * * *

(g) * * *

(3) * * * The average flow of point sources composed of storm water may be estimated. The basis for the rainfall event and the method of estimation must be indicated.

* * * * *

(7) *Effluent characteristics.* Information on the discharge of pollutants specified in this paragraph (except information on storm water discharges which is to be provided as specified in § 122.26). When "quantitative data" for a pollutant are required, the applicant must collect a sample of effluent and analyze it for the pollutant in accordance with analytical methods approved under 40 CFR part 136. When no analytical method is approved the applicant may use any suitable method but must provide a description of the method. When an applicant has two or more outfalls with substantially identical effluents, the Director may allow the applicant to test only one outfall and report that the quantitative data also apply to the substantially identical outfalls. The requirements in paragraphs (g)(7) (iii) and (iv) of this section that an applicant must provide quantitative data for certain pollutants known or believed to be present do not apply to pollutants present in a discharge solely as the result of their presence in intake water; however, an applicant must report such pollutants as present. Grab samples must be used for pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform and fecal streptococcus. For all other pollutants, 24-hour composite samples must be used. However, a minimum of one grab sample may be taken for effluents from holding ponds or other impoundments with a retention period greater than 24 hours. In addition, for discharges other than storm water discharges, the Director may waive composite sampling for any outfall for which the applicant demonstrates that the use of an automatic sampler is infeasible and that the minimum of four (4) grab samples will be a representative sample of the effluent being discharged. For storm water discharges, all samples shall be collected from the discharge resulting from a storm event that is greater than 0.1 inch and at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Where feasible, the variance in the duration of the event and the total rainfall of the event should not exceed 50 percent from the average or median rainfall event in that area. For all applicants, a flow-weighted composite shall be taken for either the entire discharge or for the first three hours of the discharge. The flow-weighted composite sample for a storm water discharge may be taken with a continuous sampler or as a combination of a minimum of three sample aliquots taken in each hour of discharge for the entire discharge or for the first three hours of the discharge, with each aliquot being separated by a minimum period of fifteen minutes (applicants submitting permit applications for storm water discharges under § 122.26(d) may collect flow weighted composite samples using different protocols with respect to the time duration between the collection of sample aliquots, subject to the approval of the Director). However, a minimum of one grab sample may be taken for storm water discharges from holding ponds or other impoundments with a retention period greater than 24 hours. For a flow-weighted composite sample, only one analysis of the composite of aliquots is required. For storm water discharge samples taken from discharges associated with industrial activities, quantitative data must be reported for the grab sample taken during the first thirty minutes (or as soon thereafter as practicable) of the discharge for all pollutants specified in § 122.26(c)(1). For all storm water permit applicants taking flow-weighted composites, quantitative data must be reported for all pollutants specified in § 122.26 except pH, temperature, cyanide, total phenols, residual chlorine, oil and grease, fecal coliform, and fecal streptococcus. The Director may allow or establish appropriate site-specific sampling procedures or requirements, including sampling locations, the season in which the sampling takes place, the minimum duration between the previous measurable storm event and the storm event sampled, the minimum or maximum level of precipitation required for an appropriate storm event, the form of precipitation sampled (snow melt or rain fall), protocols for collecting samples under 40 CFR part 136, and additional time for submitting data on a

case-by-case basis. An applicant is expected to "know or have reason to believe" that a pollutant is present in an effluent based on an evaluation of the expected use, production, or storage of the pollutant, or on any previous analyses for the pollutant. (For example, any pesticide manufactured by a facility may be expected to be present in contaminated storm water runoff from the facility.)

* * * * *

(k) *Application requirements for new sources and new discharges.* New manufacturing, commercial, mining and silvicultural dischargers applying for NPDES permits (except for new discharges of facilities subject to the requirements of paragraph (h) of this section or new discharges of storm water associated with industrial activity which are subject to the requirements of § 122.26(c)(1) and this section (except as provided by § 122.26(c)(1)(ii)) shall provide the following information to the Director, using the application forms provided by the Director:

* * * * *

4. Section 122.22(b) introductory text is revised to read as follows:

§ 122.22 Signatories to permit applications and reports (applicable to State programs, see § 123.25).

* * * * *

(b) All reports required by permits, and other information requested by the Director shall be signed by a person described in paragraph (a) of this section, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

* * * * *

5. Section 122.26 is revised to read as follows:

§ 122.26 Storm water discharges (applicable to State NPDES programs, see § 123.25).

(a) *Permit requirement.* (1) Prior to October 1, 1992, discharges composed entirely of storm water shall not be required to obtain a NPDES permit except:

(i) A discharge with respect to which a permit has been issued prior to February 4, 1987;

(ii) A discharge associated with industrial activity (see § 122.26(a)(4));

(iii) A discharge from a large municipal separate storm sewer system;

(iv) A discharge from a medium municipal separate storm sewer system;

(v) A discharge which the Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines to contribute to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States. This designation may include a discharge from any conveyance or system of conveyances used for collecting and conveying storm water runoff or a system of discharges from municipal separate storm sewers, except for those discharges from conveyances which do not require a permit under paragraph (a)(2) of this section or agricultural storm water runoff which is exempted from the definition of point source at § 122.2. The Director may designate discharges from municipal separate storm sewers on a system-wide or jurisdiction-wide basis. In making this determination the Director may consider the following factors:

(A) The location of the discharge with respect to waters of the United States as defined at 40 CFR 122.2.

(B) The size of the discharge;

(C) The quantity and nature of the pollutants discharged to waters of the United States; and

(D) Other relevant factors.

(2) The Director may not require a permit for discharges of storm water runoff from mining operations or oil and gas exploration, production, processing or treatment operations or transmission facilities, composed entirely of flows which are from conveyances or systems of conveyances (including but not limited to pipes, conduits, ditches, and channels) used for collecting and conveying precipitation runoff and which are not contaminated by contact with or that has not come into contact with, any overburden, raw material, intermediate products, finished product, byproduct or waste products located on the site of such operations.

(3) *Large and medium municipal separate storm sewer systems.* (i) Permits must be obtained for all discharges from large and medium municipal separate storm sewer systems.

(ii) The Director may either issue one system-wide permit covering all discharges from municipal separate storm sewers within a large or medium municipal storm sewer system or issue distinct permits for appropriate categories of discharges within a large or medium municipal separate storm sewer system including, but not limited to: all discharges owned or operated by the same municipality; located within the same jurisdiction; all discharges within a system that discharge to the same watershed; discharges within a system that are similar in nature; or for individual discharges from municipal separate storm sewers within the system.

(iii) The operator of a discharge from a municipal separate storm sewer which is part of a large or medium municipal separate storm sewer system must either:

(A) Participate in a permit application (to be a permittee or a co-permittee) with one or more other operators of discharges from the large or medium municipal storm sewer system which covers all, or a portion of all, discharges from the municipal separate storm sewer system;

(B) Submit a distinct permit application which only covers discharges from the municipal separate storm sewers for which the operator is responsible; or

(C) A regional authority may be responsible for submitting a permit application under the following guidelines:

(*1*) The regional authority together with co-applicants shall have authority over a storm water management program that is in existence, or shall be in existence at the time part 1 of the application is due;

(*2*) The permit applicant or co-applicants shall establish their ability to make a timely submission of part 1 and part 2 of the municipal application;

(*3*) Each of the operators of municipal separate storm sewers within the systems described in paragraphs (b)(4) (i), (ii), and (iii) or (b)(7) (i), (ii), and (iii) of this section, that are under the purview of the designated regional authority, shall comply with the application requirements of paragraph (d) of this section.

(iv) One permit application may be submitted for all or a portion of all municipal separate storm sewers within adjacent or interconnected large or medium municipal separate storm sewer systems. The Director may issue one system-wide permit covering all, or a portion of all municipal separate storm sewers in adjacent or interconnected large or medium municipal separate storm sewer systems.

(v) Permits for all or a portion of all discharges from large or medium municipal separate storm sewer systems that are issued on a system-wide, jurisdiction-wide, watershed or other basis may specify different conditions relating to different discharges covered by the permit, including different management programs for different drainage areas which contribute storm water to the system.

(vi) Co-permittees need only comply with permit conditions relating to discharges from the municipal separate storm sewers for which they are operators.

(4) *Discharges through large and medium municipal separate storm sewer systems.* In addition to meeting the requirements of paragraph (c) of this section, an operator of a storm water discharge associated with industrial activity which discharges through a large or medium municipal separate storm sewer system shall submit, to the operator of the municipal separate storm sewer system receiving the discharge no later than May 15, 1991, or 180 days prior to commencing such discharge: the name of the facility; a contact person and phone number; the location of the discharge; a description, including Standard Industrial Classification, which best reflects the principal products or services provided by each facility; and any existing NPDES permit number.

(5) *Other municipal separate storm sewers.* The Director may issue permits for municipal separate storm sewers that are designated under paragraph (a)(1)(v) of this section on a system-wide basis, jurisdiction-wide basis, watershed basis or other appropriate basis, or may issue permits for individual discharges.

(6) *Non-municipal separate storm sewers.* For storm water discharges associated with industrial activity from point sources which discharge through a non-municipal or non-publicly owned separate storm sewer system, the Director, in his discretion, may issue: a single NPDES permit, with each discharger a co-permittee to a permit issued to the operator of the portion of the system that discharges into waters of the United States; or, individual permits to each discharger of storm water associated with industrial activity through the non-municipal conveyance system.

(i) All storm water discharges associated with industrial activity that discharge through a storm water discharge system that is not a municipal separate storm sewer must be covered by an individual permit, or a permit issued to the operator of the portion of the system that discharges to waters of the United States, with each discharger to the non-municipal conveyance a co-permittee to that permit.

(ii) Where there is more than one operator of a single system of such conveyances, all operators of storm water discharges associated with industrial activity must submit applications.

(iii) Any permit covering more than one operator shall identify the effluent limitations, or other permit conditions, if any, that apply to each operator.

(7) *Combined sewer systems.* Conveyances that discharge storm water runoff combined with municipal sewage are point sources that must obtain NPDES permits in accordance with the procedures of § 122.21 and are not subject to the provisions of this section.

(8) Whether a discharge from a municipal separate storm sewer is or is not subject to regulation under this section shall have no bearing on whether the owner or operator of the discharge is eligible for funding under title II, title III or title VI of the Clean Water Act. *See* 40 CFR part 35, subpart I, appendix A(b)H.2.j.

(b) *Definitions.* (1) *Co-permittee* means a permittee to a NPDES permit that is only responsible for permit conditions relating to the discharge for which it is operator.

(2) *Illicit discharge* means any discharge to a municipal separate storm sewer that is not composed entirely of storm water except discharges pursuant to a NPDES permit (other than the NPDES permit for discharges from the municipal separate storm sewer) and discharges resulting from fire fighting activities.

(3) *Incorporated place* means the District of Columbia, or a city, town, township, or village that is incorporated under the laws of the State in which it is located.

(4) *Large municipal separate storm sewer system* means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 250,000 or more as determined by the latest Decennial Census by the Bureau of Census (appendix F); or

(ii) Located in the counties listed in appendix H, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraph (b)(4) (i) or (ii) of this section and that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraph (b)(4) (i) or (ii) of this section. In making this determination the Director may consider the following factors:

(A) Physical interconnections between the municipal separate storm sewers;

(B) The location of discharges from the designated municipal separate storm sewer relative to discharges from municipal separate storm sewers described in paragraph (b)(4)(i) of this section;

(C) The quantity and nature of pollutants discharged to waters of the United States;

(D) The nature of the receiving waters; and

(E) Other relevant factors; or

(iv) The Director may, upon petition, designate as a large municipal separate storm sewer system, municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraph (b)(4) (i), (ii), (iii) of this section.

(5) *Major municipal separate storm sewer outfall* (or "major outfall") means a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of more than 50 acres); or for municipal separate storm sewers that receive storm water from lands zoned for industrial activity (based on comprehensive zoning plans or the equivalent), an outfall that discharges from a single pipe with an inside diameter of 12 inches or more or from its equivalent (discharge from other than a circular pipe associated with a drainage area of 2 acres or more).

(6) *Major outfall* means a major municipal separate storm sewer outfall.

(7) *Medium municipal separate storm sewer system* means all municipal separate storm sewers that are either:

(i) Located in an incorporated place with a population of 100,000 or more but less than 250,000, as determined by the latest Decennial Census by the Bureau of Census (appendix G); or

(ii) Located in the counties listed in appendix I, except municipal separate storm sewers that are located in the incorporated places, townships or towns within such counties; or

(iii) Owned or operated by a municipality other than those described in paragraph (b)(4) (i) or (ii) of this section and that are designated by the Director as part of the large or medium municipal separate storm sewer system due to the interrelationship between the discharges of the designated storm sewer and the discharges from municipal separate storm sewers described under paragraph (b)(4) (i) or (ii) of this section. In making this determination the Director may consider the following factors:

(A) Physical interconnections between the municipal separate storm sewers;

(B) The location of discharges from the designated municipal separate storm sewer relative to discharges from municipal separate storm sewers described in paragraph (b)(7)(i) of this section;

(C) The quantity and nature of pollutants discharged to waters of the United States;

(D) The nature of the receiving waters; or

(E) Other relevant factors; or

(iv) The Director may, upon petition, designate as a medium municipal separate storm sewer system, municipal separate storm sewers located within the boundaries of a region defined by a storm water management regional authority based on a jurisdictional, watershed, or other appropriate basis that includes one or more of the systems described in paragraphs (b)(7) (i), (ii), (iii) of this section.

(8) *Municipal separate storm sewer* means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

(i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to waters of the United States;

(ii) Designed or used for collecting or conveying storm water;

(iii) Which is not a combined sewer; and

(iv) Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

(9) *Outfall* means a *point source* as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the United States and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States.

(10) *Overburden* means any material of any nature, consolidated or unconsolidated, that overlies a mineral deposit, excluding topsoil or similar naturally-occurring surface materials that are not disturbed by mining operations.

(11) *Runoff coefficient* means the fraction of total rainfall that will appear at a conveyance as runoff.

(12) *Significant materials* includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under section 101(14) of CERCLA; any chemical the facility is required to report pursuant to section 313 of title III of SARA; fertilizers; pesticides; and waste products such as ashes, slag and sludge that have the potential to be released with storm water discharges.

(13) *Storm water* means storm water runoff, snow melt runoff, and surface runoff and drainage.

(14) *Storm water discharge associated with industrial activity* means the discharge from any conveyance which is used for collecting and conveying storm water and which is directly related to manufacturing, processing or raw materials storage areas at an industrial plant. The term does not include discharges from facilities or activities excluded from the NPDES program under 40 CFR part 122. For the categories of industries identified in paragraphs (b)(14) (i) through (x) of this section, the term includes, but is not limited to, storm water discharges from industrial plant yards; immediate access roads and rail lines used or traveled by carriers of raw materials, manufactured products, waste material, or by-products used or created by the facility; material handling sites; refuse sites; sites used for the application or disposal of process waste waters (as defined at 40 CFR part 401); sites used for the storage and maintenance of material handling equipment; sites used for residual treatment, storage, or disposal; shipping and receiving areas; manufacturing buildings; storage areas (including tank farms) for raw materials, and intermediate and finished products; and areas where industrial activity has taken place in the past and significant materials remain and are exposed to storm water. For the categories of industries identified in paragraph (b)(14)(xi) of this section, the term includes only storm water discharges from all the areas (except access roads and rail lines) that are listed in the previous sentence where material handling equipment or activities, raw materials, intermediate products, final products, waste materials, by-products, or industrial machinery are exposed to storm water. For the purposes of this paragraph, material handling activities include the storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, finished product, by-product or waste product. The term excludes areas located on plant lands separate from the plant's industrial activities, such as office buildings and accompanying parking lots as long as the drainage from the excluded areas is not mixed with storm water drained from the above described areas. Industrial facilities (including industrial facilities that are Federally, State, or municipally owned or operated that meet the description of the facilities listed in this paragraph (b)(14)(i)–(xi) of this section) include those facilities designated under the provisions of paragraph (a)(1)(v) of this section. The following categories of facilities are considered to be engaging in "industrial activity" for purposes of this subsection:

(i) Facilities subject to storm water effluent limitations guidelines, new source performance standards, or toxic pollutant effluent standards under 40 CFR subchapter N (except facilities with toxic pollutant effluent standards which are exempted under category (xi) in paragraph (b)(14) of this section);

(ii) Facilities classified as Standard Industrial Classifications 24 (except 2434), 26 (except 265 and 267), 28 (except 283), 29, 311, 32 (except 323), 33, 3441, 373;

(iii) Facilities classified as Standard Industrial Classifications 10 through 14 (mineral industry) including active or inactive mining operations (except for areas of coal mining operations no longer meeting the definition of a reclamation area under 40 CFR 434.11(1) because the performance bond issued to the facility by the appropriate SMCRA authority has been released, or except for areas of non-coal mining operations which have been released from applicable State or Federal reclamation requirements after December 17, 1990) and oil and gas exploration, production, processing, or treatment operations, or transmission facilities that discharge storm water contaminated by contact with or that has come into contact with, any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations; (inactive mining operations are mining sites that are not being actively mined, but which have an identifiable owner/operator; inactive mining sites do not include sites where mining claims are being maintained prior to disturbances associated with the extraction, beneficiation, or processing of mined materials, nor sites where minimal activities are undertaken for the sole purpose of maintaining a mining claim);

(iv) Hazardous waste treatment, storage, or disposal facilities, including those that are operating under interim status or a permit under subtitle C of RCRA;

(v) Landfills, land application sites, and open dumps that receive or have received any industrial wastes (waste that is received from any of the facilities described under this subsection) including those that are subject to regulation under subtitle D of RCRA;

(vi) Facilities involved in the recycling of materials, including metal scrapyards, battery reclaimers, salvage yards, and automobile junkyards, including but limited to those classified as Standard Industrial Classification 5015 and 5093;

(vii) Steam electric power generating facilities, including coal handling sites;

(viii) Transportation facilities classified as Standard Industrial Classifications 40, 41, 42 (except 4221-25), 43, 44, 45, and 5171 which have vehicle maintenance shops, equipment cleaning operations, or airport deicing operations. Only those portions of the facility that are either involved in vehicle maintenance (including vehicle rehabilitation, mechanical repairs, painting, fueling, and lubrication), equipment cleaning operations, airport deicing operations, or which are otherwise identified under paragraphs (b)(14) (i)-(vii) or (ix)-(xi) of this section are associated with industrial activity;

(ix) Treatment works treating domestic sewage or any other sewage sludge or wastewater treatment device or system, used in the storage treatment, recycling, and reclamation of municipal or domestic sewage, including land dedicated to the disposal of sewage sludge that are located within the confines of the facility, with a design flow of 1.0 mgd or more, or required to have an approved pretreatment program under 40 CFR part 403. Not included are farm lands, domestic gardens or lands used for sludge management where sludge is beneficially reused and which are not physically located in the confines of the facility, or areas that are in compliance with section 405 of the CWA;

(x) Construction activity including clearing, grading and excavation activities except: operations that result in the disturbance of less than five acres of total land area which are not part of a larger common plan of development or sale;

(xi) Facilities under Standard Industrial Classifications 20, 21, 22, 23, 2434, 25, 265, 267, 27, 283, 285, 30, 31 (except 311), 323, 34 (except 3441), 35, 36, 37 (except 373), 38, 39, 4221-25, (and which are not otherwise included within categories (ii)-(x));

(c) *Application requirements for storm water discharges associated with industrial activity*—(1) *Individual application.* Dischargers of storm water associated with industrial activity are required to apply for an individual permit, apply for a permit through a group application, or seek coverage under a promulgated storm water general permit. Facilities that are required to obtain an individual permit, or any discharge of storm water which the Director is evaluating for designation (*see* 40 CFR 124.52(c)) under paragraph (a)(1)(v) of this section and is not a municipal separate storm sewer, and which is not part of a group application described under paragraph (c)(2) of this section, shall submit an NPDES application in accordance with the requirements of § 122.21 as modified and supplemented by the provisions of the remainder of this paragraph. Applicants for discharges composed entirely of storm water shall submit Form 1 and Form 2F. Applicants for discharges composed of storm water and non-storm water shall submit Form 1, Form 2C, and Form 2F. Applicants for new sources or new discharges (as defined in § 122.2 of this part) composed of storm water and non-storm water shall submit Form 1, Form 2D, and Form 2F.

(i) Except as provided in § 122.26(c)(1)(ii)-(iv), the operator of a storm water discharge associated with industrial activity subject to this section shall provide:

(A) A site map showing topography (or indicating the outline of drainage areas served by the outfall(s) covered in the application if a topographic map is unavailable) of the facility including: each of its drainage and discharge structures; the drainage area of each storm water outfall; paved areas and buildings within the drainage area of each storm water outfall, each past or present area used for outdoor storage or disposal of significant materials, each existing structural control measure to reduce pollutants in storm water runoff, materials loading and access areas, areas where pesticides, herbicides, soil conditioners and fertilizers are applied, each of its hazardous waste treatment, storage or disposal facilities (including each area not required to have a RCRA permit which is used for accumulating hazardous waste under 40 CFR 262.34); each well where fluids from the facility are injected underground; springs, and other surface water bodies which receive storm water discharges from the facility;

(B) An estimate of the area of impervious surfaces (including paved areas and building roofs) and the total area drained by each outfall (within a mile radius of the facility) and a narrative description of the following: Significant materials that in the three years prior to the submittal of this application have been treated, stored or disposed in a manner to allow exposure to storm water; method of treatment, storage or disposal of such materials; materials management practices employed, in the three years prior to the submittal of this application, to minimize contact by these materials with storm water runoff; materials loading and access areas; the location, manner and frequency in which pesticides, herbicides, soil conditioners and fertilizers are applied; the location and a description of existing structural and non-structural control measures to reduce pollutants in storm water runoff; and a description of the treatment the storm water receives, including the ultimate disposal of any solid or fluid wastes other than by discharge;

(C) A certification that all outfalls that should contain storm water discharges associated with industrial activity have been tested or evaluated for the presence of non-storm water discharges which are not covered by a NPDES permit; tests for such non-storm water discharges may include smoke tests, fluorometric dye tests, analysis of accurate schematics, as well as other appropriate tests. The certification shall include a description of the method used, the date of any testing, and the on-site drainage points that were directly observed during a test;

(D) Existing information regarding significant leaks or spills of toxic or hazardous pollutants at the facility that have taken place within the three years prior to the submittal of this application;

(E) Quantitative data based on samples collected during storm events and collected in accordance with § 122.21 of this part from all outfalls containing a storm water discharge associated with industrial activity for the following parameters:

(*1*) Any pollutant limited in an effluent guideline to which the facility is subject;

(*2*) Any pollutant listed in the facility's NPDES permit for its process wastewater (if the facility is operating under an existing NPDES permit);

(*3*) Oil and grease, pH, BOD5, COD, TSS, total phosphorus, total Kjeldahl nitrogen, and nitrate plus nitrite nitrogen;

(*4*) Any information on the discharge required under paragraph § 122.21(g)(7)(iii) and (iv) of this part;

(*5*) Flow measurements or estimates of the flow rate, and the total amount of discharge for the storm event(s) sampled, and the method of flow measurement or estimation; and

(*6*) The date and duration (in hours) of the storm event(s) sampled, rainfall measurements or estimates of the storm event (in inches) which generated the sampled runoff and the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event (in hours);

(F) Operators of a discharge which is composed entirely of storm water are exempt from the requirements of § 122.21 (g)(2), (g)(3), (g)(4), (g)(5), (g)(7)(i), (g)(7)(ii), and (g)(7)(v); and

(G) Operators of new sources or new discharges (as defined in § 122.2 of this part) which are composed in part or entirely of storm water must include estimates for the pollutants or parameters listed in paragraph (c)(1)(i)(E) of this section instead of actual sampling data, along with the source of each estimate. Operators of new sources or new discharges composed in part or entirely of storm water must provide quantitative data for the parameters listed in paragraph (c)(1)(i)(E) of this section within two years after commencement of discharge, unless such data has already been reported under the monitoring requirements of the NPDES permit for the discharge. Operators of a new source or new discharge which is composed entirely of storm water are exempt from the requirements of § 122.21 (k)(3)(ii), (k)(3)(iii), and (k)(5).

(ii) The operator of an existing or new storm water discharge that is associated with industrial activity solely under paragraph (b)(14)(x) of this section, is exempt from the requirements of § 122.21(g) and paragraph (c)(1)(i) of this section. Such operator shall provide a narrative description of:

(A) The location (including a map) and the nature of the construction activity;

(B) The total area of the site and the area of the site that is expected to undergo excavation during the life of the permit;

(C) Proposed measures, including best management practices, to control pollutants in storm water discharges during construction, including a brief description of applicable State and local erosion and sediment control requirements;

(D) Proposed measures to control pollutants in storm water discharges that will occur after construction ope ations have been completed, incl .ding a brief description of applicable State or local erosion and sediment control requirements;

(E) An estimate of the runoff coefficient of the site and the increase in impervious area after the construction addressed in the permit application is completed, the nature of fill material and existing data describing the soil or the quality of the discharge; and

(F) The name of the receiving water.

(iii) The operator of an existing or new discharge composed entirely of storm water from an oil or gas exploration, production, processing, or treatment operation, or transmission facility is not required to submit a permit application in accordance with paragraph (c)(1)(i) of this section, unless the facility:

(A) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR 117.21 or 40 CFR 302.6 at anytime since November 16, 1987; or

(B) Has had a discharge of storm water resulting in the discharge of a reportable quantity for which notification is or was required pursuant to 40 CFR 110.6 at any time since November 16, 1987; or

(C) Contributes to a violation of a water quality standard.

(iv) The operator of an existing or new discharge composed entirely of storm water from a mining operation is not required to submit a permit application unless the discharge has come into contact with, any overburden, raw material, intermediate products, finished product, byproduct or waste products located on the site of such operations.

(v) Applicants shall provide such other information the Director may reasonably require under § 122.21(g)(13) of this part to determine whether to issue a permit and may require any facility subject to paragraph (c)(1)(ii) of this section to comply with paragraph (c)(1)(i) of this section.

(2) *Group application for discharges associated with industrial activity.* In lieu of individual applications or notice of intent to be covered by a general permit for storm water discharges associated with industrial activity, a group application may be filed by an entity representing a group of applicants (except facilities that have existing individual NPDES permits for storm water) that are part of the same subcategory (*see* 40 CFR subchapter N, part 405 to 471) or, where such grouping is inapplicable, are sufficiently similar as to be appropriate for general permit coverage under § 122.28 of this part. The part 1 application shall be submitted to the Office of Water Enforcement and Permits, U.S. EPA, 401 M Street, SW., Washington, DC 20460 (EN-336) for approval. Once a part 1 application is approved, group applicants are to submit Part 2 of the group application to the Office of Water Enforcement and Permits. A group application shall consist of:

(i) *Part 1.* Part 1 of a group application shall:

(A) Identify the participants in the group application by name and location. Facilities participating in the group application shall be listed in nine subdivisions, based on the facility location relative to the nine precipitation zones indicated in appendix E to this part.

(B) Include a narrative description summarizing the industrial activities of participants of the group application and explaining why the participants, as a whole, are sufficiently similar to be a covered by a general permit;

(C) Include a list of significant materials stored exposed to precipitation by participants in the group application and materials management practices employed to diminish contact by these materials with precipitation and storm water runoff;

(D) Identify ten percent of the dischargers participating in the group application (with a minimum of 10 dischargers, and either a minimum of two dischargers from each precipitation zone indicated in appendix E of this part in which ten or more members of the group are located, or one discharger from each precipitation zone indicated in appendix E of this part in which nine or fewer members of the group are located) from which quantitative data will be submitted in part 2. If more than 1,000 facilities are identified in a group application, no more than 100 dischargers must submit quantitative data in Part 2. Groups of between four and ten dischargers may be formed. However, in groups of between four ano ten, at least half the facilities must submit quantitative data, and at least one facility in each precipitation zone in which members of the group are located must submit data. A description of why the facilities selected to perform sampling and analysis are representative of the group as a whole in terms of the information provided in paragraph (c)(1) (i)(B) and (i)(C) of this section, shall accompany this section. Different factors impacting the nature of the storm water discharges, such as processes used and material management, shall be represented, to the extent feasible, in a manner roughly equivalent to their proportion in the group.

(ii) *Part 2.* Part 2 of a group application shall contain quantitative data (NPDES Form 2F), as modified by paragraph (c)(1) of this section, so that when part 1 and part 2 of the group application are taken together, a complete NPDES application (Form 1, Form 2C, and Form 2F) can be evaluated for each discharger identified in paragraph (c)(2)(i)(D) of this section.

(d) *Application requirements for large and medium municipal separate storm sewer discharges.* The operator of a discharge from a large or medium municipal separate storm sewer or a municipal separate storm sewer that is designated by the Director under paragraph (a)(1)(v) of this section, may submit a jurisdiction-wide or system-wide permit application. Where more than one public entity owns or operates a municipal separate storm sewer within a geographic area (including adjacent or interconnected municipal separate storm sewer systems), such operators may be a coapplicant to the same application. Permit applications for discharges from large and medium municipal storm sewers or municipal storm sewers designated under paragraph (a)(1)(v) of this section shall include:

(1) *Part 1.* Part 1 of the application shall consist of:

(i) *General information.* The applicants' name, address, telephone number of contact person, ownership status and status as a State or local government entity.

(ii) *Legal authority.* A description of existing legal authority to control discharges to the municipal separate storm sewer system. When existing legal authority is not sufficient to meet the criteria provided in paragraph (d)(2)(i) of this section, the description shall list additional authorities as will be necessary to meet the criteria and shall include a schedule and commitment to seek such additional authority that will be needed to meet the criteria.

(iii) *Source identification.* (A) A description of the historic use of ordinances, guidance or other controls which limited the discharge of non-storm water discharges to any Publicly Owned Treatment Works serving the same area as the municipal separate storm sewer system.

(B) A USGS 7.5 minute topographic map (or equivalent topographic map with a scale between 1:10,000 and 1:24,000 if cost effective) extending one mile beyond the service boundaries of the municipal storm sewer system covered by the permit application. The following information shall be provided:

(*1*) The location of known municipal storm sewer system outfalls discharging to waters of the United States;

(*2*) A description of the land use activities (e.g. divisions indicating undeveloped, residential, commercial, agricultural and industrial uses) accompanied with estimates of population densities and projected growth for a ten year period within the drainage area served by the separate storm sewer. For each land use type, an estimate of an average runoff coefficient shall be provided;

(*3*) The location and a description of the activities of the facility of each currently operating or closed municipal landfill or other treatment, storage or disposal facility for municipal waste;

(*4*) The location and the permit number of any known discharge to the municipal storm sewer that has been issued a NPDES permit;

(*5*) The location of major structural controls for storm water discharge (retention basins, detention basins, major infiltration devices, etc.); and

(*6*) The identification of publicly owned parks, recreational areas, and other open lands.

(iv) *Discharge characterization.* (A) Monthly mean rain and snow fall estimates (or summary of weather bureau data) and the monthly average number of storm events.

(B) Existing quantitative data describing the volume and quality of discharges from the municipal storm sewer, including a description of the outfalls sampled, sampling procedures and analytical methods used.

(C) A list of water bodies that receive discharges from the municipal separate storm sewer system, including downstream segments, lakes and estuaries, where pollutants from the system discharges may accumulate and cause water degradation and a brief description of known water quality impacts. At a minimum, the description of impacts shall include a description of whether the water bodies receiving such discharges have been:

(*1*) Assessed and reported in section 305(b) reports submitted by the State, the basis for the assessment (evaluated or monitored), a summary of designated use support and attainment of Clean Water Act (CWA) goals (fishable and swimmable waters), and causes of nonsupport of designated uses;

(*2*) Listed under section 304(l)(1)(A)(i), section 304(l)(1)(A)(ii), or section 304(l)(1)(B) of the CWA that is not expected to meet water quality standards or water quality goals;

(*3*) Listed in State Nonpoint Source Assessments required by section 319(a) of the CWA that, without additional action to control nonpoint sources of pollution, cannot reasonably be expected to attain or maintain water quality standards due to storm sewers, construction, highway maintenance and runoff from municipal landfills and municipal sludge adding significant pollution (or contributing to a violation of water quality standards);

(*4*) Identified and classified according to eutrophic condition of publicly owned lakes listed in State reports required under section 314(a) of the CWA (include the following: A description of those publicly owned lakes for which uses are known to be impaired; a description of procedures, processes and methods to control the discharge of pollutants from municipal separate storm sewers into such lakes; and a description of methods and procedures to restore the quality of such lakes);

(*5*) Areas of concern of the Great Lakes identified by the International Joint Commission;

(*6*) Designated estuaries under the National Estuary Program under section 320 of the CWA;

(*7*) Recognized by the applicant as highly valued or sensitive waters;

(*8*) Defined by the State or U.S. Fish and Wildlife Services's National Wetlands Inventory as wetlands; and

(*9*) Found to have pollutants in bottom sediments, fish tissue or biosurvey data.

(D) *Field screening.* Results of a field screening analysis for illicit connections and illegal dumping for either selected field screening points or major outfalls covered in the permit application. At a minimum, a screening analysis shall include a narrative description, for either each field screening point or major outfall, of visual observations made during dry weather periods. If any flow is observed, two grab samples shall be collected during a 24 hour period with a minimum period of four hours between samples. For all such samples, a narrative description of the color, odor, turbidity, the presence of an oil sheen or surface scum as well as any other relevant observations regarding the potential presence of non-storm water discharges or illegal dumping shall be provided. In addition, a narrative description of the results of a field analysis using suitable methods to estimate pH, total chlorine, total copper, total phenol, and detergents (or surfactants) shall be provided along with a description of the flow rate. Where the field analysis does not involve analytical methods approved under 40 CFR part 136, the applicant shall provide a description of the method used including the name of the manufacturer of the test method along with the range and accuracy of the test. Field screening points shall be either major outfalls or other outfall points (or any other point of access such as manholes) randomly located throughout the storm sewer system by placing a grid over a drainage system map and identifying those cells of the grid which contain a segment of the storm sewer system or major outfall. The field screening points shall be established using the following guidelines and criteria:

(*1*) A grid system consisting of perpendicular north-south and east-west lines spaced ¼ mile apart shall be overlayed on a map of the municipal storm sewer system, creating a series of cells;

(*2*) All cells that contain a segment of the storm sewer system shall be identified; one field screening point shall be selected in each cell; major outfalls may be used as field screening points;

(*3*) Field screening points should be located downstream of any sources of suspected illegal or illicit activity;

(*4*) Field screening points shall be located to the degree practicable at the farthest manhole or other accessible location downstream in the system, within each cell; however, safety of personnel and accessibility of the location should be considered in making this determination;

(*5*) Hydrological conditions; total drainage area of the site; population density of the site; traffic density; age of the structures or buildings in the area; history of the area; and land use types;

(*6*) For medium municipal separate storm sewer systems, no more than 250 cells need to have identified field screening points; in large municipal separate storm sewer systems, no more than 500 cells need to have identified field screening points; cells established by the grid that contain no storm sewer segments will be eliminated from consideration; if fewer than 250 cells in medium municipal sewers are created, and fewer than 500 in large systems are created by the overlay on the municipal sewer map, then all those cells which contain a segment of the sewer system shall be subject to field screening (unless access to the separate storm sewer system is impossible); and

(*7*) Large or medium municipal separate storm sewer systems which are unable to utilize the procedures described in paragraphs (d)(1)(iv)(D) (*1*) through (*6*) of this section, because a sufficiently detailed map of the separate storm sewer systems is unavailable, shall field screen no more than 500 or 250 major outfalls respectively (or all major outfalls in the system, if less); in such circumstances, the applicant shall establish a grid system consisting of north-south and east-west lines spaced ¼ mile apart as an overlay to the boundaries of the municipal storm sewer system, thereby creating a series of cells; the applicant will then select major outfalls in as many cells as possible until at least 500 major outfalls (large municipalities) or 250 major outfalls (medium municipalities) are selected; a field screening analysis shall be undertaken at these major outfalls.

(E) *Characterization plan.* Information and a proposed program to meet the requirements of paragraph (d)(2)(iii) of this section. Such description shall include: the location of outfalls or field screening points appropriate for representative data collection under paragraph (d)(2)(iii)(A) of this section, a description of why the outfall or field screening point is representative, the seasons during which sampling is intended, a description of the sampling equipment. The proposed location of outfalls or field screening points for such sampling should reflect water quality concerns (*see* paragraph (d)(1)(iv)(C) of this section) to the extent practicable.

(v) *Management programs.* (A) A description of the existing management programs to control pollutants from the municipal separate storm sewer system. The description shall provide information on existing structural and source controls, including operation and maintenance measures for structural controls, that are currently being implemented. Such controls may include, but are not limited to: Procedures to control pollution resulting from construction activities; floodplain management controls; wetland protection measures; best management practices for new subdivisions; and emergency spill response programs. The description may address controls established under State law as well as local requirements.

(B) A description of the existing program to identify illicit connections to the municipal storm sewer system. The description should include inspection procedures and methods for detecting and preventing illicit discharges, and describe areas where this program has been implemented.

(vi) *Fiscal resources.* (A) A description of the financial resources currently available to the municipality to complete part 2 of the permit application. A description of the municipality's budget for existing storm water programs, including an overview of the municipality's financial resources and budget, including overall indebtedness and assets, and sources of funds for storm water programs.

(2) *Part 2.* Part 2 of the application shall consist of:

(i) *Adequate legal authority.* A demonstration that the applicant can operate pursuant to legal authority established by statute, ordinance or series of contracts which authorizes or enables the applicant at a minimum to:

(A) Control through ordinance, permit, contract, order or similar means, the contribution of pollutants to the municipal storm sewer by storm water discharges associated with industrial activity and the quality of storm water discharged from sites of industrial activity;

(B) Prohibit through ordinance, order or similar means, illicit discharges to the municipal separate storm sewer;

(C) Control through ordinance, order or similar means the discharge to a municipal separate storm sewer of spills, dumping or disposal of materials other than storm water;

(D) Control through interagency agreements among coapplicants the contribution of pollutants from one portion of the municipal system to another portion of the municipal system;

(E) Require compliance with conditions in ordinances, permits, contracts or orders; and

(F) Carry out all inspection, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions including the prohibition on illicit discharges to the municipal separate storm sewer.

(ii) *Source identification.* The location of any major outfall that discharges to waters of the United States that was not reported under paragraph (d)(1)(iii)(B)(*1*) of this section. Provide an inventory, organized by watershed of the name and address, and a description (such as SIC codes) which best reflects the principal products or services provided by each facility which may discharge, to the municipal separate storm sewer, storm water associated with industrial activity;

(iii) *Characterization data.* When "quantitative data" for a pollutant are required under paragraph (d)(a)(iii)(A)(*3*) of this paragraph, the applicant must collect a sample of effluent in accordance with 40 CFR 122.21(g)(7) and analyze it for the pollutant in accordance with analytical methods approved under 40 CFR part 136. When no analytical method is approved the applicant may use any suitable method but must provide a description of the method. The applicant must provide information characterizing the quality and quantity of discharges covered in the permit application, including:

(A) Quantitative data from representative outfalls designated by the Director (based on information received in part 1 of the application, the Director shall designate between five and ten outfalls or field screening points as representative of the commercial, residential and industrial land use activities of the drainage area contributing to the system or, where there are less than five outfalls covered in the application, the Director shall designate all outfalls) developed as follows:

(*1*) For each outfall or field screening point designated under this subparagraph, samples shall be collected of storm water discharges from three storm events occurring at least one month apart in accordance with the requirements at § 122.21(g)(7) (the Director may allow exemptions to sampling three storm events when climatic conditions create good cause for such exemptions);

(*2*) A narrative description shall be provided of the date and duration of the storm event(s) sampled, rainfall estimates of the storm event which generated the sampled discharge and the duration between the storm event sampled and the end of the previous measurable (greater than 0.1 inch rainfall) storm event;

(*3*) For samples collected and described under paragraphs (d)(2)(iii)(A)(*1*) and (A)(*2*) of this section, quantitative data shall be provided for: the organic pollutants listed in Table II; the pollutants listed in Table III (toxic metals, cyanide, and total phenols) of appendix D of 40 CFR part 122, and for the following pollutants:

Total suspended solids (TSS)
Total dissolved solids (TDS)
COD
BOD_5
Oil and grease
Fecal coliform
Fecal streptococcus
pH
Total Kjeldahl nitrogen
Nitrate plus nitrite
Dissolved phosphorus
Total ammonia plus organic nitrogen
Total phosphorus

(*4*) Additional limited quantitative data required by the Director for determining permit conditions (the Director may require that quantitative data shall be provided for additional parameters, and may establish sampling conditions such as the location, season of sample collection, form of precipitation (snow melt, rainfall) and other parameters necessary to insure representativeness);

(B) Estimates of the annual pollutant load of the cumulative discharges to waters of the United States from all identified municipal outfalls and the event mean concentration of the cumulative discharges to waters of the United States from all identified municipal outfalls during a storm event (as described under § 122.21(c)(7)) for BOD_5, COD, TSS, dissolved solids, total nitrogen, total ammonia plus organic nitrogen, total phosphorus, dissolved phosphorus, cadmium, copper, lead, and zinc. Estimates shall be accompanied by a description of the procedures for estimating constituent loads and concentrations, including any modelling, data analysis, and calculation methods;

(C) A proposed schedule to provide estimates for each major outfall identified in either paragraph (d)(2)(ii) or (d)(1)(iii)(B)(*1*) of this section of the seasonal pollutant load and of the event mean concentration of a representative storm for any constituent detected in any sample required under paragraph (d)(2)(iii)(A) of this section; and

(D) A proposed monitoring program for representative data collection for the term of the permit that describes the location of outfalls or field screening points to be sampled (or the location of instream stations), why the location is representative, the frequency of sampling, parameters to be sampled, and a description of sampling equipment.

(iv) *Proposed management program.* A proposed management program covers the duration of the permit. It shall include a comprehensive planning process which involves public participation and where necessary intergovernmental coordination, to reduce the discharge of pollutants to the maximum extent practicable using management practices, control techniques and system, design and engineering methods, and such other provisions which are appropriate. The program shall also include a description of staff and equipment available to implement the program. Separate proposed programs may be submitted by each coapplicant. Proposed programs may impose controls on a systemwide basis, a watershed basis, a jurisdiction basis, or on individual outfalls. Proposed programs will be considered by the Director when developing permit conditions to reduce pollutants in discharges to the maximum extent practicable. Proposed management programs shall describe priorities for implementing controls. Such programs shall be based on:

(A) A description of structural and source control measures to reduce pollutants from runoff from commercial and residential areas that are discharged from the municipal storm sewer system that are to be implemented during the life of the permit, accompanied with an estimate of the expected reduction of pollutant loads and a proposed schedule for implementing such controls. At a minimum, the description shall include:

(*1*) A description of maintenance activities and a maintenance schedule for structural controls to reduce pollutants (including floatables) in discharges from municipal separate storm sewers;

(*2*) A description of planning procedures including a comprehensive master plan to develop, implement and enforce controls to reduce the discharge of pollutants from municipal separate storm sewers which receive discharges from areas of new development and significant redevelopment. Such plan shall address controls to reduce pollutants in discharges from municipal separate storm sewers after construction is completed. (Controls to reduce pollutants in discharges from municipal separate storm sewers containing construction site runoff are addressed in paragraph (d)(2)(iv)(D) of this section;

(*3*) A description of practices for operating and maintaining public streets, roads and highways and procedures for reducing the impact on receiving waters of discharges from municipal storm sewer systems, including pollutants discharged as a result of deicing activities;

(*4*) A description of procedures to assure that flood management projects assess the impacts on the water quality of receiving water bodies and that existing structural flood control devices have been evaluated to determine if retrofitting the device to provide additional pollutant removal from storm water is feasible;

(*5*) A description of a program to monitor pollutants in runoff from operating or closed municipal landfills or other treatment, storage or disposal facilities for municipal waste, which shall identify priorities and procedures for inspections and establishing and implementing control measures for such discharges (this program can be coordinated with the program developed under paragraph (d)(2)(iv)(C) of this section); and

(*6*) A description of a program to reduce to the maximum extent practicable, pollutants in discharges from municipal separate storm sewers associated with the application of pesticides, herbicides and fertilizer which will include, as appropriate, controls such as educational activities, permits, certifications and other measures for commercial applicators and distributors, and controls for application in public right-of-ways and at municipal facilities.

(B) A description of a program, including a schedule, to detect and remove (or require the discharger to the municipal separate storm sewer to obtain a separate NPDES permit for) illicit discharges and improper disposal into the storm sewer. The proposed program shall include:

(*1*) A description of a program, including inspections, to implement and enforce an ordinance, orders or similar means to prevent illicit discharges to the municipal separate storm sewer system; this program description shall address all types of illicit discharges, however the following category of non-storm water discharges or flows shall be addressed where such discharges are identified by the municipality as sources of pollutants to waters of the United States: water line flushing, landscape irrigation, diverted stream flows, rising ground waters, uncontaminated ground water infiltration (as defined at 40 CFR 35.2005(20)) to separate storm sewers, uncomtaminated pumped ground water, discharges from potable water sources, foundation drains, air conditioning condensation, irrigation water, springs, water from crawl space pumps, footing drains, lawn watering, individual residential car washing, flows from riparian habitats and wetlands, dechlorinated swimming pool discharges, and street wash water (program descriptions shall address discharges or flows from fire fighting only where such discharges or flows are identified as significant sources of pollutants to waters of the United States);

(*2*) A description of procedures to conduct on-going field screening activities during the life of the permit, including areas or locations that will be evaluated by such field screens;

(*3*) A description of procedures to be followed to investigate portions of the separate storm sewer system that, based on the results of the field screen, or other appropriate information, indicate a reasonable potential of containing illicit discharges or other sources of non-storm water (such procedures may include: sampling procedures for constituents such as fecal coliform, fecal streptococcus, surfactants (MBAS), residual chlorine, fluorides and potassium; testing with fluorometric dyes; or conducting in storm sewer inspections where safety and other considerations allow. Such description shall include the location of storm sewers that have been identified for such evaluation);

(*4*) A description of procedures to prevent, contain, and respond to spills that may discharge into the municipal separate storm sewer;

(*5*) A description of a program to promote, publicize, and facilitate public reporting of the presence of illicit discharges or water quality impacts associated with discharges from municipal separate storm sewers;

(*6*) A description of educational activities, public information activities, and other appropriate activities to facilitate the proper management and disposal of used oil and toxic materials; and

(*7*) A description of controls to limit infiltration of seepage from municipal sanitary sewers to municipal separate storm sewer systems where necessary;

(C) A description of a program to monitor and control pollutants in storm water discharges to municipal systems from municipal landfills, hazardous waste treatment, disposal and recovery facilities, industrial facilities that are subject to section 313 of title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA), and industrial facilities that the municipal permit applicant determines are contributing a substantial pollutant loading to the municipal storm sewer system. The program shall:

(*1*) Identify priorities and procedures for inspections and establishing and implementing control measures for such discharges;

(*2*) Describe a monitoring program for storm water discharges associated with the industrial facilities identified in paragraph (d)(2)(iv)(C) of this section, to be implemented during the term of the permit, including the submission of quantitative data on the following constituents: any pollutants limited in effluent guidelines subcategories, where applicable; any pollutant listed in an existing NPDES permit for a facility; oil and grease, COD, pH, BOD_5, TSS, total phosphorus, total Kjeldahl nitrogen, nitrate plus nitrite nitrogen, and any information on discharges required under 40 CFR 122.21(g)(7) (iii) and (iv).

(D) A description of a program to implement and maintain structural and non-structural best management practices to reduce pollutants in storm water runoff from construction sites to the municipal storm sewer system, which shall include:

(*1*) A description of procedures for site planning which incorporate consideration of potential water quality impacts;

(*2*) A description of requirements for nonstructural and structural best management practices;

(*3*) A description of procedures for identifying priorities for inspecting sites and enforcing control measures which consider the nature of the construction activity, topography, and the characteristics of soils and receiving water quality; and

(*4*) A description of appropriate educational and training measures for construction site operators.

(v) *Assessment of controls.* Estimated reductions in loadings of pollutants from discharges of municipal storm sewer constituents from municipal storm sewer systems expected as the result of the municipal storm water quality management program. The assessment shall also identify known impacts of storm water controls on ground water.

(vi) *Fiscal analysis.* For each fiscal year to be covered by the permit, a fiscal analysis of the necessary capital and operation and maintenance expenditures necessary to accomplish the activities of the programs under paragraphs (d)(2) (iii) and (iv) of this section. Such analysis shall include a description of the source of funds that are proposed to meet the necessary expenditures, including legal restrictions on the use of such funds.

(vii) Where more than one legal entity submits an application, the application shall contain a description of the roles and responsibilities of each legal entity and procedures to ensure effective coordination.

(viii) Where requirements under paragraph (d)(1)(iv)(E), (d)(2)(ii), (d)(2)(iii)(B) and (d)(2)(iv) of this section are not practicable or are not applicable, the Director may exclude any operator of a discharge from a municipal separate storm sewer which is designated under paragraph (a)(1)(v), (b)(4)(ii) or (b)(7)(ii) of this section from such requirements. The Director shall not exclude the operator of a discharge from a municipal separate storm sewer identified in appendix F, G, H or I of part 122, from any of the permit application requirements under this paragraph except where authorized under this section.

(e) *Application deadlines.* Any operator of a point source required to obtain a permit under paragraph (a)(1) of this section that does not have an effective NPDES permit covering its storm water outfalls shall submit an application in accordance with the following deadlines:

(1) For any storm water discharge associated with industrial activity identified in paragraph (b)(14) (i)–(xi) of this section, that is not part of a group application as described in paragraph (c)(2) of this section or which is not covered under a promulgated storm water general permit, a permit application made pursuant to paragraph (c) of this section shall be submitted to the Director by November 18, 1991:

(2) For any group application submitted in accordance with paragraph (c)(2) of this section:

(i) Part 1 of the application shall be submitted to the Director, Office of Water Enforcement and Permits by March 18, 1991;

(ii) Based on information in the part 1 application, the Director will approve or deny the members in the group application within 60 days after receiving part 1 of the group application.

(iii) Part 2 of the application shall be submitted to the Director, Office of Water Enforcement and Permits no later than 12 months after the date of approval of the part 1 application.

(iv) Facilities that are rejected as members of a group by the permitting authority shall have 12 months to file an individual permit application from the date they receive notification of their rejection.

(v) A facility listed under paragraph (b)(14) (i)–(xi) of this section may add on to a group application submitted in accordance with paragraph (e)(2)(i) of this section at the discretion of the Office of Water Enforcement and Permits, and only upon a showing of good cause by the facility and the group applicant; the request for the addition of the facility shall be made no later than February 18,1992; the addition of the facility shall not cause the percentage of the facilities that are required to submit quantitative data to be less than 10%, unless there are over 100 facilities in the group that are submitting quantitative data; approval to become part of group application must be obtained from the group or the trade association representing the individual facilities.

(3) For any discharge from a large municipal separate storm sewer system;

(i) Part 1 of the application shall be submitted to the Director by November 18, 1991;

(ii) Based on information received in the part 1 application the Director will approve or deny a sampling plan under paragraph (d)(1)(iv)(E) of this section within 90 days after receiving the part 1 application;

(iii) Part 2 of the application shall be submitted to the Director by November 16, 1992.

(4) For any discharge from a medium municipal separate storm sewer system;

(i) Part 1 of the application shall be submitted to the Director by May 18, 1992.

(ii) Based on information received in the part 1 application the Director will approve or deny a sampling plan under paragraph (d)(1)(iv)(E) of this section within 90 days after receiving the part 1 application.

(iii) Part 2 of the application shall be submitted to the Director by May 17, 1993.

(5) A permit application shall be submitted to the Director within 60 days of notice, unless permission for a later date is granted by the Director (*see* 40 CFR 124.52(c)), for:

(i) A storm water discharge which the Director, or in States with approved NPDES programs, either the Director or the EPA Regional Administrator, determines that the discharge contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States (see paragraph (a)(1)(v) of this section);

(ii) A storm water discharge subject to paragraph (c)(1)(v) of this section.

(6) Facilities with existing NPDES permits for storm water discharges associated with industrial activity shall maintain existing permits. New applications shall be submitted in accordance with the requirements of 40 CFR 122.21 and 40 CFR 122.26(c) 180 days before the expiration of such permits. Facilities with expired permits or permits due to expire before May 18, 1992, shall submit applications in accordance with the deadline set forth under paragraph (e)(1) of this section.

(f) *Petitions.* (1) Any operator of a municipal separate storm sewer system may petition the Director to require a separate NPDES permit (or a permit issued under an approved NPDES State program) for any discharge into the municipal separate storm sewer system.

(2) Any person may petition the Director to require a NPDES permit for a discharge which is composed entirely of storm water which contributes to a violation of a water quality standard or is a significant contributor of pollutants to waters of the United States.

(3) The owner or operator of a municipal separate storm sewer system may petition the Director to reduce the Census estimates of the population served by such separate system to account for storm water discharged to combined sewers as defined by 40 CFR 35.2005(b)(11) that is treated in a publicly owned treatment works. In municipalities in which combined sewers are operated, the Census estimates of population may be reduced proportional to the fraction, based on estimated lengths, of the length of combined sewers over the sum of the length of combined sewers and municipal separate storm sewers where an applicant has submitted the NPDES permit number associated with each discharge point and a map indicating areas served by combined sewers and the location of any combined sewer overflow discharge point.

(4) Any person may petition the Director for the designation of a large or medium municipal separate storm sewer system as defined by paragraphs (b)(4)(iv) or (b)(7)(iv) of this section.

(5) The Director shall make a final determination on any petition received under this section within 90 days after receiving the petition.

6. Section 122.28(b)(2)(i) is revised to read as follows:

§ 122.28 General permits (applicable to State NPDES programs, see § 123.25).

* * * * *

(b) * * *

(2) *Requiring an individual permit.* (i) The Director may require any discharger authorized by a general permit to apply for and obtain an individual NPDES permit. Any interested person may petition the Director to take action under this paragraph. Cases where an individual NPDES permit may be required include the following:

(A) The discharger or "treatment works treating domestic sewage" is not in compliance with the conditions of the general NPDES permit;

(B) A change has occurred in the availability of demonstrated technology or practices for the control or abatement of pollutants applicable to the point source or treatment works treating domestic sewage;

(C) Effluent limitation guidelines are promulgated for point sources covered by the general NPDES permit;

(D) A Water Quality Management plan containing requirements applicable to such point sources is approved;

(E) Circumstances have changed since the time of the request to be covered so that the discharger is no longer appropriately controlled under the general permit, or either a temporary or permanent reduction or elimination of the authorized discharge is necessary;

(F) Standards for sewage sludge use or disposal have been promulgated for the sludge use and disposal practice covered by the general NPDES permit: or

(G) The discharge(s) is a significant contributor of pollutants. In making this determination, the Director may consider the following factors:

(*1*) The location of the discharge with respect to waters of the United States;

(*2*) The size of the discharge;

(*3*) The quantity and nature of the pollutants discharged to waters of the United States; and

(*4*) Other relevant factors;

* * * * *

7. Section 122.42 is amended by adding paragraph (c) to read as follows:

§ 122.42 Additional conditions applicable to specified categories of NPDES permits (applicable to State NPDES programs, see § 123.25).

* * * * *

(c) *Municipal separate storm sewer systems.* The operator of a large or medium municipal separate storm sewer system or a municipal separate storm sewer that has been designated by the Director under § 122.26(a)(1)(v) of this part must submit an annual report by the anniversary of the date of the issuance of the permit for such system. The report shall include:

(1) The status of implementing the components of the storm water management program that are established as permit conditions;

(2) Proposed changes to the storm water management programs that are established as permit condition. Such proposed changes shall be consistent with § 122.26(d)(2)(iii) of this part; and

(3) Revisions, if necessary, to the assessment of controls and the fiscal analysis reported in the permit application under § 122.26(d)(2)(iv) and (d)(2)(v) of this part;

(4) A summary of data, including monitoring data, that is accumulated throughout the reporting year;

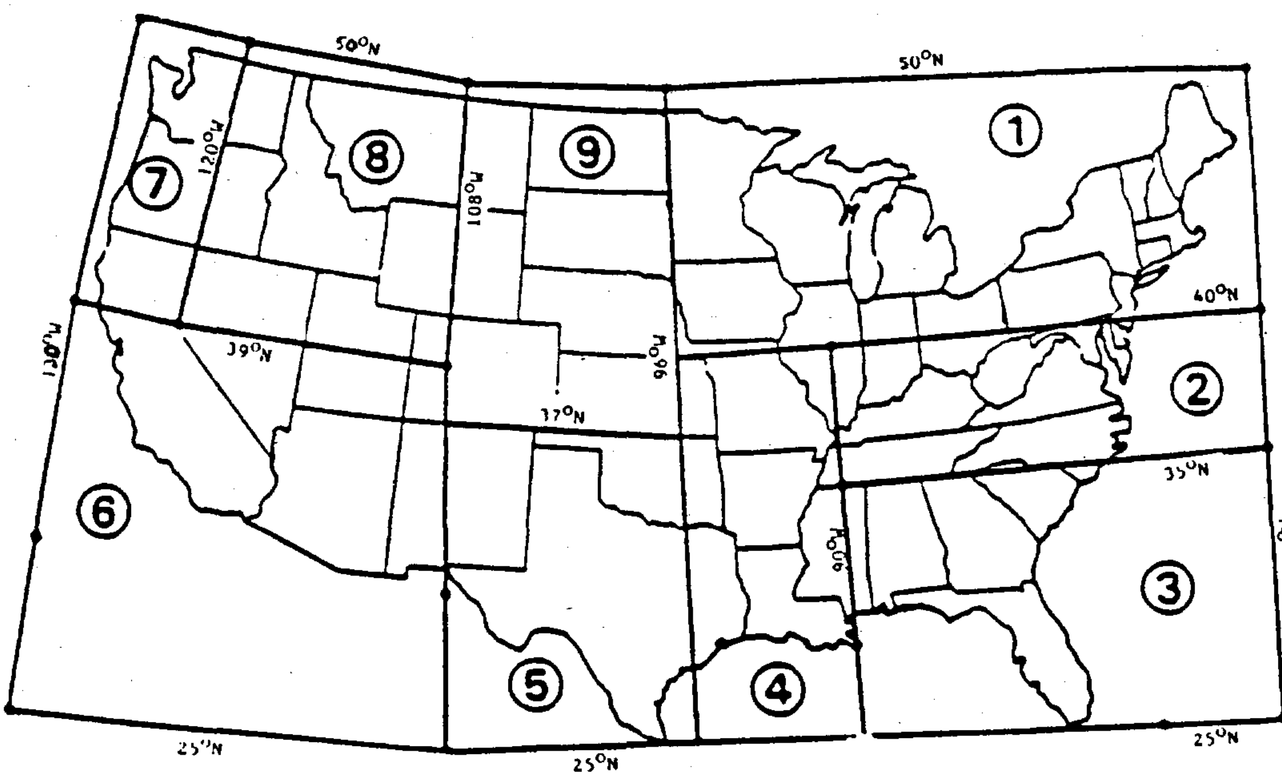
(5) Annual expenditures and budget for year following each annual report;

(6) A summary describing the number and nature of enforcement actions, inspections, and public education programs;

(7) Identification of water quality improvements or degradation;

7a. Part 122 is amended by adding appendices E through I as follows:

Appendix E to Part 122—Rainfall Zones of the United States



Not Shown: Alaska (Zone 7); Hawaii (Zone 7); Northern Mariana Islands (Zone 7); Guam (Zone 7); American Samoa (Zone 7); Trust Territory of the Pacific Islands (Zone 7); Puerto Rico (Zone 3) Virgin Islands (Zone 3).

Source: Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality, prepared for U.S. Environmental Protection Agency, Office of Water, Nonpoint Source Division, Washington, DC, 1986.

Appendix F to Part 122—Incorporated Places With Populations Greater Than 250,000 According to Latest Decennial Census by Bureau of Census.

State	Incorporated place
Alabama	Birmingham.
Arizona	Phoenix.
	Tucson.
California	Long Beach.
	Los Angeles.
	Oakland.
	Sacramento.
	San Diego.
	San Francisco.
	San Jose.
Colorado	Denver.
District of Columbia	
Florida	Jacksonville.
	Miami.
	Tampa.
Georgia	Atlanta.
Illinois	Chicago.
Indiana	Indianapolis.
Kansas	Wichita.
Kentucky	Louisville.
Louisiana	New Orleans.
Maryland	Baltimore.
Massachusetts	Boston.
Michigan	Detroit.
Minnesota	Minneapolis
	St. Paul.

State	Incorporated place
issouri	Kansas City.
	St. Louis.
Nebraska	Omaha.
New Jersey	Newark.
New Mexico	Albuquerque.
New York	Buffalo.
	Bronx Borough.
	Brooklyn Borough.
	Manhattan Borough.
	Queens Borough.
	Staten Island Borough.
North Carolina	Charlotte.
Ohio	Cincinnati.
	Cleveland.
	Columbus.
	Toledo.
Oklahoma	Oklahoma City.
	Tulsa.
Oregon	Portland.
Pennsylvania	Philadelphia.
	Pittsburgh.
Tennessee	Memphis.
	Nashville/Davidson.
Texas	Austin.
	Dallas.
	El Paso.
	Fort Worth.
	Houston.
	San Antonio.
Virginia	Norfolk.
	Virginia Beach.
Washington	Seattle.
Wisconsin	Milwaukee.

Appendix G to Part 122—Incorporated Places With Populations Greater Than 100,000 and Less Than 250,000 According to Latest Decennial Census by Bureau of Census

State	Incorporated place
Alabama	Huntsville.
	Mobile.
	Montgomery.
Alaska	Anchorage.
Arizona	Mesa.
	Tempe.
Arkansas	Little Rock.
California	Anaheim.
	Bakersfield.
	Berkeley.
	Concord.
	Fremont.
	Fresno.
	Fullerton.
	Garden Grove.
	Glendale.
	Huntington Beach.
	Modesto.
	Oxnard.
	Pasadena.
	Riverside.
	San Bernadino.
	Santa Ana.
	Stockton.
	Sunnyvale.
	Torrance.
Colorado	Aurora.
	Colorado Springs.
	Lakewood.
	Pueblo.
Connecticut	Bridgeport.
	Hartford.
	New Haven.
	Stamford.
	Waterbury.
lorida	Fort Lauderdale.

State	Incorporated place
	Hialeah.
	Hollywood.
	Orlando.
	St. Petersburg
Georgia	Columbus.
	Macon.
	Savannah.
Idaho	Boise City.
Illinois	Peoria.
	Rockford.
Indiana	Evansville.
	Fort Wayne.
	Gary.
	South Bend.
Iowa	Cedar Rapids.
	Davenport.
	Des Moines.
Kansas	Kansas City.
	Topeka.
Kentucky	Lexington-Fayette.
Louisiana	Baton Rouge.
	Shreveport.
Massachusetts	Springfield.
	Worcester.
Michigan	Ann Arbor.
	Flint.
	Grand Rapids.
	Lansing.
	Livonia.
	Sterling Heights.
	Warren.
Mississippi	Jackson.
Missouri	Independence.
	Springfield.
Nebraska	Lincoln.
Nevada	Las Vegas.
	Reno.
New Jersey	Elizabeth.
	Jersey City.
	Paterson.
New York	Albany.
	Rochester.
	Syracuse.
	Yonkers.
North Carolina	Durham.
	Greensboro.
	Raleigh.
	Winston-Salem.
Ohio	Akron.
	Dayton.
	Youngstown
Oregon	Eugene.
Pennsylvania	Allentown.
	Erie.
Rhode Island	Providence.
South Carolina	Columbia.
Tennessee	Chattanooga.
	Knoxville.
Texas	Amarillo.
	Arlington.
	Beaumont.
	Corpus Christi.
	Garland.
	Irving.
	Lubbock.
	Pasadena.
	Waco.
Utah	Salt Lake City.
Virginia	Alexandria.
	Chesapeake.
	Hampton.
	Newport News
	Portsmouth.
	Richmond.
	Roanoke.
Washington	Spokane.
	Tacoma.
Wisconsin	Madison.

Appendix H to Part 122—Counties with Unincorporated Urbanized Areas With a Population of 250,000 or More According to the Latest Decennial Census by the Bureau of Census

State	County	Unincorporated urbanized population
California	Los Angeles	912,684
	Sacramento	449,056
	San Diego	304,758
Delaware	New Castle	257,184
Florida	Dade	781,949
Georgia	DeKalb	306,379
Hawaii	Honolulu	688,178
Maryland	Anne Arundel	271,458
	Baltimore	601,308
	Montgomery	447,993
	Prince George's	450,188
Texas	Harris	409,601
Utah	Salt Lake	304,632
Virginia	Fairfax	527,178
Washington	King	336,800

Appendix I to Part 122—Counties With Unincorporated Urbanized Areas Greater Than 100,000, But Less Than 250,000 According to the Latest Decennial Census by the Bureau of Census

State	County	Unincorporated urbanized population
Alabama	Jefferson	102,917
Arizona	Pima	111,479
California	Alameda	187,474
	Contra Costa	158,452
	Kern	117,231
	Orange	210,693
	Riverside	115,719
	San Bernardino	148,644
Florida	Broward	159,370
	Escambia	147,892
	Hillsborough	238,292
	Orange	245,325
	Palm Beach	167,089
	Pinellas	194,389
	Polk	104,150
	Sarasota	110,009
Georgia	Clayton	100,742
	Cobb	204,121
	Richmond	118,529
Kentucky	Jefferson	224,958
Louisiana	Jefferson	140,836
North Carolina	Cumberland	142,727
Nevada	Clark	201,775
Oregon	Multnomah	141,100
	Washington	109,346
South Carolina	Greenville	135,398
	Richland	124,684
Virginia	Arlington	152,599
	Henrico	161,204
	Chesterfield	108,348
Washington	Snohomish	103,493
	Pierce	196,113

PART 123—STATE PROGRAM REQUIREMENTS

8. The authority citation for part 123 continues to read as follows:

Authority: Clean Water Act, 33 U.S.C. 1251 *et seq.*

9. Section 123.25 is amended by revising paragraph (a)(9) to read as follows:

§ 123.25 Requirements for permitting.

(a) * * *

(9) § 122.26—(Storm water discharges);

* * * * *

PART 124—PROCEDURES FOR DECISIONMAKING

10. The authority citation for part 124 continues to read as follows:

Authority: Resource Conservation and Recovery Act, 42 U.S.C. 6901 *et seq.*; Safe Drinking Water Act, 42 U.S.C. 300f *et seq.*; Clean Water Act, 33 U.S.C. 1251 *et seq.*; and Clean Air Act, 42 U.S.C. 1857 *et seq.*

11. Section 124.52 is revised to read as follows:

§ 124.52 Permits required on a case-by-case basis.

(a) Various sections of part 122, subpart B allow the Director to determine, on a case-by-case basis, that certain concentrated animal feeding operations (§ 122.23), concentrated aquatic animal production facilities (§ 122.24), storm water discharges (§ 122.26), and certain other facilities covered by general permits (§ 122.28) that do not generally require an individual permit may be required to obtain an individual permit because of their contributions to water pollution.

(b) Whenever the Regional Administrator decides that an individual permit is required under this section, except as provided in paragraph (c) of this section, the Regional Administrator shall notify the discharger in writing of that decision and the reasons for it, and shall send an application form with the notice. The discharger must apply for a permit under § 122.21 within 60 days of notice, unless permission for a later date is granted by the Regional Administrator. The question whether the designation was proper will remain open for consideration during the public comment period under § 124.11 or § 124.118 and in any subsequent hearing.

(c) Prior to a case-by-case determination that an individual permit is required for a storm water discharge under this section (*see* 40 CFR 122.26 (a)(1)(v) and (c)(1)(v)), the Regional Administrator may require the discharger to submit a permit application or other information regarding the discharge under section 308 of the CWA. In requiring such information, the Regional Administrator shall notify the discharger in writing and shall send an application form with the notice. The discharger must apply for a permit under § 122.26 within 60 days of notice, unless permission for a later date is granted by the Regional Administrator. The question whether the initial designation was proper will remain open for consideration during the public comment period under § 124.11 or § 124.118 and in any subsequent hearing.

Note: The following form will not appear in the Code of Federal Regulations.

BILLING CODE 6560-50-M

APPENDIX B

FEMA FLOOD INSURANCE REGULATIONS
CFR 44, PART 59 THRU 79)

PART 58—[RESERVED]

NATIONAL FLOOD INSURANCE PROGRAM

PART 59—GENERAL PROVISIONS

Subpart A—General

AUTHORITY: Sec. 7(d), 79 Stat. 670; 42 U.S.C. 3535(d); Sec. 1306, 82 Stat. 575; 42 U.S.C. 4013; sec. 1361, 82 Stat. 587; 42 U.S.C. 4102; Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963), unless otherwise noted.

Source: 41 FR 46968, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

Subpart A—General

§59.1 Definitions.

As used in this subchapter—

"Accounting period" means any annual period during which the Agreement is in effect. Each accounting period under the Agreement applies separately to all policies issued under the Program during the time period.

"Act" means the statutes authorizing the National Flood Insurance Program that are incorporated in 42 U.S.C. 4001-4128.

"Actuarial rates"—see "risk premium rates."

"Administrator" means the Federal Insurance Administrator, to whom the Director has delegated the administration of Program (34 FR 2680-81, February 27, 1969, as amended 39 FR 2787, January 24, 1974).

"Affiliates" means two or more associated business concerns which are or can be directly or indirectly controlled by one or more of the affiliates or by a third party.

"Agency" means the Federal Emergency Management Agency, 1725 I Street, NW, Washington DC 20472.

"Agreement" means the contract entered into for the term of any accounting period by and between the Administrator and the Association whereby the Association or its subcontractors will sell policies of flood insurance under the Program within areas designated by the Administrator and will adjust and pay claims for losses arising under such policies. The Agreement is renewed automatically with respect to each subsequent accounting period unless either the Administrator or the Association gives the other written notice of intention to terminate, on or before January 31 of the then current accounting period.

"Applicant" means a community which indicates a desire to participate in the Program.

"Appurtenant Structure" means a structure which is on the same parcel of property as the principal structure to be insured and the use of which is incidental to the use of the principal structure.

"Area of shallow flooding" means a designated A0 or V0 Zone on a community's Flood Insurance Rate Map (FIRM) with base flood depths from one to three feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and indeterminate, and where velocity flow may be evident.

"Area of special flood-related erosion hazard" is the land within a community which is most likely to be subject to severe flood-related erosion losses. The area may be designated as Zone E on the Flood Hazard Boundary Map (FHBM). After the detailed evaluation of the special flood-related erosion hazard area in preparation for publication of the FIRM, Zone E may be further refined.

"Area of special flood hazard" is the land in the flood plain within a community subject to a one percent or greater chance of flooding in any given year. The area may be designated as Zone A on the FHBM. After detailed ratemaking has been completed in preparation for publication of the FIRM, Zone A usually is refined into Zones A, A0, A1-99, V0, and V1-30.

"Area of special mudslide (i.e., mudflow) hazard" is the land within a community most likely to be subject to severe mudslides (i.e., mudflows). The area may be designated as Zone M on the FHBM. After the detailed evaluation of the special mudslide (i.e., mudflow) hazard area in preparation for publication of the FIRM, Zone M may be further refined.

"Association" means the National Flood Insurers Association discussed in Parts 61 and 62 of this subchapter, and is the private insurance industry pool composed of two or more of its members or any member acting for or on behalf of the Association under the Agreement.

Base flood" means the flood having a one percent chance of being equalled or exceeded in any given year.

"Building"—see *"structure."*

"Chargeable rates" mean the rates established by the Administrator pursuant to section 1308 of the Act for first layer limits of flood insurance on existing structures.

"Chief Executive Officer" of the community ("CEO") means the official of the community who is charged with the authority to implement and administer laws, ordinances and regulations for that community.

"Coastal high hazard area" means the area subject to high velocity waters, including but not limited to hurricane wave wash or tsunamis. The area is designated on a FIRM as Zone V1-30.

"Community" means any State or area or political subdivision thereof, or any Indian tribe or authorized tribal organization, or Alaska Native village or authorized native organization, which has authority to adopt and enforce flood plain management regulations for the areas within its jurisdiction.

"Contents coverage" is the insurance on personal property within an enclosed structure, including the cost of debris removal, and the reasonable cost of removal of contents to minimize damage. Personal property may be household goods usual or incidental to residential occupancy, or merchandise, furniture, fixtures, machinery, equipment and supplies usual to other than residential occupancies.

"Criteria" means the comprehensive criteria for land management and use for flood-prone areas developed under 42 U.S.C. 4102 for the purposes set forth in Part 60 of this subchapter.

"Curvilinear Line" means the border on either a FHBM or FIRM that delineates the special flood, mudslide (i.e., mudflow) and/or flood-related erosion hazard areas and consists of a curved or contour line that follows the topography.

"Deductible" means the fixed amount or percentage of any loss covered by insurance which is borne by the insured prior to the insurer's liability.

"Development" means any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations.

"Director" means the Director of the Federal Emergency Management Agency.

Eligible community" or *"participating community"* means a community for which the Administrator has authorized the sale of flood insurance under the National Flood Insurance Program.

"Emergency Flood Insurance Program" or *"emergency program"* means the Program as implemented on an emergency basis in accordance with section 1336 of the Act. It is intended as a program to provide a first layer amount of insurance on all insurable structures before the effective date of the initial FIRM.

"Erosion" means the process of the gradual wearing away of land masses. This peril is not per se covered under the Program.

Exception" means a waiver from the positions of Part 60 of this subchapter directed to a community which relieves it from the requirements of a rule, regulation, order or other determination made or issued pursuant to the Act.

"Existing construction" means for the purposes of determining rates, structures for which the "start of construction" commenced before the effective date of the FIRM or before January 1, 1975, for FIRMs effective before that date. "Existing construction" may also be referred to as "existing structures."

"Existing mobile home park or mobile home subdivision," means a parcel (or contiguous parcels) of land divided into two or more mobile home lots for rent or sale for which the construction of facilities for servicing the lot on which the mobile home is

to be affixed (including, at a minimum, the installation of utilities, either final site grading or the pouring of concrete pads, and the construction of streets) is completed before the effective date of flood plain management regulations adopted by a community.

"*Expansion to an existing mobile home park or mobile home subdivision*" means the preparation of additional sites by the construction of facilities for servicing the lots on which the mobile homes are to be affixed (including the installation of utilities, either final site grading or pouring of concrete pads, or the construction of streets).

"*Existing structures*" see "*existing construction.*"

"*Federal agency*" means any department, agency, corporation, or other entity or instrumentality of the executive branch of the Federal Government, and includes the Federal National Mortgage Association and the Federal Home Loan Mortgage Corporation.

"*Federal instrumentality responsible for the supervision, approval, regulation, or insuring of banks, savings and loan associations, or similar institutions*" means the Board of Governors of the Federal Reserve System, the Federal Deposit Insurance Corporation, the Comptroller of the Currency, the Federal Home Loan Bank Board, the Federal Savings and Loan Insurance Corporation, and the National Credit Union Administration.

"*Financial assistance*" means any form of loan, grant, guaranty, insurance, payment, rebate, subsidy, disaster assistance loan or grant, or any other form of direct or indirect Federal assistance; other than general or special revenue sharing or formula grants made to States.

"*Financial assistance for acquisition or construction purposes*" means any form of financial assistance which is intended in whole or in part for the acquisition, construction, reconstruction, repair, or improvement of any publicly or privately owned building or mobile home, and for any machinery, equipment, fixtures, and furnishings contained or to be contained therein, and shall include the purchase or subsidization of mortgages or mortgage loans but shall exclude assistance pursuant to the Disaster Relief Act of 1974 other than assistance under such Act in connection with a flood. It includes only financial assistance insurable under the Standard Flood Insurance Policy.

"*First-layer coverage*" is the maximum amount of structural and contents insurance coverage available under the Emergency Program.

"*Flood*" or "*Flooding*" means:

(a) A general and temporary condition of partial or complete inundation of normally dry land areas from:

(1) The overflow of inland or tidal waters.

(2) The unusual and rapid accumulation or runoff of surface waters from any source.

(3) Mudslides (i.e., mudflows) which are proximately caused or precipitated by accumulations of water on or under the ground.

(b) The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in (a)(1) of this section.

"*Flood elevation determination*" means a determination by the Administrator of the water surface elevations of the base flood, that is, the flood level that has a one percent or greater chance of occurrence in any given year.

"*Flood elevation study*" means an examination, evaluation and determination of flood hazards and, if appropriate, corresponding water surface elevations, or an examination, evaluation and determination of mudslide (i.e., mudflow) and/or flood-related erosion hazards.

"*Flood Hazard Boundary Map*" (FHBM) means an official map of a community, issued by the Administrator, where the boundaries of the flood, mudslide (i.e., mudflow) related erosion areas having special hazards have been designated as Zone A, M, and/or E.

"*Flood insurance*" means the insurance coverage provided under the Program.

"*Flood Insurance Rate Map*" (FIRM) means an official map of a community, on which the Administrator has delineated both the special hazard areas and the risk premium zones applicable to the community.

"*Flood Insurance Study*" see "*Flood elevation study.*"

"*Flood plain*" or "*flood-prone area*" means any land area susceptible to being inundated by water from any source (see definition of "flooding").

"*Flood plain management*" means the operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to emergency preparedness plans, flood control works and flood plain management regulations.

"*Flood plain management regulations*" means zoning ordinances, subdivision regulations, building codes, health regulations, special purpose ordinances (such as a flood plain ordinance, grading ordinance and erosion control ordinance) and other applications of police power. The term describes such state or local regulations, in any combination thereof, which provide standards for the purpose of flood damage prevention and reduction.

"*Flood protection system*" means those physical structural works for which funds have been authorized, appropriated, and expended and which have been constructed specifically to modify flooding in order to reduce the extent of the area within a community subject to a "special flood hazard" and the extent of the depths of associated flooding. Such a system typically includes hurricane tidal barriers, dams, reservoirs, levees or dikes. These specialized flood modifying works are those constructed in conformance with sound engineering standards.

"*Flood proofing*" means any combination of structural and non-structural additions, changes, or adjustments to structures which reduce or eliminate flood damage to real estate or improved real property, water and sanitary facilities, structures and their contents.

"*Flood-related erosion*" means the collapse or subsidence of land along the shore of a lake or other body of water as a result of undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding.

Flood-related erosion area" or *flood-related erosion prone area*" means a land area adjoining the shore of a lake or other body of water, which due to the composition of the shoreline or bank and high water levels or wind-driven currents, is likely to suffer flood-related erosion damage.

"*Flood-related erosion area management*" means the operation of an overall program of corrective and preventive measures for reducing flood-related erosion damage, including but not limited to emergency preparedness plans, flood-related erosion control works, and flood plain management regulations.

"*Floodway*"—see "*regulatory floodway.*"

"*Floodway encroachment lines*" mean the lines marking the limits of floodways on Federal, State and local flood plain maps.

"*Freeboard*" means a factor of safety usually expressed in feet above a flood level for purposes of flood plain management. "Freeboard" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed.

"*General Counsel*" means the General counsel of the Federal Emergency Management Agency.

"*Habitable Floor*" means any floor usable for living purposes, which includes working, sleeping, eating, cooking or recreation, or a combination thereof. A floor used only for storage purposes is not a "Habitable Floor."

"*Independent scientific body*" means a non-federal technical or scientific organization involved in the study of land use planning, flood plain management, hydrology, geology, geography, or any other related field of study concerned with flooding.

"*Insurance adjustment organization*" means any organization or person engaged in the business of adjusting loss claims arising under the Standard Flood Insurance Policy.

"*Insurance company*" or "*insurer*" means any person or organization authorized to engage in the insurance business under the laws of any State.

"*Mangrove stand*" means an assemblage of mangrove trees which are mostly low trees noted for a copious development of interlacing adventitious roots above the ground and which contain one or more of the following species: Black mangrove (Avicennia Nitida); red mangrove (Rhizophora Mangle); white mangrove (Languncularia Racemosa); and buttonwood (Conocarpus Erecta).

"Map" means the Flood Hazard Boundary Map (FHBM) or the Flood Insurance Rate map (FIRM) for a community issued by the Federal Insurance Administration.

"Mean sea level" means the average height of the sea for all stages of the tide.

"Mobile home" means a structure, transportable in one or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. It does not include recreational vehicles or travel trailers. The term includes, but it is not limited to, the definition of "mobile home" as set forth in regulations governing the Mobile Home Safety and Construction Standards Program (24 CFR 3282.7(a)).

"Mobile home park or mobile home subdivision"—see "existing mobile home park or mobile home subdivision" or *"new mobile home park or mobile home subdivision."*

"Mudslide" (i.e., mudflow) describes a condition where there is a river, flow or inundation of liquid mud down a hillside usually as a result of a dual condition of loss of brush cover, and the subsequent accumulation of water on or under the ground preceded by a period of unusually heavy or sustained rain. A mudslide (i.e., mudflow) may occur as a distinct phenomenon while a landslide is in progress, and will be recognized as such by the Administrator only if the mudflow, and not the landslide, is the proximate cause of damage that occurs.

"Mudslide (i.e., mudflow) prone area" means an area with land surfaces and slopes of unconsolidated material where the history, geology and climate indicate a potential for mudflow.

"Mudslide (i.e., mudflow) area management" means the operation of an overall program of corrective and preventive measures for reducing mudslide (i.e., mudflow) damage, including but not limited to emergency preparedness plans, mudslide control works, and flood plain management regulations.

"National Flood Insurers Association" is the industry flood insurance pool authorized by the Director in accordance with sections 1331 and 1332 of the Act (see "Agreement" and "Association") (42 U.S.C. 4051-4052). The Association headquarters are currently located at 1755 South Jefferson Davis Highway, Suite 1102, Arlington, Virginia 22202 (703) 920-8830.

"New construction" means, for the purpose of determining insurance rates, structures for which the "start of construction" commenced on or after the effective date of an initial FIRM or after December 31, 1974, whichever is later. For flood plain management purposes, "new construction" means structures for which the "start of construction" commenced on or after the effective date of a flood plain management regulation adopted by a community.

"New mobile home park or mobile home subdivision" means a parcel (or contiguous parcels) of land divided into two or more mobile home lots for rent or sale for which the construction of facilities for servicing the lot on which the mobile home is to be affixed (including at a minimum, the installation of utilities, either final site grading or the pouring of concrete pads, and the construction of streets) is completed on or after the effective date of flood plain management regulations adopted by a community.

"100-year flood" see "base flood."

"Participating community," also known as an "eligible community," means a community in which the Administrator has authorized the sale of flood insurance.

"Person" includes any individual or group of individuals, corporation, partnership, association, or any other entity, including State and local governments and agencies.

"Policy" means the Standard Flood Insurance Policy.

"Premium" means the total premium payable by the insured for the coverage or coverages provided under the policy. The calculation of the premium may be based upon either chargeable rates or risk premium rates, or a combination of both.

"Principally above ground" means that at least 51 percent of the actual cash value of the structure, less land value, is above ground.

"Program" means the National Flood Insurance Program authorized by 42 U.S.C. 4001-4128.

"Project cost" means the total financial cost of a flood protection system (including design, land acquisition, construction, fees, overhead, and profits), unless the Federal Insurance Administrator determines a given "cost" not to be a part of such project cost.

"Regular Program" means the Program authorized by the Act under which risk premium rates are required for the first half of available coverage (also known as "first layer" coverage) for all new construction and substantial improvements started on or after the effective date of the FIRM, or after December 31, 1974, for FIRM's effective on or before that date. All buildings, the construction of which started before the effective date of the FIRM, or before January 1, 1975, for FIRMs effective before that date, are eligible for first layer coverage at either subsidized rates or risk premium rates, whichever are lower. Regardless of date of construction, risk premium rates are always required for the second layer coverage and such coverage is offered only after the Administrator has completed a risk study for the community.

"Regulatory floodway" means the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

"Risk premium rates" mean those rates established by the Administrator pursuant to individual community studies and investigations which are undertaken to provide flood insurance in accordance with Section 1307 of the Act and the accepted actuarial principles. "Risk premium rates" include provisions for operating costs and allowances.

"Riverine" means relating to, formed by, or resembling a river (including tributaries), stream, brook, etc.

"Sand dunes" mean naturally occurring accumulations of sand in ridges or mounds landward of the beach.

"Second layer coverage" means an additional limit of coverage equal to the amounts made available under the Emergency Program, and made available under the Regular Program only where authorized by the Administrator.

"Servicing company" means a corporation, partnership, association, or any other organized entity which subcontracts with the National Flood Insurers Association to service insurance policies under the National Flood Insurance Program for a particular area.

"Sheet flow area"—see "area of shallow flooding."

"Special Hazard Area" means an area having special flood, mudslide (i.e., mudflow) and/or flood-related erosion hazards, and shown on a FHBM or FIRM as Zone, A, A0, A1-99, V0, V1-30, M or E.

"Standard Flood Insurance Policy" means the flood insurance policy issued by the National Flood Insurers Association pursuant to Federal statutes and regulations.

"Start of construction" means the first placement of permanent construction of a structure (other than a mobile home) on a site, such as the pouring of slabs or footings or any work beyond the stage of excavation. Permanent construction does not include land preparation, such as clearing, grading, and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for a basement, footings, piers or foundations or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not as part of the main structure. For a structure (other than a mobile home) without a basement or poured footings, the "start of construction" includes the first permanent framing or assembly of the structure or any part thereof on its piling or foundation. For mobile homes not within a mobile home park or mobile home subdivision, "start of construction" means the affixing of the mobile home to its permanent site. For mobile homes within mobile home parks or mobile home subdivisions, "start of construction" is the date on which the construction of facilities for servicing the site on which the mobile home is to be affixed (including, at a minimum, the construction of streets, either final site grading or the pouring of concrete pads, and installation of utilities) is completed.

"State" means any State, the District of Columbia, the territories and possessions of the United States, the Commonwealth of Puerto Rico, and the Trust Territory of the Pacific Islands.

"State coordinating agency" means the agency of the state government, or other office designated by the Governor of the state or by state statute at the request of the Administrator to assist in the implementation of the National Flood Insurance Program in that state.

"*Storm cellar*" means a space below grade used to accommodate occupants of the structure and emergency supplies as a means of temporary shelter against severe tornado or similar wind storm activity.

"*Structure*" means, for flood plain management purposes, a walled and roofed building, including a gas or liquid storage tank, that is principally above ground, as well as a mobile home. "Structure" for insurance coverage purposes, means a walled and roofed building, other than a gas or liquid storage tank, that is principally above ground and affixed to a permanent site, as well as a mobile home on foundation. For the latter purpose, the term includes a building while in the course of construction, alteration or repair, but does not include building materials or supplies intended for use in such construction, alteration or repair, unless such materials or supplies are within an enclosed building on the premises.

"*Subsidized rates*" mean the rates established by the Administrator involving in the aggregate a subsidization by the Federal Government.

"*Substantial improvement*" means any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure either, (a) before the improvement or repair is started, or (b) if the structure has been damaged, and is being restored, before the damage occurred. For the purposes of this definition "substantial improvement" is considered to occur when the first alteration of any wall, ceiling, floor, or other structural part of the building commences, whether or not that alteration affects the external dimensions of the structure. The term does not, however, include either (1) any project for improvement of a structure to comply with existing state or local health, sanitary, or safety code specifications which are solely necessary to assure safe-living conditions or (2) any alteration of a structure listed on the National Register of Historic Places or a State Inventory of Historic Places.

"*Variance*" means a grant of relief by a community from the terms of a flood plain management regulation.

"*Water surface elevation*" means the projected heights in relation to Mean Sea Level reached by floods of various magnitudes and frequencies in the flood plains of coastal or reverine areas.

(National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4128); and Secretary's delegation of authority to Federal Insurance Administrator, 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))

[41 FR 46968, Oct. 26, 1976, as amended at 43 FR 7140, Feb. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979]

§59.2 Description of program.

(a) The National Flood Insurance Act of 1968 was enacted by Title XIII of the Housing and Urban Development Act of 1968 (Pub. L. 90-448, August 1, 1968) to provide previously unavailable flood insurance protection to property owners in flood-prone areas. Mudslide (as defined in §59.1) protection was added to the Program by the Housing and Urban development Act of 1969 (Pub. L. 91-152, December 24, 1969). Flood-related erosion (as defined in §59.1) protection was added to he Program by the Flood Disaster Protection Act of 1973 (Pub. L. 93-234, December 31, 1973). The Flood Disaster Protection Act of 1973 requires the purchase of flood insurance on and after March 2, 1974, as a condition of receiving any form of Federal or federally-related financial assistance for acquisition or construction purposes with respect to insurable buildings and mobile homes within an identified special flood, mudslide (i.e., mudflow), or flood-related erosion hazard area that is located within any community participating in the Program. The Act also requires that on and after July 1, 1975, or one year after a community has been formally notified by the Administrator of its identification as a community containing one or more special flood, mudslide (i.e., mudflow), or flood-related erosion hazard areas, no such Federal financial assistance, shall be provided within such an area unless the community in which the area is located is then participating in the Program, subject to certain exceptions. See FIA published Guidelines at §59.4(c).

(b) To qualify for the sale of federally-subsidized flood insurance a community must adopt and submit to he Administrator as part of its application, flood plain management regulations, satisfying at a minimum the criteria set forth at Part 60 of this subchapter, designed to reduce or avoid future flood, mudslide (i.e., mudflow) or flood-related erosion damages. These regulations must include effective enforcement provisions.

(c) Minimum requirements for adequate flood plain management regulations are set forth in §60.3 for floodprone areas, in §60.4 for mudslide (i.e., mudflow) areas and in §60.5 for flood-related erosion areas. Those applicable requirements and standards are based on the amount of technical information available to the community.

(National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4123); and Secretary's delegation of authority to Federal Insurance Administrator, 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))

(41 FR 46968, Oct. 26, 1976, as amended at 43 FR 7140, Feb. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979]

§59.3 Emergency program.

The 1968 Act required a risk study to be undertaken for each community before it could become eligible for the sale of flood insurance. Since this requirement resulted in a delay in providing insurance, the Congress, in section 408 of the Housing and Urban Development Act of 1969 (Pub. L. 91-152, December 24, 1969), established an Emergency Flood Insurance Program as a new Section 1336 of the National Flood Insurance Act (42 U.S.C. 4056) to permit the early sale of insurance in flood-prone communities. The emergency program, which under existing law extends to September 30, 1978, does not affect the requirement that a community must adopt adequate flood plain management regulations pursuant to Part 60 of this subchapter but permits insurance to be sold before a study is conducted to determine risk premium rates for the community. The program still requires upon the effective date of a FIRM the charging of risk premium rates for all new construction and substantial improvements and or higher limits of coverage for existing structures.

(National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4128); and Secretary's delegation of authority to Federal Insurance Administrator, 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))

[43 FR 7140, Feb. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979]

§59.4 References.

(a) The following are statutory references for the National Flood Insurance Program, under which these regulations are issued:

(1) National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), Pub. L. 90-448, approved August 1, 1968, 42 U.S.C. 4001 et seq.

(2) Housing and Urban Development Act of 1969 (Pub. L. 91-152, approved December 24, 1969).

(3) Flood Disaster Protection Act of 1973 (87 Stat. 980), Pub. L. 93-234, approved December 31, 1973.

(4) Section 816 of the Housing and Community Development Act of 1974 (87 Stat. 975), Pub. L. 93-383, approved August 22, 1974.

(5) Pub. L. 5-128 (effective October 12, 1977).

(6) The above statutes are included in 42 U.S.C. 4001 et seq.

(b) The following are references relevant to the National Flood Insurance Program:

(1) Executive Order 11988 (Flood-plain Management, dated May 24, 1977 (42 FR 26951, May 25, 1977)).

(2) The Flood Control Act of 1960 (Pub. L. 86-645).

(3) Title II, section 314 of Title III and section 406 of Title IV of the Disaster Relief Act of 1974 (Pub. L. 93-288).

(4) Coastal Zone Management Act (Pub. L. 92-583), as amended Pub. L. 94-370.

(5) Water Resources Planning Act (Pub. L. 89-90), as amended Pub L. 94-112 (October 16, 1975).

(6) Title I, National Environmental Policy Act (Pub. L. 91-190).

(7) Land and Water Conservation Fund Act (Pub. L. 89-578), and subsequent amendments thereto.

(8) Water Resources Council, Principals and Standards for Planning, Water and Related Land Resources (38 FR 24778-24869, September 10, 1973).

(9) Executive Order 11593 (Protection and Enhancement of the Cultural Environment), dated May 13, 1971 (36 FR 8921, May 15, 1971).

(10) 89th Cong., 2nd Session, H.D. 465.

(11) Required land use element for comprehensive planning assistance under section 701 of the Housing Act of 1954, as amended by the Housing and Community Development Act of 1974 (24 CFR §600.72).

(12) Executive Order 11990 (Protection of Wetlands, dated May 24, 1977 (42 FR 26951, May 25, 1977)).

(13) Water Resources Council (Guidance for Floodplain Management) (42 FR 52590, September 30, 1977).

(14) Unified National Program for Floodplain Management of the United States Water Resources Council, July 1976.

(c) The following reference guidelines represent the views of the Federal Insurance Administration with respect to the mandatory purchase of flood insurance under section102 of the Flood Disaster Protection Act of 1973: Mandatory Purchase of Flood Insurance Guidelines (39 FR 26186-26193, July 17, 1974; 40 FR 16710, April 14, 1975; 40 FR 54277-54278, November 21, 1975; and 41 FR 2426, January 16, 1976).

(National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4128); and Secretary's delegation of authority to Federal Insurance Administrator, 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))

[41 FR 46968, Oct. 26, 1976, as amended at 43 FR 7140, Feb. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979]

Subpart B—Eligibility Requirements

§59.21 Purpose of subpart.

This subpart lists actions that must be taken by a community to become eligible and to remain eligible for the Program.

§59.22 Prerequisites for the sale of flood insurance.

(a) To qualify for flood insurance availability a community shall apply for the entire area within its jurisdiction, and shall submit:

(1) Copies of legislative and executive actions indicating a local need for flood insurance and an explicit desire to participate in the National Flood Insurance Program;

(2) Citations to State and local statutes and ordinances authorizing actions regulating land use and copies of the local laws and regulations cited;

(3) A copy of the flood plain management regulations the community has adopted to meet the requirements of §§60.3, 60.4 and/or §60.5 of this subchapter. This submission shall include copies of any zoning, building, and subdivision regulations, health codes, special purpose ordinances (such as a flood plain ordinance, grading ordinance, or flood-related erosion control ordinance), and any other corrective and preventive measures enacted to reduce or prevent flood, mudslide (i.e., mudflow) or flood-related erosion damage;

(4) A list of the incorporated communities within the applicant's boundaries;

(5) Estimates relating to the community as a whole and to the flood, mudslide (i.e., mudflow) and flood-related erosion prone areas concerning:

(i) Population;

(ii) Number of one to four family residences;

(iii) Number of small businesses; and

(iv) Number of all other structures.

(6) Address of a local repository, such as a municipal building, where the Flood Hazard Boundary Maps (FHBM's) and Flood Insurance Rate Maps (FIRM's) will be made available for public inspection;

(7) A summary of any State or Federal activities with respect to flood plain, mudslide (i.e., mudflow) or flood-related erosion area management within the community, such as federally-funded flood control projects and State-administered flood plain management regulations;

(8) A commitment to recognize and duly evaluate flood, mudslide (i.e., mudflow) and/or flood-related erosion hazards in all official actions in the areas having special flood, mudslide (i.e., mudflow) and/or flood-related erosion hazards and to take such other official action reasonably necessary to carry out the objectives of the program; and

(9) A commitment to:

(i) Assist the Administrator at his/her request, in his/her delineation of the limits of the areas having special flood, mudslide (i.e., mudflow) or flood-related erosion hazards;

(ii) Provide such information concerning present uses and occupancy of the flood plain, mudslide (i.e., mudflow) or flood-related erosion areas as the Administrator may request;

(iii) Maintain for public inspection and furnish upon request, for the determination of applicable flood insurance risk premium rates within all areas having special flood hazards identified on a FHBM or FIRM, any certificates of flood-proofing, and information on the elevation (in relation to mean sea level) of the level of the lowest habitable floor (including basement if habitable) of all new or substantially improved structures, and include whether or not such structures contain a basement, and if the structure has been floodproofed, the elevation (in relation to mean sea level) to which the structure was floodproofed;

(iv) Cooperate with Federal, State, and local agencies and private firms which undertake to study, survey, map, and identify flood plain, mudslide (i.e., mudflow) or flood-related erosion areas, and cooperate with neighboring communities with respect to the management of adjoining flood plain, mudslide (i.e., mudflow) and/or flood-related erosion areas in order to prevent aggravation of existing hazards;

(v) Upon occurrence, notify the Administrator in writing whenever the boundaries of the community have been modified by annexation or the community has otherwise assumed or no longer has authority to adopt and enforce flood plain management regulations for a particular area. In order that all FHBM's and FIRM's accurately represent the community's boundaries, include within such notification a copy of a map of the community suitable for reproduction, clearly delineating the new corporate limits or new area for which the community has assumed or relinquished flood plain management regulatory authority.

(b) An applicant shall legislatively:

(1) Appoint or designate the agency or official with the responsibility, authority, and means to implement the commitments made in paragraph (a) of his section, and

(2) Designate the official responsible to submit an annual report to the Administrator concerning the community participation in the Program including, but not limited to the development and implementation of flood plain management regulations and

(3) Utilize annual report form (OMB No. 63-R1546) as follows:

( ) Community ____________ County ____________ State ____________

( ) Responsible Official ____________ ( ) Title ____________ ( ) Telephone ____________

( ) Address ________________________________

Signature ____________ Date ____________

( ) ☐ Please check this box and indicate above any change since your last annual report

1. PHYSICAL CHANGES AND RECENT FLOODING IN YOUR COMMUNITY

a. Boundary Changes. Have your community's corporate limits or boundaries changed since your last annual report? (IF YES, PLEASE ATTACH A NEW MAP SHOWING REVISED COMMUNITY BOUNDARIES). Yes [ ] No [ ]

b. Natural Changes. Have there been any natural or physical changes which would increase or decrease flooding in your community? (e.g., subsidence, pronounced erosion, seismic effects, sedimentation, or debris build-up)? (IF YES, PLEASE ATTACH THE MOST RECENT FIA FLOOD HAZARD MAP AND INDICATE THE EXTENT OF CHANGES AND THE AREAS AFFECTED). Yes [ ] No [ ]

c. Man-Made Changes. Have there been any projects or activities which would increase or decrease flooding in your community (e.g., dams, dikes, levees, bridges, storm sewers, drainage facilities, extensive filling)? (IF YES, PLEASE ATTACH THE MOST RECENT FIA FLOOD HAZARD MAP AND INDICATE THE EXTENT OF THE ACTIVITIES AND THE AREAS AFFECTED). Yes [ ] No [ ]

d. Recent Flooding. Has any flooding occurred in your community since the last annual report? (IF YES, PLEASE ATTACH THE MOST RECENT FIA FLOOD HAZARD MAP SHOWING THE AREAS AFFECTED, AND ON A SEPARATE SHEET INDICATE FOR EACH FLOOD THE OCCURRENCE DATE, WATER ELEVATION, NUMBER OF STRUCTURES DAMAGED AND ESTIMATE THE FINANCIAL DAMAGE). Yes [ ] No [ ]

2. AMENDMENTS TO EXISTING LAWS

Have any amendments relating to floods or flood areas been made to your community's code and/or flood plain management laws since your last annual report? (IF YES, PLEASE ATTACH A CERTIFIED COPY OF THE ADOPTED AMENDMENTS). Yes [ ] No [ ]

3. COORDINATION, STATISTICS, AND ESTIMATES

a. Coordination. Has your community had any problems in coordinating its flood plain management program with adjacent communities? (IF YES, PLEASE ATTACH A SEPARATE SHEET EXPLAINING THE PROBLEMS). Yes [ ] No [ ]

b. Statistics. The following data will serve as an indication of your community's effectiveness in enforcing its flood plain management measures.

	Number Requested	Number Granted
(1.) Construction permits in the flood-prone areas	________	________
(2.) Variances from the 100-year flood elevation requirement	________	________
(3.) Other variances from FIA flood plain management requirements	________	________
(4.) Total variances from all FIA requirements (combined total of = (2) & (3))	________	________
(5.) Of the total variances from all FIA requirements, how many were for structures on lots exceeding 1/2 acre?	________	________

n. Estimates. (Estimate the answers for the following using the best data and sources available):

	Population	No. of 1-4 Family Structures	No. of Small Business Structures	No. of All Other Structures
Estimates of totals in the special flood hazard areas delineated on the FIA Flood Insurance Rate Map (i.e., using all zones except B, C, & D)	______	______	______	______
Estimates of totals in the entire community.	______	______	______	______

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(c) The documents required by paragraph (a) of this section and evidence of the actions required by paragraph (b) of this section shall be submitted to the Federal Insurance Administrator, Federal Emergency Management Agency, 1725 I Street, NW, Washington, DC 20472.

(d) A copy of the documents required by paragraph (a) of this section and evidence of the actions required by paragraph (b) of this section shall be submitted by an applicant to the appropriate State and areawide clearinghouses established in accordance with Part I of OMB Circular No. A-95 (41 FR 2052-2065, January 13, 1976). Clearinghouse review of the documents shall not be a prerequisite to the Administrator's acceptance of a community's application for the availability of flood insurance under the Emergency Program. However, clearinghouses may assist the applicant in assuring maximum consistency with State, regional and local comprehensive plans and flood plain management programs.

§59.23 Priorities for the sale of flood insurance under the regular program.

Flood-prone, mudslide (i.e., mudflow) and flood-related erosion prone communities are placed on a register of areas eligible for ratemaking studies and then selected from this register for ratemaking studies on the basis of the following considerations—

(a) Recommendations of State officials;

(b) Location of community and urgency of need for flood insurance;

(c) Population of community and intensity of existing or proposed development of the flood plain, the mudslide (i.e., mudflow) and the flood-related erosion area;

(d) Availability of information on the community with respect to its flood, mudslide (i.e., mudflow) and flood-related erosion characteristics and previous losses;

(e) Extent of State and local progress in flood plain, mudslide (i.e., mudflow) area and flood-related erosion area management, including adoption of flood plain management regulations consistent with related ongoing programs in the area.

§59.24 Suspension of community eligibility.

(a) A community eligible for the sale of flood insurance shall be subject to suspension from the Program for failing to submit copies of adequate flood plain management regulations meeting the minimum requirements of paragraphs (b), (c), (d) or (e) of §60.3 or paragraph (b) of §60.4 or §60.5, within six months from the date the Administrator provides the data upon which the flood plain regulations for the applicable paragraph shall be based. Where there has not been any submission by the community, the Administrator shall notify the community that 90 days remain in the six month period in order to submit adequate flood plain management regulations. Where there has been an inadequate submission, the Administrator shall notify the community of the specific deficiencies in its submitted flood plain management regulations and inform the community of the amount of time remaining within the six month period. If, subsequently, copies of adequate flood plain management regulations are not received by the Administrator, he shall, no later than 30 days before the expiration of the original six month period, provide written notice to the community and to the state and assure publication in the Federal Register under Part 64 of this subchapter, of the community's loss of eligibility for the sale of flood insurance, such suspension to become effective upon the expiration of the six month period. Should the community remedy the defect and the Administrator receive copies of adequate flood plain management regulations within the notice period, the suspension notice shall be rescinded by the Administrator. If the Administrator receives notice from the State that it has enacted adequate flood plain management regulations for the community within the notice period, the suspension notice shall be rescinded by the Administrator. The community's eligibility shall remain terminated after suspension until copies of adequate flood plain management regulations have been received and approved by the Administrator.

(b) A community eligible for the sale of flood insurance which fails to adequately enforce or repeals its flood plain management regulations meeting the minimum requirements set forth in §§60.3, 60.4 or §60.5 shall be subject to suspension of its Program eligibility. Under such circumstances, the Administrator shall grant the community 30 days in which to show cause why it should not be suspended. The Administrator may conduct a hearing before commencing suspensive action. If a community is to be suspended, the Administrator shall inform it upon 30 days prior written notice and publication in the Federal Register under Part 64 of this subchapter of its loss of eligibility for the sale of flood insurance. In the event of impending suspension, the Administrator shall issue a press release to the local media explaining the reasons and effects of the suspension. The community's eligibility shall only be reinstated by the Administrator upon his receipt of a local legislative or executive measure reaffirming the community's formal intent to adequately enforce the flood plain management regulations adopted in compliance with the requirements of this Subpart, together with evidence of action taken by the community to abrogate, to the maximum extent possible, the action(s) which caused the suspension. In such cases, the Administrator, in order to evaluate the community's performance under the terms of its submission, may either conditionally reinstate the community's eligibility or withhold reinstatement for a period not to exceed one year from the date of his receipt of the submission.

(c) The Administrator shall promptly notify the Association of those communities whose eligibility has been suspended, and the Association shall promptly notify its servicing companies. Flood insurance shall not be sold or renewed in any suspended community until the Association is subsequently notified by the Administrator of the date of the community's formal reinstatement. Policies sold or renewed within a community during a period of ineligibility are deemed to be voidable by the Administrator whether or not the parties to sale or renewal had actual notice of the ineligibility.

PART 60—CRITERIA FOR LAND MANAGEMENT AND USE

Subpart A—Requirements for Flood Plain Management Regulations

Authority: Sec. 7(d), 79 Stat. 670; 42 U.S.C. 3535(d); Sec. 1306, 82 Stat. 575; 42 U.S.C. 4013; Sec. 1361, 82 Stat. 587; 42 U.S.C. 4102; Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 41 FR 46975, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

Subpart A—Requirements for Flood Plain Management Regulations

§60.1 Purpose of subpart.

(a) The Act provides that flood insurance shall not be sold or renewed under the program within a community, unless the community has adopted adequate flood plain management regulations consistent with Federal criteria. Responsibility for establishing such criteria is delegated to the Administrator.

(b) This subpart sets forth the criteria developed in accordance with the Act by which the Administrator will determine the adequacy of a community's flood plain management regulations. These regulations must be legally-enforceable, applied uniformly throughout the community to all privately and publicly owned land within flood-prone, mudslide (i.e., mudflow) or flood-related erosion areas, and the community must provide that the regulations take precedence over any less restrictive conflicting local laws, ordinances or codes. Except as otherwise provided in §60.6, the adequacy of such regulations shall be determined on the basis of the standards set forth in §60.3 for flood-prone areas, §60.4 for mudslide areas and §60.5 for flood-related erosion areas.

(c) Nothing in this subpart shall be construed as modifying or replacing the general requirement that all eligible communities must take into account flood, mudslide (i.e., mudflow) and flood-related erosion hazards, to the extent that they are known, in all official actions relating to land management and use.

(d) The criteria set forth in this subpart are minimum standards for the adoption of flood plain management regulations by flood-prone, mudslide (i.e., mudflow)-prone and flood-related erosion-prone communities. Any community may exceed the minimum criteria under this Part by adopting more comprehensive flood plain management regulations utilizing the standards such as contained in Subpart C of this Part. In some instances, community officials may have access to information or knowledge of conditions that require, particularly for human safety, higher standards than the minimum criteria set forth in Subpart A of this Part. Therefore, any flood plain management regulations adopted by a State or a community which are more restrictive than the criteria set forth in this Part are encouraged and shall take precedence.

§60.2 Minimum compliance with flood plain management criteria.

(a) A flood-prone community applying for flood insurance eligibility shall meet the standards of §60.3(a) in order to become eligible if a FHBM has not been issued for the community at the time of application. Thereafter, the community will be given a period of six months from the date the Administrator provides the data set forth in §60.3 (b), (c), (d), or (e) in which to meet the requirements of the applicable paragraph. If a community has received a FHBM, but has not yet applied for Program eligibility, the community shall apply for eligibility directly under the standards set forth in §60.3(b). Thereafter, the community will be given a period of six months from the date the Administrator provides the data set forth in §60.3 (c), (d), or (e) in which to meet the requirements of the applicable paragraph.

(b) A mudslide (i.e., mudflow)-prone community applying for flood insurance eligibility shall meet the standards of §60.4(a) to become eligible. Thereafter, the community will be given a period of six months from the date the mudslide (i.e., mudflow) areas having special mudslide hazards are delineated in which to meet the requirements of §60.4(b).

(c) A flood-related erosion-prone community applying for flood insurance eligibility shall meet the standards of §60.5(a) to become eligible. Thereafter, the community will be given a period of six months from the date the flood-related erosion areas having special erosion hazards are delineated in which to meet the requirements of §60.5(b).

(d) Communities identified in Part 65 of this subchapter as containing more than one type of hazard (e.g., any combination of special flood, mudslide [i.e., mudflow], and flood-related erosion hazard areas) shall adopt flood plain management regulations for each type of hazard consistent with the requirements of §§60.3, 60.4 and 60.5.

(e) Local flood plain management regulations may be submitted to the State Coordinating Agency designated pursuant to §60.25 for its advice and concurrence. The submission to the State shall clearly describe proposed enforcement procedures.

(f) The community official responsible for submitting annual reports to the Administrator pursuant to §59.22(b)(2) of this subchapter shall also submit copies of each annual report to any State Coordinating Agency.

(g) A community shall assure that its comprehensive plan is consistent with the flood plain management objectives of this Part.

(h) The community shall adopt and enforce flood plain management regulations based on data provided by the Administrator. Without prior approval of the Administrator, the community shall not adopt and enforce flood plain management regulations based upon modified data reflecting natural or man-made physical changes.

(i) The community, upon its receipt of the data set forth in paragraph (c), (d) or (e) of §60.3 or paragraph (b) of §60.4 or §60.5, shall inform the appropriate State and areawide clearinghouse established in accordance with Part I of OMB Circular No. A-95 (41 FR 2052-2065, January 13, 1976), that the community has a period of six months in which to adopt and submit to the Administrator adequate flood plain management regulations. (The clearinghouses are encouraged to assist the community within the six month period in developing such regulations and in assuring regional coordination.) The community shall submit to the appropriate State and areawide clearinghouse, concurrently with its submission to the Administrator, a copy of all adopted flood plain management regulations intended to comply with paragraphs (c), (d) or (e) of §60.3 or paragraph (b) of §60.4 or §60.5. Clearinghouse review, for a period not to exceed sixty days from the date a community submits flood plain management regulations to the clearinghouse, shall be provided prior to the Administrator's action on such regulations. Clearinghouse comments, or a statement by the community that no comments or recommendations have been received from the clearinghouse, should be submitted by the community to the Administrator. However, it may be necessary for the clearinghouse to review the community's regulations within a shorter time period in the event of pending action to suspend the community's Program participation, pursuant to §59.24 of this Subchapter, for failure to adopt adequate flood plain management regulations within the required six months. The Administrator, within seven working days of taking a major action on the community's flood plain management submission, shall provide a copy of his/her disposition concerning the submission to each clearinghouse from which a comment was received.

§60.3 Flood plain management criteria for flood-prone areas.

The Administrator will provide the data upon which flood plain management regulations shall be based. If the Administrator has not provided sufficient data to furnish a basis for these regulations in a particular community, the community shall obtain, review and reasonably utilize data available from other Federal, State or other sources pending receipt of data from the Administrator. However, when special flood hazard area designations and water surface elevations have been furnished by the Administrator, they shall apply. The symbols defining such special flood hazard designations are set forth in §64.3 of this subchapter. In all cases the minimum requirements governing the adequacy of the flood plain management regulations for flood-prone areas adopted by a particular community depend on the amount of technical data formerly provided to the community by the Administrator. Minimum standards for communities are as follows:

(a) When the Administrator has not defined the special flood hazard areas within a community, has not provided water surface elevation data, and has not provided sufficient data to identify the floodway or coastal high hazard area, but the community has indicated the presence of such hazards by submitting an application to participate in the Program, the community shall:

(1) Require permits for all proposed construction or other development in the community, including the placement of mobile homes, so that it may determine whether such construction or other development is proposed within flood-prone areas;

(2) Review proposed development to assure that all necessary permits have been received from those governmental agencies from which approval is required by Federal or State law, including section 404 of the Federal Water Pollution Control Act Amendments of 1972, 33 U.S.C. 1334;

(3) Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding. If a proposed building site is in a flood-prone area, all new construction and substantial improvements (including the placement of prefabricated buildings and mobile homes) shall (i) be designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the structure, (ii) be constructed with materials and utility equipment resistant to flood damage, and (iii) be constructed by methods and practices that minimize flood damage;

(4) Review subdivision proposals and other proposed new development to determine whether such proposals will be reasonably safe from flooding. If a subdivision proposal or other proposed new development is in a flood-prone area, any such proposals shall be reviewed to assure that (i) all such proposals are consistent with the need to minimize flood damage within the flood-prone area, (ii) all public utilities and facilities, such as sewer, gas, electrical, and water systems are located and constructed to minimize or eliminate flood damage, and (iii) adequate drainage is provided to reduce exposure to flood hazards;

(5) Require within flood-prone areas new and replacement water supply systems to be designed to minimize or eliminate infiltration of flood waters into the systems; and

(6) Require within flood-prone areas (i) new and replacement sanitary sewage systems to be designed to minimize or eliminate infiltration of flood waters into the systems and discharges from the systems into flood waters and (ii) onsite waste disposal systems to be located to avoid impairment to them or contamination from them during flooding.

(b) When the Administrator has designated areas of special flood hazards (A zones) by the publication of a community's FHBM, but has neither produced water surface elevation data nor identified a floodway or coastal high hazard area, the community shall:

(1) Require permits for all proposed construction and other developments including the placement of mobile homes, within Zone A on the community's FHBM;

(2) Require the application of the standards in paragraphs (a)(2), (3), (4), (5) and (6) of this section to development within Zone A on the community's FHBM;

(3) Require that all subdivision proposals and other proposed new developments greater than 50 lots or 5 acres, whichever is the lesser, include within such proposals base flood elevation data;

(4) Obtain, review, and reasonably utilize any base flood elevation data available from a Federal, State, or other source, until such other data has been provided by the Administrator, as criteria for requiring that (i) all new construction and substantial improvements of residential structures have the lowest floor (including basement) elevated to or above the base flood level and (ii) all new construction and substantial improvements of nonresidential structures have the lowest floor (including basement) elevated or floodproofed to or above the base flood level;

(5) For the purpose of the determination of applicable flood insurance risk premium rates within Zone A on a community's FHBM, (i) obtain the elevation (in relation to mean sea level) of the lowest habitable floor (including basement) of all new or substantially improved structures, and whether or not such structures contain a basement, (ii) obtain, if the structure has been floodproofed, the elevation (in relation to mean sea level) to which the structure was floodproofed, and (iii) maintain a record of all such information with the official designated by the community under §59.22(a)(9)(iii);

(6) Notify, in riverine situations, adjacent communities and the State Coordinating Office prior to any alteration or relocation of a watercourse, and submit copies of such notifications to the Administrator;

(7) Assure that the flood carrying capacity within the altered or relocated portion of any watercourse is maintained;

(8) Require that all mobile homes to be placed within Zone A on a community's FHBM shall be anchored to resist flotation, collapse, or lateral movement by providing over-the-top and frame ties to ground anchors. Specific requirements shall be that (i) over-the-top ties be provided at each of the four corners of the mobile home, with two additional ties per side at intermediate locations and mobile homes less than 50 feet long requiring one additional tie per side; (ii) frame ties be provided at each corner of the home with five additional ties per side at intermediate points and mobile homes less than 50 feet long requiring four additional ties per side; (iii) all components of the anchoring system be capable of carrying a force of 4,800 pounds; and (iv) any additions to the mobile home be similarly anchored;

(9) Require that an evacuation plan indicating alternate vehicular access and escape routes be filed with appropriate Disaster Preparedness Authorities for mobile home parks and mobile home subdivisions located within Zone A on the community's FHBM.

(c) When the Administrator has provided a notice of final base flood elevations within Zones A1-30 on the community's FIRM and, if appropriate, has designated AO zones A99 zones and unnumbered A zones on the community's FIRM, but has not identified a regulatory floodway or coastal high hazard area, the community shall:

(1) Require the standards of paragraph (b) of this section within all A1-30 zones unnumbered A zones and AO zones, on the community's FIRM;

(2) Require that all new construction and substantial improvements of residential structures within Zones A1-30 on the community's FIRM have the lowest floor (including basement) elevated to or above the base flood level, unless the community is granted an exception by the Administrator for the allowance of basements and/or storm cellars in accordance with §60.6(b)(3) and (b)(4);

(3) Require that all new construction and substantial improvements of nonresidential structures within Zones A1-30 on the community's firm (i) have the lowest floor (including basement) elevated to or above the base flood level or, (ii) together with attendant utility and sanitary facilities, be designed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy;

(4) Provide that where floodproofing is utilized for a particular structure in accordance with paragraphs (c)(3) and (c)(8) of this section or (b)(3) of §60.6 either (i) a registered professional engineer or architect shall certify that the floodproofing methods are adequate to withstand the flood depths, pressures, velocities, impact and uplift forces and other factors associated with the base flood, and a record of such certificates indicating the specific elevation (in relation to mean sea level) to which such structures are floodproofed shall be maintained with the official designated by the community under §59.22(a)(9)(iii); or, (ii) a certified copy of a local regulation containing detailed flood-proofing specifications which satisfy the watertight performance standards of paragraph (c)(3) of this section or (b)(3) of §60.6 shall be submitted to the Administrator for approval;

(5) Require within Zones A1-30 on the community's FIRM for new mobile home parks and mobile home subdivisions, for expansions to existing mobile home parks

and mobile home subdivisions, and for existing mobile home parks and mobile home subdivisions where the repair, reconstruction or improvement of the streets, utilities and pads equals or exceeds 50% of the value of the streets, utilities and pads before the repair, reconstruction or improvement has commenced, that (i) stands or lots are elevated on compacted fill or on pilings so that the lowest floor of the mobile home will be at or above the base flood level, (ii) adequate surface drainage and access for a hauler are provided, and (iii) in the instance of elevation on pilings, lots are large enough to permit steps, piling foundations are placed in stable soil no more than ten feet apart, and reinforcement is provided for pilings more than six feet above the ground level;

(6) Require for all mobile homes to be placed within Zones A1-30 on the community's FIRM, but not into a mobile home park or mobile home subdivision that (i) stands or lots are elevated on compacted fill or on pilings so that the lowest floor of the mobile home will be at or above the base flood level, (ii) adequate surface drainage and access for a hauler are provided, and (iii) in the instance of elevation on pilings, lots are large enough to permit steps, piling foundations are placed in stable soil no more than 10 feet apart, and reinforcement is provided for piers more than six feet above ground level;

(7) Require within any AO zone on the community's FIRM that all new construction and substantial improvements of residential structures have the lowest floor (including basement) elevated above the crown of the nearest street to or above the depth number specified on the community's FIRM;

(8) Require within any AO zone on the community's FIRM that all new construction and substantial improvements of nonresidential structures (i) have the lowest floor (including basement) elevated above the crown of the nearest street to or above the depth number specified on the FIRM, or (ii) together with attendant utility and sanitary facilities be completely flood-proofed to or above that level so that any space below that level is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy;

(9) Require within any A99 zones on a community's FIRM the standards of paragraphs (a)(1) thru (a)(4)(i) and (b)(5) thru (b)(9) of this section;

(10) Require until a regulatory floodway is designated, that no new construction, substantial improvements, or other development (including fill) shall be permitted within Zones A1-30 on the community's FIRM, unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.

(d) When the Administrator has provided a notice of final base flood elevations within Zones A1-30 on the community's FIRM and, if appropriate, has designated AO zones A99 zones and unnumbered A zones on the community's FIRM, and has provided data from which the community shall designate its regulatory floodway, the community shall:

(1) Meet the requirements of paragraphs (c)(1) through (c)(9) of this section;

(2) Select and adopt a regulatory floodway based on the principle that the area chosen for the regulatory floodway must be designed to carry the waters of the base flood, without increasing the water surface elevation of that flood more than one foot at any point;

(3) Prohibit encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway that would result in any increase in flood levels within the community during the occurrence of the base flood discharge;

(4) Prohibit the placement of any mobile homes, except in an existing mobile home park or mobile home subdivision, within the adopted regulatory floodway.

(e) When the Administrator has provided a notice of final base flood elevations within Zones A1-30 on the community's FIRM and, if appropriate, has designated AO zones, A99 zones and unnumbered A zones on the community's FIRM, and has identified on the community's FIRM Zone V1-30 (coastal high hazard area), the community shall:

(1) Meet the requirements of paragraphs (c)(1) through (c)(10) of this section;

(2) For the purpose of the determination of applicable flood insurance risk premium rates within Zone V1-30 on a community's FIRM, (i) obtain the elevation (in relation to mean sea level) of the lowest habitable floor (including basement) of all new or substantially improved structures, and whether or not such structures contain a basement, (ii) obtain, if the structure has been floodproofed, the elevation (in relation to mean sea level) to which the structure was floodproofed, and (iii) maintain a record of all such information with the official designated by the community under § 59.22(a)(9)(iii);

(3) Provide that all new construction within Zones V1-30 on the community's FIRM is located landward of the reach of mean high tide;

(4) Provide (i) that all new construction and substantial improvements within Zones V1-30 on the community's FIRM are elevated on adequately anchored pilings or columns, and securely anchored to such piles or columns so that the lowest portion of the structural members of the lowest floor (excluding the pilings or columns) is elevated to or above the base flood level and (ii) that a registered professional engineer or architect certify that the structure is securely anchored to adequately anchored pilings or columns in order to withstand velocity waters and hurricane wave wash;

(5) Provide that all new construction and substantial improvements within Zones V1-30 on the community's FIRM have the space below the lowest floor free of obstructions or be constructed with "breakaway walls" intended to collapse under stress without jeopardizing the structural support of the structure so that the impact on the structure by abnormally high tides or wind-driven water is minimized. Such temporarily enclosed space shall not be used for human habitation;

(6) Prohibit the use of fill for structural support of buildings within Zones V1-30 on the community's FIRM;

(7) Prohibit the placement of mobile homes, except in existing mobile home parks and mobile home subdivisions, within Zones V1-30 on the community's FIRM;

(8) Prohibit man-made alteration of sand dunes and mangrove stands within Zones V1-30 on the community's FIRM which would increase potential flood damage.

§ 60.4 Flood plain management criteria for mudslide (i.e., mudflow)-prone areas.

The Administrator will provide the data upon which flood plain management regulations shall be based. If the Administrator has not provided sufficient data to furnish a basis for these regulations in a particular community, the community shall obtain, review, and reasonably utilize data available from other Federal, State or other sources pending receipt of data from the Administrator. However, when special mudslide (i.e., mudflow) hazard area designations have been furnished by the Administrator, they shall apply. The symbols defining such special mudslide (i.e., mudflow) hazard designations are set forth in § 64.3 of this subchapter. In all cases, the minimum requirements for mudslide (i.e., mudflow)-prone areas adopted by a particular community depend on the amount of technical data provided to the community by the Administrator. Minimum standards for communities are as follows:

(a) When the Administrator has not yet identified any area within the community as an area having special mudslide (i.e., mudflow) hazards, but the community has indicated the presence of such hazards by submitting an application to participate in the Program, the community shall:

(1) Require permits for all proposed construction or other development in the community so that it may determine whether development is proposed within mudslide (i.e., mudflow)-prone areas;

(2) Require review of each permit application to determine whether the proposed site and improvements will be reasonable safe from mudslides (i.e., mudflows). Factors to be considered in making such a determination should include but not be limited to (i) the type and quality of soils, (ii) any evidence of ground water or surface water problems, (iii) the depth and quality of any fill, (iv) the overall slope of the site, and (v) the weight that any proposed structure will impose on the slope;

(3) Require, if a proposed site and improvements are in a location that may have mudslide (i.e., mudflow) hazards, that (i) a site investigation and further review be made by persons qualified in geology and soils engineering, (ii) the proposed grading, excavations, new construction, and substantial

improvements are adequately designed and protected against mudslide (i.e., mudflow) damages, (iii) the proposed grading, excavations, new construction and substantial improvements do not aggravate the existing hazard by creating either on-site or off-site disturbances, and (iv) drainage, planting, watering, and maintenance be such as not to endanger slope stability.

(b) When Administrator has delineated Zone M on the community's FIRM, the community shall:

(1) Meet the requirements of paragraph (a) of this section; and

(2) Adopt and enforce a grading ordinance or regulation in accordance with data supplied by the Administrator which (i) regulates the location of foundation systems and utility systems of new construction and substantial improvements, (ii) regulates the location, drainage and maintenance of all excavations, cuts and fills and planted slopes, (iii) provides special requirements for protective measures including but not necessarily limited to retaining walls, buttress fills, subdrains, diverter terraces, benchings, etc., and (iv) requires engineering drawings and specifications to be submitted for all corrective measures, accompanied by supporting soils engineering and geology reports. Guidance may be obtained from the provisions of the 1973 edition and any subsequent edition of the Uniform Building Code, sections 7001 through 7006, and 7008 through 7015. The Uniform Building Code is published by the International Conference of Building Officials, 50 South Los Robles, Pasadena, California 91101.

§60.5 Flood plain management criteria for flood-related erosion-prone areas.

The Administrator will provide the data upon which flood plain management regulations for flood-related erosion-prone areas shall be based. If the Administrator has not provided sufficient data to furnish a basis for these regulations in a particular community, the community shall obtain, review, and reasonably utilize data available from other Federal, State or other sources, pending receipt of data from the Administrator. However, when special flood-related erosion hazard area designations have been furnished by the Administrator they shall apply. The symbols defining such special flood-related erosion hazard designations are set forth in §64.3 of this subchapter. In all cases the minimum requirements governing the adequacy of the flood plain management regulations for flood-related erosion-prone areas adopted by a particular community depend on the amount of technical data provided to the community by the Administrator. Minimum standards for communities are as follows:

(a) When the Administrator has not yet identified any area within the community as having special flood-related erosion hazards, but the community has indicated the presence of such hazards by submitting an application to participate in the Program, the community shall:

(1) Require the issuance of a permit for all proposed construction, or other development in the area of flood-related erosion hazard, as it is known to the community;

(2) Require review of each permit application to determine whether the proposed site alterations and improvements will be reasonably safe from flood-related erosion and will not cause flood-related erosion hazards or otherwise aggravate the existing flood-related erosion hazard; and

(3) If a proposed improvement is found to be in the path of flood-related erosion or to increase the erosion hazard, require the improvement to be relocated or adequate protective measures to be taken which will not aggravate the existing erosion hazard.

(b) When the Administrator has delineated Zone E on the community's FIRM, the community shall:

(1) Meet the requirements of paragraph (a) of this section; and

(2) Require a setback for all new development from the ocean, lake, bay, riverfront or other body of water, to create a safety buffer consisting of a natural vegetative or contour strip. This buffer will be designated by the Administrator according to the flood-related erosion hazard and erosion rate, in conjunction with the anticipated "useful life" of structures, and depending upon the geologic, hydrologic, topographic and climatic characteristics of the community's land. The buffer may be used for suitable open space purposes, such as for agricultural, forestry, outdoor recreation and wildlife habitat areas, and for other activities using temporary and portable structures only.

§60.6 Variances and exceptions.

(a) The Administrator does not set forth absolute criteria for granting variances from the criteria set forth in §§60.3, 60.4, and 60.5. The issuance of a variance is for flood plain management purposes only. Insurance premium rates are determined by statute according to actuarial risk and will not be modified by the granting of a variance. The community, after examining the applicant's hardships, shall approve or disapprove a request. While the granting of variances generally is limited to a lot size less than one-half acre (as set forth in paragraph (a)(2) of this section), deviations from that limitation may occur. However, as the lot size increases beyond one-half acre, the technical justification required for issuing a variance increases. The Administrator may review a community's findings justifying the granting of variances, and if that review indicates a pattern inconsistent with the objectives of sound flood plain management, the Administrator may take appropriate action under §59.24(b) of this subchapter. Variances may be issued by a community for the reconstruction, rehabilitation or restoration of structures listed on the National Register of Historic Places or a State Inventory of Historic Places, without regard to the procedures set forth in this section. Procedures for the granting of variances by a community are as follows:

(1) Variances shall not be issued by a community within any designated regulatory floodway if any increase in flood levels during the base flood discharge would result;

(2) Variances may be issued by a community for new construction and substantial improvements to be erected on a lot of one-half acre or less in size contiguous to and surrounded by lots with existing structures constructed below the base flood level, in conformance with the procedures of paragraphs (a) (3), (4), (5) and (6) of this section;

(3) Variances shall only be issued by a community upon (i) a showing of good and sufficient cause, (ii) a determination that failure to grant the variance would result in exceptional hardship to the applicant, and (iii) a determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisances, cause fraud on or victimization of the public, or conflict with existing local laws or ordinances;

(4) Variances shall only be issued upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief;

(5) A community shall notify the applicant in writing over the signature of a community official that (i) the issuance of a variance to construct a structure below the base flood level will result in increased premium rates for flood insurance up to amounts as high as $25 for $100 of insurance coverage and (ii) such construction below the base flood level increases risks to life and property. Such notification shall be maintained with a record of all variance actions as required in paragraph (a)(6) of this section; and

(6) A community shall (i) maintain a record of all variance actions, including justification for their issuance, and (ii) report such variances issued in its annual report submitted to the Administrator.

(b)(1) The requirement that each flood-prone, mudslide (i.e., mudflow)-prone, and flood-related erosion prone community must adopt and submit adequate flood plain management regulations as a condition of initial and continued flood insurance eligibility is statutory and cannot be waived, and such regulations shall be adopted by a community within the time periods specified in §§60.3, 60.4 or §60.5. However, certain exceptions from the standards contained in this subpart may be permitted where the Administrator recognizes that, because of extraordinary circumstances, local conditions may render the application of certain standards the cause for severe hardship and gross inequity for a particular community. Consequently, a community proposing the adoption of flood plain management regulations which vary from the standards set forth in §§60.3, 60.4, or §60.5, shall explain in writing to the Administrator the nature and extent of and the reasons for the exception request and shall include sufficient supporting economic, environmental, topographic, hydrologic, and other scientific and technical data, and data with respect to the impact on public safety and the environment.

(2) The Administrator shall prepare a Special Environmental Clearance to determine whether the proposal for an exception under paragraph (b)(1) of this section will have significant impact on the human environment. The decision whether an (i)

Environmental Impact Statement (EIS) or i) a Finding of Inapplicability is required must be made by the Environmental Clearance Officer of the initiating office with the approval of the Assistant Secretary for Community Planning and Development based on review by the Director, Office of Environmental Quality and the General Counsel (Assistant General Counsel for Finance and Administrative Law) in accord with HUD Handbook 1390.1 (38 FR 19182, 19186), "Departmental Policies, Responsibilities and Procedures for Protection and Enhancement of Environmental Quality" which implements the National Environmental Policy Act of 1969 (Pub. L. 91-190) for FEMA programs, and guidelines of the Council on Environmental Quality (40 CFR Part 1500). Ninety or more days may be required for an environmental quality clearance if the proposed exception will have significant impact on the human environment thereby requiring an EIS.

(3) In accordance with paragraph (b)(1) of this section, a community may propose flood plain management regulations which adopt standards for basements below the base flood level. The Administrator may approve the proposal when the basements are to be designed so that below the base flood level the structure is watertight (i.e., completely dry without human intervention during flooding) with walls impermeable to the passage of water and structural components with the capability to resist hydrostatic and hydrodynamic loads and effects of buoyancy.

(4) In accordance with paragraph (b)(1) of this section, a community may propose flood plain management regulations to permit storm cellars below the base flood level. The Administrator may approve the proposal for storm cellars (as defined in §59.1 of this subchapter) after the community has demonstrated an historical need for storm cellars as a means of shelter against recorded occurrences of severe tornado or similar wind storm activities in the area and based upon a community's acknowledgement that (i) all new storm cellars shall be limited to nonhabitable uses, (ii) all electrical, heating and other mechanical equipment shall be above the base flood level for all new storm cellars; and (iii) the design of storm cellars shall assure that the integrity of the main structure during time of flooding is maintained.

§60.7 Revisions of criteria for flood plain management regulations.

From time to time Part 60 may be revised as experience is acquired under the Program and new information becomes available. Communities will be given six months from the effective date of any new regulation to revise their flood plain management regulations to comply with any such changes.

§60.8 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

Subpart B—Requirements for State Flood Plain Management Regulations

§60.11 Purpose of this subpart.

(a) A State is considered a "community" pursuant to §59.1 of this Subchapter; and, accordingly, the Act provides that flood insurance shall not be sold or renewed under the Program unless a community has adopted adequate flood plain management regulations consistent with criteria established by the Administrator.

(b) This subpart sets forth the flood plain management criteria required for State-owned properties located within special hazard areas identified by the Administrator. A State shall satisfy such criteria as a condition to the purchase of a Standard Flood Insurance Policy for a State-owned structure or its contents, or as a condition to the approval by the Administrator, pursuant to Part 75 of this subchapter, of its plan of self-insurance.

§60.12 Flood plain management criteria for State-owned properties in special hazard areas.

(a) The State shall comply with the minimum flood plain management criteria set forth in §§60.3, 60.4, and 60.5. A State either shall:

(1) Comply with the flood plain management requirements of all local communities participating in the program in which State-owned properties are located; or

(2) Establish and enforce flood plain management regulations which, at a minimum, satisfy the criteria set forth in §§60.3, 60.4, and 60.5.

(b) The procedures by which a state government adopts and administers flood plain management regulations satisfying the criteria set forth in §§60.3, 60.4 and 60.5 may vary from the procedures by which local governments satisfy the criteria.

(c) If any State-owned property is located in a non-participating local community, then the State shall comply with the requirements of paragraph (a)(2) of this section for the property.

§60.13 Noncompliance.

If a State fails to submit adequate flood plain management regulations applicable to State-owned properties pursuant to §60.12 within six months of the effective date of this regulation, or fails to adequately enforce such regulations, the State shall be subject to suspensive action pursuant to §59.24. Where the State fails to adequately enforce its flood plain management regulations, the Administrator shall conduct a hearing before initiating such suspensive action.

Subpart C—Additional Considerations in Managing Flood-Prone, Mudslide (i.e., Mudflow)-Prone, and Flood-Related Erosion-Prone Areas

§60.21 Purpose of this subpart.

The purpose of this subpart is to encourage the formation and adoption of overall comprehensive management plans for flood-prone, mudslide (i.e., mudflow)-prone and flood-related erosion-prone areas. While adoption by a community of the standards in this subpart is not mandatory, the community shall completely evaluate these standards.

§60.22 Planning considerations for flood-prone areas.

(a) The flood plain management regulations adopted by a community for flood-prone areas should:

(1) Permit only that development of flood-prone areas which (i) is appropriate in light of the probability of flood damage and the need to reduce flood loses, (ii) is an acceptable social and economic use of the land in relation to the hazards involved, and (iii) does not increase the danger to human life;

(2) Prohibit nonessential or improper installation of public utilities and public facilities in flood-prone areas.

(b) Informulating community development goals after the occurrence of a flood disaster, each community shall consider—

(1) Preservation of the flood-prone areas for open space purposes;

(2) Relocation of occupants away from flood-prone areas;

(3) Acquisition of land or land development rights for public purposes consistent with a policy of minimization of future property losses;

(4) Acquisition of frequently flood-damaged structures;

(c) Informulating community development goals and in adopting flood plain management regulations, each community shall consider at least the following factors—

(1) Human safety;

(2) Diversion of development to areas safe from flooding in light of the need to reduce flood damages and in light of the need to prevent environmentally incompatible flood plain use;

(3) Full disclosure to all prospective and interested parties (including but not limited to purchasers and renters) that (i) certain structures are located within flood-prone areas, (ii) variances have been granted for certain structures located within flood-prone areas, and (iii) premium rates applied to new structures built at elevations below the base flood substantially increase as the elevation decreases;

(4) Adverse effects of flood plain development on existing development;

(5) Encouragement of floodproofing to reduce flood damage;

(6) Flood warning and emergency preparedness plans;

(7) Provision for alternative vehicular access and escape routes when normal routes are blocked or destroyed by flooding;

(8) Establishment of minimum floodproofing and access requirements for schools, hospitals, nursing homes, orphanages, penal institutions, fire stations, police stations, communications centers, water and sewage pumping stations, and other public or quasi-public facilities already located in the flood-prone area, to enable them to

withstand flood damage; and to facilitate emergency operations;

(9) Improvement of local drainage to control increased runoff that might increase the danger of flooding to other properties;

(10) Coordination of plans with neighboring community's flood plain management programs;

(11) The requirement that all new construction and substantial improvements in areas subject to subsidence be elevated above the base flood level equal to expected subsidence for at least a ten year period;

(12) For riverine areas, requiring subdividers to furnish delineations for floodways before approving a subdivision;

(13) Prohibition of any alteration or relocation of a watercourse, except as part of an overall drainage basin plan. In the event of an overall drainage basin plan, provide that the flood carrying capacity within the altered or relocated portion of the watercourse is maintained;

(14) Requirement of setbacks for new construction within Zones V1-30 on a community's FIRM;

(15) Requirement of additonal elevation above the base flood level for all new construction and substantial improvements within Zones A1-30 and V1-30 on the community's FIRM to protect against such occurrences as wave wash and floating debris, to provide an added margin of safety against floods having a magnitude greater than the base flood, or to compensate for future urban development;

(16) Requirement of consistency between state, regional and local comprehensive plans and flood plain management programs;

(17) Requirement of pilings or columns rather than fill, for the elevation of structures within flood-prone areas, in order to maintain the storage capacity of the flood plain and to minimize the potential for negative impacts to sensitive ecological areas;

(18) Prohibition, within any floodway or coastal high hazard area, of plants or facilities in which hazardous substances are manufactured.

§60.23 Planning considerations for mudslide (i.e. mudflow)/prone areas.

The planning process for communities identified under Part 65 of this subchapter as containing Zone M, or which indicate in their applications for flood insurance pursuant to §59.22 of this subchapter that they have mudslide (i.e., mudflow) areas, should include—

(a) The existence and extent of the hazard;

(b) The potential effects of inappropriate hillside development, including

(1) Loss of life and personal injuries, and

(2) Public and private property losses, costs, liabilities, and exposures resulting from potential mudslide (i.e., mudflow) hazards;

(c) The means of avoiding the hazard including the (1) availability of land which is not mudslide (i.e., mudflow-prone and the feasibility of developing such land instead of further encroaching upon mudslide (i.e., mudflow) areas, (2) possibility of public acquisition of land, easements, and development rights to assure the proper development of hillsides, and (3) advisability of preserving mudslide (i.e., mudflow) areas as open space;

(d) The means of adjusting to the hazard, including the (1) establishment by ordinance of site exploration, investigation, design, grading, construction, filing, compacting, foundation, sewerage, drainage, subdrainage, planting, inspection and maintenance standards and requirements that promote proper land use, and (2) provision for proper drainage and subdrainage on public property and the location of public utilities and service facilities such as sewer, water, gas and electrical systems and streets in a manner designed to minimize exposure to mudslide (i.e., mudflow) hazards and prevent their aggravation;

(e) Coordination of land use, sewer, and drainage regulations and ordinances with fire prevention, flood plain, mudslide (i.e., mudflow), soil, land, and water regulation in neighboring communities;

(f) Planning subdivisions and other developments in such a manner as to avoid exposure to mudslide (i.e., mudflow) hazards and the control of public facility and utility extension to discourage inappropriate development;

(g) Public facility location and design requirements with higher site stability and access standards for schools, hospitals, nursing homes, orphanages, correctional and other residential institutions, fire and police stations, communication centers, electric power transformers and substations, water and sewer pumping stations and any other public or quasi-public institutions located in the mudslide (i.e., mudflow) area to enable them to withstand mudslide (i.e., mudflow) damage and to facilitate emergency operations; and

(h) Provision for emergencies, including (1) warning, evacuation, abatement, and access procedures in the event of mudslide (i.e., mudflow), (2) enactment of public measures and initiation of private procedures to limit danger and damage from continued or future mudslides (i.e., mudflow), (3) fire prevention procedures in the event of the rupture of gas or electrical distribution systems by mudslides, (4) provisions to avoid contamination of water conduits or deterioration of slope stability by the rupture of such systems, (5) similar provisions for sewers which in the event of rupture pose both health and site stability hazards and (6) provisions for alternative vehicular access and escape routes when normal routes are blocked or destroyed by mudslides (i.e., mudflow);

(i) The means for assuring consistency between state, areawide, and local comprehensive plans with the plans developed for mudslide (i.e., mudflow)-prone areas;

(j) Deterring the nonessential installation of public utilities and public facilities in mudslide (i.e., mudflow)-prone areas.

§60.24 Planning considerations for flood-related erosion-prone areas.

The planning process for communities identified under Part 65 of this subchapter as containing Zone E or which indicate in their applications for flood insurance coverage pursuant to §59.22 of this subchapter that they have flood-related erosion areas should include—

(a) The importance of directing future developments to areas not exposed to flood-related erosion;

(b) The possibility of reserving flood-related erosion-prone areas for open space purposes;

(c) The coordination of all planning for the flood-related erosion-prone areas with planning at the State and Regional levels, and with planning at the level of neighboring communities;

(d) Preventive action in E zones, including setbacks, shore protection works, relocating structures in the path of flood-related erosion, and community acquisition of flood-related erosion-prone properties for public purposes;

(e) Consistency of plans for flood-related erosion-prone areas with comprehensive plans at the state, regional and local levels.

§60.25 State coordination.

(a) State participation in furthering the objectives of this part should include:

(1) Encouraging and assisting communities in qualifying for participation in the Program;

(2) Enacting where necessary, legislation to enable counties and municipalities to regulate flood, mudslide (i.e., mudflow) and flood-related erosion area development;

(3) Designating an agency of the State government to be responsible for coordinating Federal, State, and local aspects of flood plain, mudslide (i.e., mudflow) area and flood-related erosion area management activities in the State;

(4) Assisting in the delineation of flood-related erosion areas, mudslide (i.e., mudflow) areas, riverine floodways, and coastal high hazard areas, and providing all relevant technical data to the Administrator;

(5) Establishing minimum State flood plain, mudslide (i.e., mudflow) and flood-related erosion regulatory standards consistent with those established in this Part;

(6) Guiding and assisting municipal and county public bodies and agencies in developing flood plain, mudslide (i.e., mudflow) and flood-related erosion area management plans and flood plain management regulations;

(7) Recommending priorities for ratemaking studies among those communities of the State which qualify for such studies;

(8) Communicating flood plain, mudslide (i.e., mudflow) and flood-related erosion area information to local governments and to the general public;

(9) Participating in flood, mudslide (i.e., mudflow) and flood-related erosion warning and emergency preparedness programs;

(10) Assisting communities in disseminating information on minimum elevations for structures permitted in flood plain areas having special hazards, and in disseminating other information relating to mudslide (i.e., mudflow) and flood-related erosion areas having special hazards;

(11) Advising public and private agencies

(particularly those whose activities or projects might obstruct drainage or the flow of rivers or streams or increase slope instability), on the avoidance of unnecessary aggravation of flood, mudslide (i.e., mudflow) and flood-related erosion hazards;

(12) Requiring that proposed uses of flood plain, mudslide (i.e., mudflow) and flood-related erosion areas conform to standards established by State environmental and water pollution control agencies to assure that proper safeguards are being provided to prevent pollution during periods of flooding;

(13) Providing local communities with information on the Program, with particular emphasis on the coordination of State and Federal requirements pertaining to the management of flood-prone, mudslide (i.e., mudflow)-prone, and flood-related erosion-prone areas;

(14) Assuring coordination and consistency of flood plain management and planning with comprehensive planning at the state, areawide and local levels;

(15) Amending state recording acts so that the following may be recorded for the public's knowledge: (i) a parcel of land and/or a structure is located within a flood-prone, mudslide (i.e., mudflow) and/or flood-related erosion prone area and (ii) a variance has been granted for building at an elevation below the base flood level, thereby resulting in increased premium rates for flood insurance under the Program.

(16) Assuring coordination between its State Coordinating Agency and any State office established to supervise state participation in the Coastal Zone Management Program;

(17) Providing notification to the Administrator in the event a participating community violates the Program's requirements;

(18) Assuring coordination efforts in the event a dispute over enactment and administration of flood plain management regulations arises between communities.

(b) For States whose flood plain, mudslide (i.e., mudflow) area and flood-related erosion area management program substantially encompass the activities described in paragraph (a) of this Section, the Administrator shall:

(1) Give special consideration to State priority recommendations before selecting communities for ratemaking studies from the register described in §59.23 of this subchapter;

(2) Accept State approved and certified local flood plain management regulations as meeting the requirements of this Part.

§ 60.26 Local coordination.

(a) Local flood plain, mudslide (i.e., mudflow) and flood-related erosion area management, forecasting, emergency preparedness, and damage abatement programs should be coordinated with relevant Federal, State, and regional programs;

(b) A community adopting flood plain management regulations pursuant to these criteria should coordinate with the appropriate State agency to promote public acceptance and use of effective flood plain, mudslide, (i.e., mudflow) and flood-related erosion regulations;

(c) A community should notify adjacent communities prior to substantial commercial developments and large subdivisions to be undertaken in areas having special flood, mudslide (i.e., mudflow) and/or flood-related erosion hazards.

PART 61—INSURANCE COVERAGE AND RATES

Authority: Sec. 7(d), 79 Stat. 670; 42 U.S.C. 3535(d); sec. 1306, 82 Stat. 575 (42 U.S.C. 4013); Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963), unless otherwise noted.

Source: 43 FR 2570, Jan. 17, 1978, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

§ 61.1 Purpose of part.

This Part describes the types of properties eligible for flood insurance coverage under the Program, the limits of such coverage, and the premium rates actually to be paid by insureds. The specific communities eligible for coverage are designated by the Administrator from time to time as applications are approved under the emergency program and as ratemaking studies of communities are completed prior to the regular program. Lists of such communities are periodically published under Part 64 of this subchapter.

§ 61.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§ 61.3 Types of coverage.

Insurance coverage under the Program is available for structures and their contents. Coverage for each may be purchased separately. One policy to provide insurance for more than one structure is not available under the Program.

§ 61.4 Limitations on coverage.

(a) All flood insurance made available under the Program is subject:

(1) To the Act, the Amendments thereto, and the Regulations issued under the Act;

(2) To the terms and conditions of the Standard Flood Insurance Policy, which shall be promulgated by the Administrator for substance and form, and which is subject to interpretation by the Administrator as to scope of coverage pursuant to the applicable statutes and regulations;

(3) To the specified limits of coverage set forth in the Application and Declarations page of the policy; and

(4) To the maximum limits of coverage set forth in § 61.6.

(b) Insurance under the Program is available only for loss due to flood, as defined in §59.1 of this subchapter. The policy covers damage from a general condition of flooding in the area which results from other than natural causes, such as the breaking of a dam, but does not cover damage which results from causes on the insured's own property or within his control or from any condition which causes damage, which condition is substantially confined to the insured's premises or properties immediately adjacent thereto.

(c) The policy does not cover losses from rain, snow, sleet, hail, or water spray that do not result in a general condition of flooding. It covers losses from freezing or thawing, or from the pressure or weight of ice and water, only where they occur simultaneously with and as a part of flood damage. It covers losses from mudslide (i.e., mudflow) but does not cover damage from landslides or from earthquakes or similar earth movements which are volcanic or tectonic in origin. The policy does not cover erosion which is not flood-related, claims resulting from occurrences already in progress at the time of the inception date of the term of the policy, or losses caused by land slippage rather than mudslide (see definition of mudslide/mudflow in §59.1 of this subchapter). Damage by seepage and sewer backup may be covered only when directly resulting from a flooding situation. Abnormal erosion caused by high water levels accompanied by violent wave action along a lake or other body of water is considered a flood (see definition of flood-related erosion in §59.1 of this subchapter). However, there is no coverage where normal, continuous wave action, accompanied by erosion or the gradual and anticipated wearing away of the land is the proximate cause of property damage.

(d) The policy protects against loss to contents only at the location described in the application, except that contents necessarily removed from the premises for preservation from a flood are protected against loss or damage from flood at the new location, if placed in a fully enclosed building, pro rata for a period of 45 days.

§ 61.5 Special terms and conditions.

(a) No new flood insurance or renewal of flood insurance policies shall be written for properties declared by a duly constituted State or local zoning or other authority to be in violation of any flood plain, mudslide (i.e., mudflow) or flood-related erosion area management or control law, regulation, or ordinance.

(b) In order to reduce the administrative costs of the Program, of which the Federal Government pays a major share, payment of the full policyholder premium must be made at the time of application.

(c) Because of the seasonal nature of flooding, refunds of premiums upon cancellation of coverage by the insured are permitted only if the insurer ceases to have an ownership interest in the covered property at the location described in the policy. Refunds of premiums for any other reason are subject to the conditions set forth in §62.5 of this subchapter.

(d) Each loss sustained by the insured is subject to a deductible provision under which the insured bears a portion of the loss before payment is made under the policy. The amount of the deductible for each loss occurrence is: (1) For structural losses, $200, and (2) for contents losses, $200.

(e) Payment for a loss under the policy does not reduce the amount of insurance applicable to any other loss during the policy term which arises out of a separate flood occurrence, but all losses arising out of a continuous or protracted occurrence are deemed to have arisen out of a single occurrence.

(f) The following property and contents for residential structures are not insurable under the Program:

(1) Accounts, bills, currency, deeds, evidence of debt, money, securities, bullion, manuscripts or other valuable papers or records, and coins or stamps;

(2) Fences, retaining walls, seawalls, outdoor swimming pools, bulkheads, wharves, piers, bridges, docks; other open structures located on or partially over water; or personal property in the open;

(3) Land values, lawns, trees, shrubs or plants, growing crops, or livestock; underground structures or underground equipment, and those portions of walks, driveways and other paved or poured surfaces outside the foundation walls of the structure;

(4) Animals, birds, fish, aircraft, motor vehicles including parts and equipment (other than motorized equipment pertaining to the service of the premises and not licensed for highway use), trailers on wheels, watercraft including their furnishings and equipment; or business property.

(g) The following property and contents for nonresidential structures are not insurable under the Program:

(1) Accounts, bills, currency, deeds, evidence of debt, money, securities, bullion, manuscripts or other valuable papers or records, and coins or stamps;

(2) Fences, retaining walls, seawalls, outdoor swimming pools, bulkheads, wharves, piers, bridges, docks; other open structures located on or partially over water; personal property in the open;

(3) Land values, lawns, trees, shrubs or plants, growing crops, or livestock; underground structures or underground equipment, and those portions of walks, driveways and other paved or poured surfaces outside the foundation walls of the structures;

(4) Automobiles including parts and equipment, any self-propelled vehicle or machine, except motorized equipment not licensed for use on public thoroughfares and operated principally on the premises of the insured; watercraft or aircraft.

(h) The policy on an eligible property may be cancelled by the insurer only for nonpayment of premium. However, any willful misrepresentation or concealment of any material fact by the insured at any time voids the entire policy as of the date the wrongful act was committed, but does not affect coverage prior to the date of the wrongful act.

(i) The standard flood insurance policy is authorized only under terms and conditions established by Federal statute, the program's regulations, the Administrator's interpretations and the express terms of the policy itself. Accordingly, representations regarding the extent and scope of coverage which are not consistent with the National Flood Insurance Act of 1968, as amended, or the Program's regulations, are void, and the duly licensed property or casualty agent acts for the insured and does not act as agent for the Federal Government, the Federal Emergency Management Agency, or the servicing agent.

§61.6 Maximum amounts of coverage available.

(a) Pursuant to section 1306 of the Act, the following are the limits of coverage available under the emergency program and under the regular program.

	Emergency program		Regular program
	First layer	Second layer	Total amount available
Single family residential			
Except in Hawaii, Alaska, Guam, U.S. Virgin Islands	35,000	150,000	185,000
In Hawaii, Alaska, Guam, U.S. Virgin Islands	50,000	[1] 150,000	185,000
Other residential			
Except in Hawaii, Alaska, Guam, U.S. Virgin Islands	100,000	150,000	250,000
In Hawaii, Alaska, Guam, U.S. Virgin Islands	150,000	[2] 150,000	250,000
Small business	100,000	150,000	250,000
Churches and other properties	100,000	100,000	200,000
Contents			
Residential	10,000	50,000	60,000
Small business	100,000	200,000	300,000
Churches, other properties (per unit)	100,000	100,000	200,000

[1] Note.—Add to 35,000
[2] Note.—Add to 100,000

(b) The maximum limits of coverage required under the Act are twice the amounts available under First Layer Coverage.

§61.7 Risk premium rate determinations.

(a) Pursuant to section 1307 of the Act, the Administrator is authorized to undertake studies and investigations to enable him/her to estimate the risk premium rates necessary to provide flood insurance in accordance with accepted actuarial principles, including applicable operating costs and allowances. Such rates are also referred to in this subchapter as "actuarial rates."

(b) The Administrator is also authorized to prescribe by regulation the rates which can reasonably be charged to insureds in order to encourage them to purchase the flood insurance made available under the Program. Such rates are referred to in this subchapter as "chargeable rates." For areas having special flood, mudslide (i.e., mudflow), and flood-related erosion hazards, chargeable rates are usually lower than actuarial rates.

§61.8 Applicability of risk premium rates.

Risk premium rates are applicable to all flood insurance made available for:

(a) Any structure, the construction or substantial improvement of which was started after December 31, 1974 or on or after the effective date of the initial FIRM, whichever is later.

(b) Coverage which exceeds the following limits:

(1) For dwelling properties in States other than Alaska, Hawaii, the Virgin Islands, and Guam (i) $35,000 aggregate liability for any property containing only one unit, (ii) $100,000 for any property containing more than one unit, and (iii) $10,000 liability per unit for any contents related to such unit.

(2) For dwelling properties in Alaska, Hawaii, the Virgin Islands, and Guam (i) $50,000 aggregate liability for any property containing only one unit, (ii) $150,000 for property containing more than one unit, and (iii) $10,000 aggregate liability per unit for any contents related to such unit.

(3) For churches and other properties (i) $100,000 for the structure and (ii) $100,000 for contents of any such unit.

(c) Any structure or the contents thereof for which the chargeable rates prescribed by this Part would exceed the risk premium rates.

§61.9 Establishment of chargeable rates.

(a) Pursuant to section 1308 of the Act, chargeable rates per year per $100 of flood insurance are established as follows for all areas designated by the Administrator Under Part 64 of this subchapter for the offering of flood insurance:

Rates for new and renewal policies

Type of structure	Rate per year per $100 coverage on structure	Rate per year per $100 coverage on contents
(1) Residential	$0.25	$0.35
(2) All other (including hotels and hotels and motels with normal occupancy of less than 6 mo in duration)	.40	.75

(b) The contents rate shall be based upon the use of the individual premises for which contents coverage is purchased.

§61.10 Minimum premiums.

The minimum premium required for any policy, regardless of the amount of coverage, is $25. The minimum premium required for any added coverage or increase in the amount of coverage during the term of existing policy is $4, regardless of unexpired term of the policy at the time the change.

§61.11 Effective date and time of coverage under the Standard Flood Insurance Policy.

(a) The effective date and time of any new or added or increase in the amount of flood insurance coverage shall be 12:01 a.m. of the day following the application date and the presentment of payment of premium in the following cases:

(1) During the 30-day period which follows a community's initial eligibility for flood insurance under the emergency program;

(2) During the 30-day period which follows a community's initial eligibility for flood insurance under the regular program;

(3) At any time as to any application for additional coverage or increased limits made in connection with a policy then in force.

(b) Where title to property is conveyed, any new or added coverage or increase in the amount of coverage with respect to the property shall be effective as of the time title to the property is transferred to the purchaser when:

(1) The flood insurance policy is applied for and the presentment of payment of premium is made at or prior to the transfer of title; or

(2) The existing flood insurance policy on the property was assigned to the purchaser at or before the transfer of title to the property.

(c) Except as provided by (a) or (b) of this section the effective date and time of any new policy shall be 12:01 a.m. (local time) on the 5th calendar day after the application date and the presentment of payment of premium; for example, a flood insurance policy applied for with the payment of the premium on April 1 to cover property located in a community that has been participating in the program longer than 30 days will become effective at 12:01 a.m. on April 6.

(d) Adding new coverage or increasing the amount of coverage in force is permitted during the term of any policy. The additional premium for any new coverage or increase in the amount of coverage shall be calculated pro rata in accordance with the rates currently in force, with a minimum premium of $4.

(National Flood Insurance Act of 1968 (title XIII of the Housing and Urban Development Act of 1968); effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4128); and Secretary's delegation of authority to Federal Insurance Administrator (43 FR 7719, February 24, 1978))

[43 FR 50427, Oct. 30, 1978. Redesignated at 44 FR 31177, May 31, 1979]

§61.12 Rates based on a flood protection system involving Federal funds.

(a) Where the Administrator determines that a community has made adequate progress on the construction of a flood protection system involving federal funds which will significantly limit the area of special flood hazards, the applicable risk premium rates for any property, located within a special flood hazard area intended to be protected directly by such system will be those risk premium rates which would be applicable when the system is complete.

(b) Adequate progress in paragraph (a) of this section means that the community has provided information to the Administrator sufficient to determine that substantial completion of the flood protection system has been effected because:

(1) 100 percent of the total financial project cost of the completed flood protection system has been authorized;

(2) At least 60 percent of the total financial project cost of the completed flood protection system has been appropriated;

(3) At least 50 percent of the total financial project cost of the completed flood protection system has been expended;

(4) The flood protection system's physical features are under construction and 50 percent completed as measured by the actual expenditure of the estimated construction budget funds; and

(5) The community has not been responsible for any delay in the completion of the system.

(c) Each request by a community for a determination must be submitted in writing to the Engineering Division, Office of Flood Insurance, Federal Insurance Administration, Federal Emergency Management Agency, 1725 I Street, NW, Washington DC 20472, and contain a complete statement of all relevant facts relating to the flood protection system, including, but not limited to, supporting technical data (e.g., U.S. Army Corps of Engineers flood protection project data), cost schedules, budget appropriation data and the extent of federal funding of the system's construction. Such facts shall include information sufficient to identify all persons affected by such flood protection system or by such request: a full and precise statement of intended purposes of the flood protection system; and a carefully detailed description of such project, including construction completion target dates. In addition, true copies of all contracts, agreements, leases, instruments, and other documents involved must be submitted with the request. Relevant facts reflected in documents, however, must be included in the statement and not merely incorporated by reference, and must be accompanied by an analysis of their bearing on the requirements of paragraph (b) of this section, specifying the pertinent provisions. The request must contain a statement whether, to the best of the knowledge of the person responsible for preparing the application for the community, the flood protection system is currently the subject matter of litigation before any Federal, State or local court or administrative agency, and the purpose of that litigation. The request must also contain a statement as to whether the community has previously requested a determination with respect to the same subject matter from the Administrator, detailing the disposition of such previous request. As documents become part of the file and cannot be returned, the original documents should not be submitted.

(d) The effective date for any risk premium rates established under this section shall be the date of final determination by the Administrator that adequate progress toward completion of a flood protection system has been made in a community.

(e) A responsible official of a community which received a determination that adequate progress has been made towards completion of a flood protection system shall certify to the Administrator annually on the anniversary date of receipt of such determination that no present delay in completion of the system is attributable to local sponsors of the system, and that a good faith effort is being made to complete the project.

(f) A community for which risk premium rates have been made available under section 1307(e) of the National Flood Insurance Act of 1968, as amended, shall notify the Administrator if, at any time, all progress on the completion of the flood protection system has been halted or if the project for the completion of the flood protection system has been canceled.

§61.13 Standard Flood Insurance Policy.

(a) *Incorporation of forms.* Each of the Standard Flood Insurance Policy forms included in Appendix "A" hereto ("General Property" and "Dwelling Building and Contents") and by reference incorporated herein shall be incorporated into the Standard Flood Insurance Policy.

(b) *Endorsements.* All endorsements to the Standard Flood Insurance Policy shall be final upon publication in the FEDERAL REGISTER for inclusion in Appendix A.

(c) *Applications.* The application and renewal application forms utilized by the National Flood Insurance Program shall be the only application forms used in connection with the Standard Flood Insurance Policy.

(d) *Waivers.* The Standard Flood Insurance Policy and required endorsements must be used in the Flood Insurance Program, and no provision of the said documents shall be altered, varied, or waived other than through the issuance of an appropriate amendatory endorsement, approved by the Administrator as to form and substance for uniform use.

(e) *Oral and written binders.* No oral binder or contract shall be effective. No written binder shall be effective unless issued with express authorization of the Administrator.

[43 FR 2570, Jan. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979 and amended at 44 FR 62517, Oct. 31, 1979]

§61.14 Standard Flood Insurance Policy Interpretations.

(a) *Definition.* A Standard Flood Insurance Policy Interpretation is a written determination by the Administrator construing the scope of the flood insurance coverage that has been and is provided under the policy.

(b) *Publication and requests for interpretation.* The Administrator shall, pursuant to these regulations from time to time, issue interpretative rulings regarding the provisions of the Standard Flood Insurance Policy. Such Interpretations shall be published in the Federal Register, made a part of Appendix C to these regulations, and incorporated by reference as part of these regulations. Any policyholder or person in privity with a policyholder may file a request for an interpretation in writing with the Federal Insurance Administration, Federal Emergency Management Agency, 1725 I Street, NW, Washington DC 20472.

§61.15 Assumption of Liabilities under all Outstanding Flood Insurance Policies issued by the National Flood Insurers Association.

On January 1, 1978, all Standard Flood Insurance Policies issued by the National Flood Insurers Association prior to January 1, 1978, which have their annual policy period extending into the calendar year 1978, shall be considered to be Standard Flood Insurance Policies issued by the Federal Insurance Administration, Federal Emergency Management Agency, 1725 I Street, NW, Washington, DC 20472.

APPENDIX A (1)

FEDERAL EMERGENCY MANAGEMENT AGENCY FEDERAL INSURANCE ADMINISTRATION

STANDARD FLOOD INSURANCE POLICY

(Issued Pursuant to the National Flood Insurance Act of 1968, or Any Acts Amendatory Thereof)

DWELLING FORM

In consideration of the payment of the premium, in reliance upon the statements in the application and declarations form made a part hereof and subject to all the terms of this policy, the insurer does insure the Insured and legal representatives, to the extent of the actual cash value of the property at the time of loss, but not exceeding the amount which it would cost to repair or replace the property with material of like kind quality within a reasonable time after such loss, without allowance for any increased cost of repair or reconstruction by reason of any ordinance or law regulating construction or repair, and without compensation for loss resulting from interruption of business or manufacture, nor in any event for more than the interest of the insured, against all DIRECT LOSS BY "FLOOD" as defined herein, to the property described while located or contained as described in the application and declarations form attached hereto, or pro rata for 45 days at each proper place to which any of the property shall necessarily be removed for preservation from the peril of "Flood, but not elsewhere.

Assignment of this policy by the Insured is allowed. The Insurer under this Policy is the Federal Emergency Management Agency.

DEFINITION OF "FLOOD"

Wherever in this policy the term "flood" occurs, it shall be held to mean: A. A general and temporary condition of partial or complete inundation of normally dry land areas from:

1. The overflow of inland or tidal waters.
2. The unusual and rapid accumulation or runoff of surface waters from any source.
3. Mudslide (i.e., mudflow), a river or flow of liquid mud approximately caused by flooding as defined in subparagraph A-2 above or by the accumulation of water under the ground.

B. The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding the anticipated cyclical levels.

PERILS EXCLUDED

The Insurer shall not be liable for loss:

A. By (1) rain, snow, sleet, hail or water spray; (2) freezing, thawing or by the pressure or weight of ice or water, except where the property covered has been simultaneously damaged by flood; (3) water, moisture or mudslide (i.e., mudflow) damage of any kind resulting primarily from conditions, causes or occurrences which are solely related to the described premises or are within the control of the insured (including but not limited to design, structural or mechanical defects, failures, stoppages or breakages of water or sewer lines, drains, pumps, fixtures, or equipment) or any condition which causes flooding which is substantially confined to the described premises or properties immediately adjacent thereto; or (4) seepage, backup of water, or hydrostatic pressure not related to a condition of "flood" as defined;

B. Caused directly or indirectly by (1) hostile or warlike action in time of peace or war, including action in hindering, combating or defending against an actual, impending or expected attack, (a) by any government or sovereign power (de jure or de facto), or by any authority maintaining or using military, naval or air forces, or (b) by military, naval or air forces, or (c) by an agent of any such government, power authority or forces, it being understood that any discharge, explosion or use of any weapon of war employing nuclear fission or fusion shall be conclusively presumed to be such a hostile or warlike action by such a government, power, authority or forces; (2) insurrection, rebellion, revolution, civil war, usurped power, or action taken by governmental authority in hindering, combating or defending against such an occurrence;

C. By nuclear reaction or nuclear radiation or radioactive contamination, all whether controlled or uncontrolled, or due to any act or condition incident to any of the foregoing, whether such loss be direct or indirect, proximate or remote, or be in whole or in part caused by, contributed to, or aggravated by the peril insured against by this policy;

D. By the theft or by fire, windstorm explosion, earthquake, landslide or any other earth movement except such mudslide or erosion as is covered under the peril of flood;

E. Caused by or resulting from power, heating or cooling failure, unless such failure results from physical damage to power, heating or cooling equipment situated on premises where the property covered is located, caused by the peril insured against;

F. Caused directly or indirectly by neglect of the Insured to use all reasonable means to save and preserve the property at the time of and after an occurrence of the peril insured against by this policy; but for contents covered herein and subject to the terms of the policy including the limits of liability, the Insurer will reimburse the Insured for reasonable expenses necessarily incurred by him in complying with the requirements of this paragraph, including but not limited to, reasonable expenses for removal or temporary storage (not exceeding 45 days), or both, of insured contents, from the described premises because of the imminent danger of flood.

PROPERTY COVERED

A. Dwelling.—The term "dwelling" shall mean a residential building designed for the occupancy of from 1 to 4 families and occupied principally for dwelling purposes by the number of families stated herein.

When the insurance under this policy covers a dwelling, such insurance shall include additions in contact therewith; also, if the property of the owner of the described dwelling and when not otherwise covered, building equipment, fixtures and outdoor equipment, all pertaining to the service of the described premises and while within an enclosed structure located on the described premises; also, materials and supplies while within an enclosed structure located on the described premises or adjacent thereto, intended for use in construction, alteration or repair of such dwelling or appurtenant private structures on the described premises.

The Insured may apply up to 10% of the amount of insurance applicable to the dwelling covered under this policy, not as an additional amount of insurance, to cover loss to appurtenant private structures (other than the described dwelling and additions in contact therewith) located on the described premises. This extension of coverage shall not apply to structures (other than structures used exclusively for private garage purposes) which are rented or leased in whole or in part, or held for such rental or lease, to other than a tenant of the described dwelling of which are used in whole or in part for commercial manufacturing of farming purposes.

B. Contents.—When the insurance under this policy covers contents, such insurance shall cover all household and personal property usual or incidental to the occupancy of the premises as a dwelling—except other property not covered under the provisions of this policy, and any property more specifically covered in whole or in part by other insurance including the peril insured against in this policy, belonging to the Insured or members of the Insured's family of the same household, or for which the Insured may be liable, or, at the option of the Insured, belonging to a servant or guest of the Insured; all while within an enclosed structure located on the described premises.

The Insured may apply up to 10% of the amount of insurance applicable to the contents covered under this policy not as an additional amount of insurance as follows:

(a) If not owner of the described premises, to cover loss to improvements, alterations, and additions to the described dwelling appurtenant enclosed private structures as described above.

(b) If an individual condominium unit owner of the described premises, to cover loss to the interior walls, floors, and ceilings that are not otherwise covered under a condominium association policy on the described dwelling and appurtenant enclosed private structures as described above.

The Insurer shall not be liable for loss in any one occurrence for more than:

1. $500.00 in the aggregate on paintings, etchings, pictures, tapestries, art glass windows and other works of art (such as but not limited to statuary, marbles, bronzes, antique furniture, rare books, antique silver, porcelains, rare glass or bric-a-brac);

2. $500.00 in the aggregate on jewelry, watches, necklaces, bracelets, gems, precious and semi-precious stones, articles of gold, silver or platinum and furs or any article containing fur which represents its principal value.

C. Debris Removal.—This insurance covers expense incurred in the removal of debris of or on the dwelling, appurtenant enclosed private structures or contents covered hereunder, which may be occasioned by loss caused by the peril insured against in this policy.

The total liability under this policy for both loss to property and debris removal expense shall not exceed the amount of insurance applying under this policy to the property covered.

PROPERTY NOT COVERED

This policy shall not cover:

A. Accounts, bills, currency, deeds, evidences of debt, money, securities, bullion, manuscripts or other valuable papers or records, numismatic or philatelic property.

B. Fences, retaining walls, seawalls, outdoor swimming pools, bulkheads, wharves, piers, bridges, docks; other open structures located on or partially over water; or personal property in the open.

C. Land values; lawn, trees, shrubs or plants, growing crops, or livestock; underground structures or underground equipment, and those portions of walks, driveways and other paved or poured surfaces outside the foundation walls of the structure.

D. Animals, birds, fish; aircraft and motor vehicles (other than motorized equipment pertaining to the services of the premises and not licensed for highway use) including their parts and equipment; trailers on wheels; watercraft including their furnishings and equipment; and business property.

DEDUCTIBLES

A. With respect to loss to the dwelling, appurtenant private structures, and debris removal covered hereunder, the Insurer shall be liable for only that portion of the loss in any one occurrence which is in excess of $200.00.

B. With respect to loss to contents or debris removal covered hereunder, or to expenses, incurred under paragraph F of "Perils Excluded," the Insurer shall be liable for only that portion of the loss in any one occurrence which is in excess of $200.00.

REPLACEMENT COST PROVISIONS

These provisions shall apply only to a Single Family Dwelling covered hereunder. Outdoor radio and television antennas and aerials, carpeting, awnings, domestic appliances and outdoor equipment, all whether attached to the building structure or not, are excluded from the replacement cost coverage.

A. If at the time of loss the total amount of insurance applicable to said dwelling is 80% or more of the full replacement cost of such dwelling, or is the maximum amount of insurance available under the National Flood Insurance Program, the coverage of this policy applicable to such dwelling is extended to include the full cost of repair or replacement (without deduction for depreciation).

B. If at the time of loss the total amount of insurance applicable to said dwelling is less than 80% of the full replacement cost of such dwelling and less than the maximum amount of insurance available under the National Flood Insurance Program, the Insurer's liability for loss under this policy shall not exceed the larger of the following amounts:

1. The actual cash value (meaning replacement cost less depreciation) of that part of the dwelling damaged or destroyed; or

2. That portion of the full cost of repair or replacement without deduction for depreciation of that part of the dwelling damaged or destroyed, which the total amount of insurance applicable to said dwelling bears to 80% of the full replacement cost of such dwelling.

If 80% of the full replacement cost of such dwelling is greater than the maximum amount of insurance available under the National Flood Insurance Program, use the maximum amount in lieu of the 80% figure in the application of this limit.

C. The Insurer's liability for loss under this policy shall not exceed the smallest of the following amounts:

1. The limit of liability of this policy applicable to the damaged or destroyed building.

2. The replacement cost of the dwelling or any part thereof identical with such dwelling on the same premises and intended for the same occupancy and use; or

3. The amount actually and necessarily expended in repairing or replacing said dwelling or any part thereof intended for the same occupancy and use.

D. When the full cost of repair or replacement is more than $1,000 or more than 5% of the whole amount of insurance applicable to said dwelling, the Insurer shall not be liable for any loss under paragraph A or subparagraph B-2 of these provisions unless and until actual repair or replacement is completed.

E. In determining if the whole amount of insurance applicable to said dwelling is 80% or more of the full replacement cost of such dwelling, the cost of excavations, underground flues and pipes, underground wiring and drains, and brick, stone and concrete foundations, piers and other supports which are below the under surface of the lowest basement floor, or where there is no basement, which are below the surface of the ground inside the foundation walls, shall be disregarded.

F. The Named Insured may elect to disregard this condition in making claim hereunder, but such election shall not prejudice the Named Insured's right to make further claim within 180 days after loss for any additional liability brought about by these provisions.

GENERAL CONDITIONS AND PROVISIONS

A. Pair and Set Clause.—If there is loss of an article which is part of a pair or set, the measure of loss shall be a reasonable and fair proportion of the total value of the pair or set, giving consideration to the importance of said article, but such loss shall not be construed to mean total loss of the pair or set.

B. Concealment, Fraud.—This entire policy shall be void if, whether before or after a loss, the Insured has willfully concealed or misrepresented any material fact or circumstance concerning this insurance or the subject thereof, or the interest of the Insured therein, or in case of any fraud or false swearing by the Insured relating thereto.

C. Other Insurance.—The Insurer shall not be liable for a greater proportion of any loss, less the amount of deductible, from the peril of flood than the amount of insurance under this policy bears to the whole amount of flood insurance (excluding therefrom any amount of "excess insurance" as hereinafter defined) covering the property, or which would have covered the property except for the existence of this insurance, whether collectible or not.

In the event that the whole amount of flood insurance (excluding therefrom any amount of "excess insurance" as hereinafter defined) covering the property exceeds the maximum amount of insurance permitted under the provisions of the National Flood Insurance Act of 1968, or any acts amendatory thereof, it is hereby understood and agreed that the insurance under this policy shall be limited to a proportionate share of the maximum amount of insurance permitted on such property under said Act, and that a refund of any extra premium paid, computed on a pro rata basis, shall be made by the Insurer upon request in writing submitted not later than 2 years after the expiration of the policy term during which such extra amount of insurance was in effect.

"Excess Insurance" as used herein shall be held to mean insurance of such part of the actual cash value of the property as is in excess of the maximum amount of insurance permitted under said Act with respect to such property.

D. Added and Waiver Provisions.—The extent of the application of insurance under this policy and of the contribution to be made by the Insurer in case of loss, and any other provision or agreement not inconsistent with the provisions of this policy, may be provided for in writing added hereto, but no provision may be waived except such as by the terms of this policy is subject to change.

No permission affecting this insurance shall exist, or waiver of any provision be valid, unless granted herein or expressed in writing added hereto. No provision, stipulation or forfeiture shall be held to be waived by any requirement or proceeding on the part of the Insurer relating to appraisal or to any examination provided for herein.

E. Cancellation of Policy or Reduction in Amount of Insurance.—This policy may be cancelled at any time at the request of the Insured, in which case the Insurer shall, upon demand and surrender of this policy, refund the excess of paid premiums above the customary short rates for the expired time; provided, however, that the premium paid for the then current policy term shall be fully earned if the Insured retains an interest in the property covered at the location described in the application and declarations form.

The amount of insurance under this policy may be reduced at any time at the request of the Insured, in which case the Insurer shall, upon demand, refund the excess of paid premiums above the customary short rates for the expired time for the amount of the reduction; provided, however, that the premium paid for the then current policy term shall be fully earned to the extent that the Insured retains an interest in the property covered at the location described in the application and declarations form.

This policy may be cancelled by the Insurer for non-payment of the premium by giving to the Insured a 20-days' written notice of cancellation.

F. Conditions Suspending or Restricting Insurance.—Unless otherwise provided in writing added hereto, the Insurer shall not be liable for loss occurring while the hazard is increased by any means within the control or knowledge of the Insured, provided, however, this insurance shall not be prejudiced by any act or neglect of any person (other than the Insured), when such act or neglect is not within the control of the Insured.

G. Alterations and Repairs.—Permission is granted to make alterations, additions and repairs, and to complete structures in course of construction. In the event of loss hereunder, the Insured is permitted to make reasonable repairs, temporary or permanent, provided such repairs are confined solely to the protection of the property from further damage and provided further that the Insured shall keep an accurate record of such repair expenditures. The cost of any such repairs directly attributable to damage by the peril insured against shall be included in determining the amount of loss hereunder. Nothing herein contained is intended to modify the policy requirements applicable in case loss occurs, and in particular the requirement that in case loss occurs the Insured shall protect the property from further damage.

H. Property of Others.—Unless otherwise provided in writing added hereto, loss to any property of others covered under this policy shall be adjusted with the Insured for the account of the owners of said property, except that the right to adjust such loss with said owners is reserved to the Insurer. Any such insurance under this policy shall not inure directly or indirectly to the benefit of any carrier or other bailee for hire.

I. Liberalization Clause.—If during the period that insurance is in force under this policy, or within 45 days prior to the inception date thereof, on behalf of the Insurer there be adopted under the National Flood Insurance Act of 1968, or any acts amendatory thereof, any forms, endorsements, rules or regulations by which this policy could be extended or broadened, without additional premium charge, by endorsement or substitution of form, then such extended or broadened insurance shall inure to the benefit of the Insured hereunder as though such endorsement or substitution of form had been made.

J. Statutory Provisions.—Any terms of this policy which are in conflict with the statutes of the state wherein the property is located are hereby amended to conform to such statutes, except that in cases of conflict with applicable Federal law or regulation, such Federal law or regulation shall control the terms of the policy.

K. Loss Clause.—Payment of any loss under this policy shall not reduce the amount of insurance applicable to any other loss during the policy term which arises out of a separate occurrence of the peril insured against hereunder; provided, that all loss arising out of a continuous or protracted occurrence shall be deemed to constitute loss arising out of a single occurrence.

L. Mortgage Clause (Applicable to building items only and effective only when policy is made payable to a mortgagee (or trustee) named in the application and declarations form attached to this policy).—Loss, if any, under this policy, shall be payable to the aforesaid as mortgagee (or trustee) as interest may appear under all present or future mortgagees upon the property described in which the aforesaid may have an interest as mortgagee (or trustee), in order of precedence of said mortgages, and this insurance, as to the interest of the mortgagee (or trustee) only therein, shall not be invalidated by any act or neglect of the mortagage or owner of the described property, nor by any foreclosure or other proceedings or notice of sale relating to the property, nor by any change in the title or ownership of the property, nor by the occupation of the premises for purposes more hazardous than are permitted by this policy; provided, that in case the mortgagor or owner shall neglect to pay any premium due under this policy, the mortgagee (or trustee) shall, on demand, pay the same.

Provided, also, that the mortgagee (or trustee) shall notify the Insurer of any change of ownership or occupancy or increase of hazard which shall come to the knowledge of said mortgagee (or trustee) and unless permitted by this policy, it shall be noted thereon and the mortgagee (or trustee) shall, on demand, pay the premium for such increased hazard for the term of the use thereof; otherwise this policy shall be null and void.

If this policy is cancelled by the Insurer, it shall continue in force for the benefit only of the mortgagee (or trustee) for 30 days after written notice to the mortgagee (or trustee) of such cancellation and shall then cease, and the Insurer shall have the right, on like notice, to cancel this agreement.

Whenever the Insurer shall pay the mortgagees (or trustee) any sum for loss under this policy and shall claim that, as to the mortgagor or owner, no liability therefor existed, the Insurer shall, to the extent of such payment, be thereupon legally subrogated to all the rights of the party to whom such payment shall be made, under all securities held as collateral to the mortgage debt, or may, at its option, pay to the mortgagee (or trustee) the whole principal due or to grow due on the mortgage with interest, and shall thereupon receive a full assignment and transfer of the mortgage and of all such other securities; but no subrogation shall impair the right of the mortgagee (or trustee) to recover the full amount of said mortgagee's (or trustee's) claim.

M. Mortgagee Obligations.—If the Insured fails to render proof of loss, the named mortgagee (or trustee) upon notice, shall render proof of loss in the form herein specified within 60 days thereafter and shall be subject to the provisions of this policy relating to appraisal and time of payment and of bringing suit.

N. Requirements In Case of Loss.—The Insured shall give written notice, as soon as practicable to the Insurer of any loss, protect the property from further damage, forthwith separate the damaged and undamaged property and put it in the best possible order. Within 60 days after the loss, unless such time is extended in writing by the Insurer, the Insured shall render to the Insurer, a proof of loss, signed and sworn to by the Insured, stating the knowledge and belief of the Insured as to the following: the time and origin of the loss, the interest of the Insured and of all others in the property, actual cash value of each item thereof and the amount of loss thereto, all encumbrances thereon, all other contracts of insurance, whether valid or not, covering any of said property, any changes in the title, use, occupation, location, possession or exposures of said property since the issuing of this policy, by whom and for what purpose any building herein described and the several parts thereof were occupied at the time of loss. The Insured, at the option of the Insurer, may be required to furnish a complete inventory of the destroyed, damaged and undamaged property, showing in detail quantities, costs, actual cash value and amount of loss claimed, and verified plans and specifications of any building, fixtures or machinery destroyed or damaged.

The Insured, as often as may be reasonably required, shall exhibit to any person designated by the Insurer all that remains of any property herein described, and submit to examinations under oath by any person named by the Insurer, and subscribe the same; and, as often as may be reasonably required, shall produce for examination all books of account, bills, invoices and other vouchers, or certified copies thereof if originals be lost, at such reasonable time and place as may be designated by the Insurer or its representative, and shall permit extracts and copies thereof to be made.

O. Appraisal.—In case the Insured and the Insurer shall fail to agree as to the actual cash value or the amount of loss, then on the written demand of either, each shall select a competent and disinterested appraiser and notify the other of the appraiser selected within 20 days of such demand. The appraisers shall first select a competent and disinterested umpire; and failing for 15 days to agree upon such umpire, then, on request of the Insured or the Insurer, such umpire shall be selected by a judge of a court of record in the State in which the insured property is located. The appraisers shall then appraise the loss, stating separately actual cash value and loss of each item; and, failing to agree, shall submit their differences, only, to the umpire. An award in writing, so itemized, of any two when filed with the Insurer shall determine the amount of actual cash value and loss. Each appraiser shall be paid by the party selecting him and the expenses of appraisal and umpire shall be paid by the parties equally.

P. Options.—It shall be optional with the Insurer to take all, or any part, of the property at the agreed or appraised value, and also to repair, rebuild or replace the property destroyed or damaged with other of like kind and quality within a reasonable time, on giving notice of its intention so to do within 30 days after the receipt of the proof of loss herein required.

Q. Abandonment.—There shall be no abandonment to the Insurer of any property.

R. When Loss Payable.—The amount of loss for which the Insurer may be liable shall be payable 60 days after proof of loss, as herein provided, is received by the Insurer and ascertainment of the loss is made either by agreement between the Insured and the Insurer expressed in writing or by the filing with the Insurer of an award as herein provided.

S. Action Against the Insurer.—No suit or action on this policy for the recovery of any claim shall be sustainable in any court of law or equity unless all the requirements of this policy shall have been complied, with and unless commenced within 12 months next after the date of mailing of notice of disallowance or partial disallowance of the claim. An action on such claim against the Insurer may be instituted, without regard to the amount in controversy, in the United States District Court for the district in which the property shall have been situated.

T. Subrogation.—In the event of any payment under this policy, the Insurer shall be subrogated to all the Insured's right of recovery therefor against any party, and the Insurer may require from the Insured an assignment of all rights of recovery against any party for loss to the extent that payment therefor is made by the Insurer. The Insured shall do nothing after loss to prejudice such right; however, this insurance shall not be invalidated should the Insured waive in writing prior to a loss any or all right of recovery against any party for loss occurring to the described property.

IN WITNESS WHEREOF, the Insurer has executed and attested these presents; but this policy shall not be valid unless countersigned by the duly authorized representative of the Insurer.

GLORIA M. JIMENEZ,
Federal Insurance Administrator.

APPENDIX A (2)

FEDERAL EMERGENCY MANAGEMENT AGENCY FEDERAL INSURANCE ADMINISTRATION

STANDARD FLOOD INSURANCE POLICY

[Issued Pursuant to the National Flood Insurance Acts of 1968, or Any Act Amendatory Thereof]

GENERAL PROPERTY FORM

In consideration of the payment of the premium, in reliance upon the statements in the application and declarations form made a part hereof and subject to all the terms of this policy, the Insurer does insure the Insured and legal representatives, to the extent of the actual cash value of the property at the time of loss, but not exceeding the amount which it would cost to repair or replace the property with material of like kind and quality within a reasonable time after such loss. Without allowance for any increased cost of repair or reconstruction by reason of only ordinance or law regulating construction or repair, and without compensation for loss resulting from interruption of business or manufacture, nor in any event for more than the interest of the insured, against all *direct loss by "flood"* as defined herein, to the property described while located or contained as described in the application and declarations form attached hereto or pro rata for 45 days at each proper place to which any of the property shall necessarily be removed for preservation from the peril of "Flood", but not elsewhere.

Assignment of this policy by the Insured is allowed. The Insurer under this Policy is the Federal Emergency Management Agency.

DEFINITION OF "FLOOD"

Wherever in this policy the term "flood" occurs, it shall be held to mean:

A. A general and temporary condition of partial or complete inundation of normally dry land areas from:

1. The overflow of inland or tidal waters
2. The unusual and rapid accumulation or runoff of surface waters from any source.
3. Mudslide (i.e., mudflow), a river or flow of liquid mud proximately caused by flooding as defined in subparagraph A-2 above or by the accumulation of water under the ground.

B. The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding the anticipated cyclical levels.

PERILS EXCLUDED

The Insurer shall not be liable for loss:

A. By (1) rain, snow, sleet, hail or water spray; (2) freezing, thawing or by the pressure or weight of ice or water except where the property covered has been simultaneously damaged by flood; (3) water moisture or mudslide (i.e., mudflow) damage of any kind resulting primarily from conditions, causes or occurrences which are solely related to the described premises or are within the control of the insured (including but not limited to design, structural or mechanical defects, failures, stoppages or breakages of water or sewer lines, drains, pumps, fixtures, or equipment) or any condition which causes flooding which is substantially confined to the described premises or properties immediately adjacent thereto or; (4) seepage backup of water, or hydrostatic pressure not related to a condition of "flood" as defined;

B. Caused directly or indirectly by (1) hostile or warlike action in time of peace or war, including action in hindering, combating or defending against an actual, impending or expected attack, (a) by any government or sovereign power (de jure or de facto), or by any authority maintaining or using military, naval or air forces, or (b) by military, naval or air forces, or (c) by an agent of any such government, power, authority or forces, it being understood that any discharge, explosion or use of any weapon of war employing nuclear fission or fusion shall be conclusively presumed to be such a hostile or warlike action by such a government power authority or forces; (2) insurrection, rebellion, revolution, civil war, usurped power, or action taken by governmental authority in hindering combating or defending against such an occurrence;

C. By nuclear reaction or nuclear radiation or radioactive contamination, all whether controlled or uncontrolled, or due to any act or condition incident to any of the foregoing whether such loss be direct or indirect, proximate or remote, or be in whole or in part caused by, contributed to, or aggravated by the peril insured against by this policy;

D. By theft or by fire windstorm explosion earthquake landslide or any other earth movement except such mudslide or erosion as is covered under the peril of flood;

E. Caused by or resulting from power, heating or cooling failure, unless such failure results from physical damage to power, heating or cooling equipment situated on premises where the property covered is located caused by the peril insured against.

F. Caused directly or indirectly by neglect of the Insured to use all reasonable means to save and preserve the property at the time of and after an occurrence of the peril insured against by this policy; but for contents covered herein and subject to the terms of the policy including the limits of liability, the Insurer will reimburse the Insured for reasonable expenses necessarily incurred by him in complying with the requirements of this paragraph including but not limited to reasonable expenses for removal or temporary storage (not exceeding 45 days), or both of insured contents, from the described premises because of the imminent danger of flood.

PROPERTY COVERED

A. Building.—When the insurance under this policy covers a building, such insurance shall include additions and extensions attached thereto; permanent fixtures, machinery and equipment forming a part of and pertaining to the service of the building; personal property of the insured as landlord used for the maintenance or service of the building including fire extinguishing apparatus, floor coverings, refrigerating and ventilating equipment, all while within the described building; also, materials and supplies while within an enclosed structure located on the described premises or adjacent thereto, intended for use in construction alteration or repair of such building or appurtenant private structures on the described premises.

When the insurance under this policy covers a building used for residential purposes, the insured may apply up to 10% of the amount of insurance, applicable to such building, not as an additional amount of insurance, to cover loss to appurtenant private structures (other than the described building and additions and extensions attached thereto) located on the described premises. This extension of coverage shall not apply to structures. (Other than structures used exclusively for private garage purposes) which are rented or leased in whole or in part, or held for such rental or lease, to other than a tenant of the described building, or which are used in whole or in part for commercial, manufacturing or farming purposes.

B. Contents.—When the insurance under this policy covers contents, coverage shall be for either household contents or other than household contents, but not for both.

1. When the insurance under this policy covers other than household contents, such insurance shall cover merchandise and stock, materials and stock supplies of every description; furniture, fixtures, machinery and equipment of every description all owned by the insured; improvements and betterments (as hereinafter defined) to the building if the insured is not the owner of the building and when not otherwise covered; all while within the described inclosed building.

2. When the insurance under this policy covers household contents, such insurance shall cover all household and personal property usual or incidental to the occupancy of the premises as a residence—except animals, birds, fish, business property, other property not covered under the provisions of this policy, and any property more specifically covered in whole or in part by the other insurance including the peril insured against in this policy; belonging to the Insured or members of the Insured's family of the same household, or for which the Insured may be liable, or, at the option of the Insured, belonging to a servant or guest of the Insured; all while within the described building.

The Insured, if not the owner of the described building, may apply up to 10% of the amount of insurance applicable to the household contents covered under this item, not as an additional amount of insurance, to cover loss to improvements and betterments (as hereinafter defined) to the described building.

The Insured, if an individual condominium unit owner in the described building, may apply up to 10% of the amount of insurance on contents covered under this policy, not as an additional amount of insurance, to cover loss to the interior walls floors and ceilings that are not otherwise covered under a condominium association policy on the described building.

The Insurer shall not be liable for loss in any one occurrence for more than:

(a) $500,000 in the aggregate on paintings, etchings, pictures, tapestries, art glass windows and other works of art (such as but not limited to statuary, marbles, bronzes, antique furniture, rare books, antique silver, porcelains, rare glass or bric-a-brac);

(b) $500,000 in the aggregate on jewelry, watches, necklaces, bracelets, gems, precious and semi-precious stones, articles of gold, silver or platinum and furs or any article containing fur which represents its principal value.

3. When the insurance under this policy covers improvements and betterments, such insurance shall cover the Insured's used interest in improvements and betterments to the described building.

(a) The term "improvements and betterments" wherever used in this policy is defined as fixtures, alterations, installations, or additions comprising a part of the described building and made, or acquired, at the expense of the Insured exclusive of rent paid by the Insured, but which are not legally subject to removal by the Insured.

(b) The word "lease" wherever used in this policy shall mean the lease or rental agreement, whether written or oral, in effect as of the time of loss.

(c) In the event improvements and betterments are damaged or destroyed during the term of this policy by the peril insured against, the liability of the Insurer shall be determined as follows:

(1) If repaired or replaced at the expense of the Insured within a reasonable time after such loss, the actual cash value of the damaged or destroyed improvements and betterments.

(2) If not repaired or replaced within a reasonable time after such loss, that proportion of the original cost at time of installation of the damaged or destroyed improvements and betterments which the unexpired term of the lease at the time of loss bears to the period(s) from the date(s) such improvements and betterments were made to the expiration date of the lease.

(3) If repaired or replaced at the expense of others for the use of the Insured, there shall be no liability hereunder.

C. Debris Removal.—This insurance covers expense incurred in the removal of debris of or on the building or contents covered hereunder, which may be occasioned by loss caused by the peril insured against in this policy.

The total liability under this policy for both loss to property and debris removal expense shall not exceed the amount of insurance applying under this policy to the property covered.

PROPERTY NOT COVERED

This policy shall not cover:

A. Accounts, bills, currency, deeds, evidences of debt, money, securities, bullion, manuscripts or other valuable papers or records, numismatic or philatelic property.

B. Fences, retaining walls, seawalls, outdoor swimming pools, bulkheads, wharves, piers, bridges, docks; other open structures located on or partially over water; or personal property in the open.

C. Land values; lawn, trees, shrubs or plants, growing crops, or livestock; underground structures or underground equipment, and those portions of walks, driveways and other paved or poured surfaces outside the foundation walls of the structure.

D. Automobiles; any self-propelled vehicles or machines, except motorized equipment not licensed for use on public thoroughfares and operated principally on the premises of the Insured; watercraft or aircraft.

E. Contents specifically covered by other insurance except for the excess of value of such property above the amount of such insurance.

DEDUCTIBLES

A. With respect to loss to the building, appurtenant private structures, and debris removal covered hereunder, the Insurer shall be liable for only that portion of the loss in any one occurrence which is in excess of $200.00.

B. With respect to loss to contents or debris removal covered hereunder, or to expenses, incurred under paragraph F of "Perils Excluded," the Insurer shall be liable for only that portion of the loss in any one occurrence which is in excess of $200.00.

GENERAL CONDITIONS AND PROVISIONS

A. Pair and Set Clause.—If there is loss of an article which is part of a pair or set, the measure of loss shall be a reasonable and fair proportion of the total value of the pair or set, giving consideration to the importance of said article, but such loss shall not be construed to mean total loss of the pair or set.

B. Concealment, Fraud.—This entire policy shall be void if, whether before or after a loss, the Insured has willfully concealed or misrepresented any material fact or circumstance concerning this insurance or the subject thereof, or the interest of the Insured therein, or in case of any fraud or false swearing by the Insured relating thereto.

C. Other Insurance.—The Insured shall not be liable for a greater proportion of any loss, less the amount of deductible, from the peril of flood than the amount of insurance under this policy bears to the whole amount of flood insurance (excluding therefrom any amount of "excess insurance" as hereinafter defined) covering the property, or which would have covered the property except for the existence of this insurance, whether collectible or not.

In the event that the whole amount of flood insurance (excluding therefrom any amount of "excess insurance" as hereinafter defined) covering the property exceeds the maximum amount of insurance permitted under the provisions of the National Flood Insurance Act of 1968, or any acts amendatory thereof, it is hereby understood and agreed that the insurance under this policy shall be limited to a proportionate share of the maximum amount of insurance permitted on such property under said Act, and that a refund of any extra premium paid, computed on a pro rata basis, shall be made by the insurer upon request in writing submitted not later than 2 years after the expiration of the policy term during which such extra amount of insurance was in effect.

"Excess Insurance" as used herein shall be held to mean insurance of such part of the actual cash value of the property as is in excess of the maximum amount of insurance permitted under said Act with respect to such property.

D. Added and Waiver Provision.—The extent of the application of insurance under this policy and of the contribution to be made by the Insurer in case of loss, and any other provision or agreement not inconsistent with the provisions of this policy, may be provided for in writing added hereto, but no provision may be waived except such as by the terms of this policy is subject to change.

No permission affecting this insurance shall exist, or waiver of any provision be valid, unless granted herein or expressed in writing added hereto. No provision, stipulation or forfeiture shall be held to be waived by any requirement or proceeding on the part of the Insurer relating to appraisal or to any examination provided for herein.

E. Cancellation of Policy or Reduction in Amount of Insurance.—This policy may be cancelled at any time at the request of the Insured, in which case the Insurer shall, upon demand and surrender of this policy, refund the excess of paid premiums above the customary short rates for the expired time; provided, however, that the premium paid for the then current policy term shall be fully earned if the Insured retains an interest in the property covered at the location described in the application and declarations form.

The amount of insurance under this policy may be reduced at any time at the request of the Insured, in which case the Insurer shall, upon demand, refund the excess of paid premiums above the customary short rates for the expired time for the amount of the reduction; provided, however, that the premium paid for the then current policy term shall be fully earned to the extent that the Insured retains an interest in the property covered at the location described in the application and declarations form.

This policy may be cancelled by th Insurer for non-payment of the premium by giving to the Insured a 20-days' written notice of cancellation.

F. Conditions Suspending or Restricting Insurance.—Unless otherwise provided in writing added hereto, the Insurer shall not be liable for loss occurring while the hazard is increased by any means within the control or knowledge of the Insured, provided, however, this insurance shall not be prejudiced by any act or neglect of any person (other than the insured), when such act or neglect is not within the control of the Insured.

G. Alterations and Repairs.—Permission is granted to make alterations, additions and repairs, and to complete structures in course of construction. In the event of loss hereunder, the Insured is permitted to make reasonable repairs, temporary or permanent, provided such repairs are confined solely to the protection of the property from further damage and provided further that the Insured shall keep an accurate record of such repair expenditures. The cost of any such repairs directly attributable to damage by the peril insured against shall be included in determining the amount of loss hereunder. Nothing herein contained is intended to modify the policy requirements applicable in case loss occurs, and in particular the requirement that in case loss occurs the Insured shall protect the property from further damage.

H. Property of Others (Servants and Guests Only).—Unless otherwise provided in writing added hereto, loss to any property of others covered under this policy shall be adjusted with the Insured for the account of the owners of said property, except that the right to adjust such loss with said owners is reserved to the Insurer. Any such insurance under this policy shall not inure directly or indirectly to the benefit of any carrier or other bailee for hire.

I. Liberalization Clause.—If during the period that insurance is in force under this policy, or within 45 days prior to the inception date thereof, on behalf of the Insurer there be adopted under the National Flood Insurance Act of 1968, or any acts amendatory thereof any forms, endorsements, rules or regulations by which this policy could be extended or broadened, without additional premium charge, by endorsement or substitution of form, then such extended or broadened insurance shall inure to the benefit of the Insured hereunder as though such endorsement or substitution of form had been made.

J. Statutory Provisions.—Any terms of this policy which are in conflict with the statutes of the state wherein the property is located are hereby amended to conform to such statutes, except that in cases of conflict with applicable Federal law or regulations, such Federal law or regulation shall control the terms of this policy.

K. Loss Clause.—Payment of any loss under this policy shall not reduce the amount of insurance applicable to any other loss during the policy term which arises out of a separate occurrence of the peril insured against hereunder provided, that all loss arising out of a continuous or protracted occurrence shall be deemed to constitute loss arising out of a single occurrence.

L. Mortgage Clause (Applicable to building items only and effective only when policy is made payable to a mortgagee (or trustee) named in the application and declarations form attached to this policy).—Loss, if any, under this policy, shall be payable to the aforesaid as mortgagee (or trustee) as interest may appear under all present or future mortgages upon the property described in which the aforesaid may have an interest as mortgagee (or trustee), in order of precedence of said mortgages, and this insurance, as to the interest of the mortgagee (or trustee) only therein, shall not be invalidated by any act or neglect of the mortgagor or owner of the described property, nor by any foreclosure or other proceedings or notice of sale relating to the property, nor by any change in the title or ownership of the property, nor by the occupation of the premises for purposes more hazardous than are permitted by this policy; provided, that in case the mortgagor or owner shall neglect to pay any premium due under this policy, the mortgagee (or trustee) shall, on demand, pay the same.

Provided, also, that the mortgagee (or trustee) shall notify the Insurer of any change of ownership or occupancy or increase of hazard which shall come to the knowledge of said mortgagee (or trustee) and, unless permitted by this policy, it shall be noted thereon and—the mortgagee (or trustee) shall, on demand, pay the premium for such increased hazard for the term of the use thereof; otherwise this policy shall be null and void.

If this policy is cancelled by the Insurer, it shall continue in force for the benefit only of the mortgagee (or trustee) for 30 days after written notice to the mortgagee (or trustee) of such cancellation and shall then cease, and the Insurer shall have the right, on like notice, to cancel this agreement.

Whenever the Insurer shall pay the mortgagee (or trustee) any sum for loss under this policy and shall claim that, as to the mortgagor or owner, no liability therefor existed, the Insurer shall, to the extent of such payment, be thereupon legally subrogated to all the rights of the party to whom such payment shall be made, under all securities held as collateral to the mortgage debt, or may, at its option, pay to the mortgagee (or trustee) the whole principal due or to grow due on the mortgage with interest, and shall thereupon receive a full assignment and transfer of the mortgage and of all such other securities; but no subrogation shall impair the right of the mortgagee (or trustee) to recover the full amount of said mortgagee's (or trustee's) claim.

M. Mortgagee Obligations.—If the Insured fails to render proof of loss, the named mortgagee (or trustee), upon notice, shall render proof of loss in the form herein specified within 60 days thereafter and shall be subject to the provisions of this policy relating to appraisal and time of payment and of bringing suit.

N. Loss Payable Clause (Applicable to contents items only).—Loss, if any, shall be adjusted with the Insured and shall be payable to the Insured and loss payee as their interests may appear.

O. Requirements in Case of Loss.—The Insured shall give written notice, as soon as practicable, to the Insurer of any loss, protect the property from further damage, forthwith separate the damaged and undamaged property and put it in the best possible order. Within 60 days after the loss, unless such time is extended in writing by the Insurer, the Insured shall render to the Insurer, a proof of loss, signed and sworn to by the Insured stating the knowledge and belief of the Insured as to the following: the time and origin of the loss, the interest of the Insured and of all others in the property, actual cash value of each item thereof and the amount of loss thereto, all encumbrances thereon, all other contracts of insurance, whether valid or not, covering any of said property, any changes in the title, use, occupation, location, possession or exposures of said property since the issuing of this policy, by whom and for what purpose any building herein described and the several parts thereof were occupied at the time of loss. The Insured, at the option of the Insurer, may be required to furnish a complete inventory of the destroyed, damaged and undamaged property, showing in detail quantities, costs, actual cash value and amount of loss claimed, and verified plans and specifications of any building, fixtures or machinery destroyed or damaged.

The Insured, as often as may be reasonably required, shall exhibit to any person designated by the Insurer all that remains of any property herein described, and submit to examinations under oath by any person named by the Insurer, and subscribe the same; and, as often as may be reasonably required, shall produce for examination all books of account, bills, invoices and other vouchers, or certified copies thereof if originals be lost, at such reasonable time and place as may be designated by the Insurer or its representative, and shall permit extracts and copies thereof to be made.

P. Appraisal.—In case the Insured and the Insurer shall fail to agree as to the actual cash value of the amount of loss, then, on the written demand of either, each shall select a competent and disinterested appraiser and notify the other of the appraiser selected within 20 days of such demand. The appraisers shall first select a competent and disinterested umpire; and failing for 15 days to agree upon such umpire, then, on request of the Insured or the Insurer, such umpire shall be selected by a judge of a court of record in the State in which the insured property is located. The appraisers shall then appraise the loss, stating separately actual cash value and loss to each item; and, failing to agree, shall submit their differences, only, to the umpire. An award in writing, so itemized, of any two when filed with the Insurer shall determine the amount of actual cash value and loss. Each appraiser shall be paid by the party selecting him and the expenses of appraisal and umpire shall be paid by the parties equally.

Q. Options.—It shall be optional with the Insurer to take all, or any part, of the property at the agreed or appraised value, and also to repair, rebuild or replace the property destroyed or damaged with other of like kind and quality within a reasonable time, on giving notice of its intention so to do within 30 days after the receipt of the proof of loss herein required.

R. Abandonment.—There shall be no abandonment to the Insurer of any property.

S. When Loss Payable.—The amount of loss for which the Insurer may be liable shall be payable 60 days after proof of loss, as herein provided, is received by the Insurer and ascertainment of the loss is made either by agreement between the Insured and the Insurer expressed in writing or by the filing with the Insurer of an award as herein provided.

T. Action Against the Insurer.—No suit or action on this policy for the recovery of any claim shall be sustainable in any court of law or equity unless all the requirements of this policy shall have been complied with, and unless commenced within 12 months next after the date of mailing of notice of disallowance or partial disallowance of the claim. An action on such claim against the Insurer may be instituted, without regard to the amount in controversy, in the United States District Court for the district in which the property shall have been situated.

U. Subrogation.—In the event of any payment under this policy, the Insurer shall be subrogated to all the Insured's right of recovery therefor against any party, and the Insurer may require from the Insured an assignment of all rights of recovery against any party for loss to the extent that payment therefor is made by the Insurer. The Insured shall do nothing after loss to prejudice such right; however, this insurance shall not be invalidated should the Insured waive in writing prior to a loss any or all right of recovery against any party for loss occurring to the described property.

IN WITNESS WHEREOF, the Insurer has executed and attested these presents; but this policy shall not be valid unless countersigned by the duly authorized representative of the Insurer.

GLORIA M. JIMENEZ,
Federal Insurance Administrator.

Endorsement 1

CONDOMINIUM ASSOCIATION ENDORSEMENT

If the named Insured on this policy is a condominium association, then at the time of loss by flood the following terms, subject to all other provisions of the policy, will apply:

1. The building coverage of this policy, subject to the stated limits will cover damage to all building items covered under the policy and owned in common by the condominium association members.

2. The building coverage of this policy, subject to the stated limits, is extended to cover damage to all structural items within

the Individual Condominium Units, including walls, floors, ceilings, and their related coverings, such as paint, paper, panelling, carpeting, and tile. Also covered are installed appliances for heating, cooling, plumbing and electrical purposes. The structural items may be original installations or replacement or additional items.

3. The building coverage outlined in paragraph 2 above has application only to the extent that the policy's stated limits have not been exhausted under paragraph 1.

4. The policy deductible relating to the building coverage shall be applied against the total damage to all of the building's structural elements and not against the covered loss, and shall not be applied separately in the case of each unit sustaining damage.

5. The contents coverage of this policy covers damage, subject to the stated limits, to all contents items owned in common by the association members and contained in the insured building or removed therefrom in accordance with the policy's terms.

6. The policy deductible relating to contents coverage shall be applied against the total damage to all contents owned in common by the condominium association members and contained in the insured building or removed therefrom in accordance with the policy's terms and not against the covered loss.

7. Loss under this endorsement shall be adjusted with the condominium association and shall be payable to the insurance trustee of record, as designated by the association.

(National Flood Insurance Act of 1968 (title XIII of the Housing and Urban Development Act of 1968), as amended (42 U.S.C. 4001-4128))

[43 FR 2570, Jan. 17, 1978, as amended at 44 FR 32215, June 5, 1979. Redesignated at 44 FR 31177, May 31, 1979]

PART 62—SALE OF INSURANCE AND ADJUSTMENT OF CLAIMS

Subpart A—Issuance of Policies

Authority: Sec. 7(d), 79 Stat. 670; 42 U.S.C. 3535(d); sec. 1306, 82 Stat. 575 (42 U.S.C. 4013); Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 43 FR 2575, Jan 17, 1978, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

Subpart A—Issuance of Policies

§62.1 Purpose of part.

The purpose of this Part is to set forth the manner in which flood insurance under the Program is made available to the general public in those communities designated as eligible for the sale of insurance under Part 64 of this subchapter, and to prescribe the general method by which the Administrator exercises his/her responsibility regarding the manner in which claims for losses are paid.

§62.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§62.3 Servicing Agent.

(a) Pursuant to sections 1345 and 1346 of the Act, the Administrator has entered into the Agreement with a servicing agent to authorize it to assist in issuing flood insurance policies under the Program in communities designated by the Administrator and to accept responsibility for delivery of policies and payment of claims for losses as prescribed by and at the discretion of the Administrator.

(b) The following company has been contracted to act as a servicing agent for the Federal Insurance Administration:

EDS Federal Corp., 6410 Rockledge Drive, Bethesda, Md. 20034.

(c) The servicing agent will arrange for the issuance of flood insurance to any person qualifying for such coverage under Parts 61 and 64 of this subchapter who submits an application to the servicing agent in accordance with the terms and conditions of the contract between the Agency and the servicing agent.

(d) Applications and premiums should be mailed to:

National Flood Insurance Program, Federal Insurance Administration, Federal Emergency Management Agency, P.O. Box 2448, Arlington, Va. 22202.

§62.4 Limitations on sale of policies.

(a) The servicing agent shall be deemed to have agreed, as a condition of its contract that it shall not offer flood insurance under any authority or auspices in any amount within the maximum limits of coverage specified in §61.6 of this subchapter, in any area the Administrator designates in Part 64 of this subchapter as eligible for the sale of flood insurance under the Program, other than in accordance with this Part, the Agreement, and the Standard Flood Insurance Policy.

(b) The agreement and all activities thereunder are subject to Title VI of the Civil Rights Act of 1964, 42 U.S.C. 2000d, and to the applicable Federal regulations and requirements issued from time to time pursuant thereto. No person shall be excluded from participation in, denied the benefits of, or subjected to discrimination under the Program, on the ground of race, color, sex, creed or national origin. Any complaint or information concerning the existence of any such unlawful discrimination in any matter within the purview of this Part should be referred to the Administrator.

§62.5 Premium refund.

A Standard Flood Insurance Policyholder whose property has been determined not to be in a special hazard area after the map revision or a Letter of Map Amendment under Part 70 of this subchapter may cancel the policy within the current policy year provided (a) he was required to purchase or to maintain flood insurance coverage, or both, as a condition for financial assistance, and (b) his property was located in an identified special hazard area as represented on an effective FHBM or FIRM when the financial assistance was provided. If no claim under the policy has been paid or is pending, the full premium shall be refunded for the current policy year, and for an additional policy year where the insured had been required to renew the policy during the period when a revised map was being reprinted.

§62.6 Minimum commissions.

The earned commission which shall be paid to any property or casualty insurance agent licensed in the state in which the insured property is located with respect to each policy or renewal he duly procures for an eligible purchaser shall not be less than $10. Any refunds of premiums authorized under this subchapter shall not affect a previously earned commission, and no agent shall be required to return that earned commission.

§62.7 Notice to policyholders.

Pursuant to the National Flood Insurance Program (42 U.S.C. 4001-4128) the servicing agent shall provide a notice in all flood insurance policies issued and renewed containing the following information:

(a) The policy indicated on the reverse side will expire 12 p.m. on the day prior to the renewal date shown. Your policy, when renewed, will be issued by the Federal Government, as insurer, rather than by the National Flood Insurers Association, whose contractual relationship with the Department of Housing and Urban Development terminated on December 31, 1977.

(b) To avoid a lapse in coverage your renewal premium for the next annual term must be received prior to the expiration of the current policy term. If you elect the increased amount of insurance shown in B, your renewal premium must be received 15 days prior to the current term expiration date in order for the increased amounts of insurance to take effect on the renewal effective date shown.

(c) If this policy is allowed to expire, the mortgagee of the insured property, if any, will be provided written notice as is provided for under the policy conditions.

(d) If you have any questions, contact

your local agent. If you are unable to contact the agent, refer questions to the nearest National Flood Insurance Servicing Center.

Subpart B—Claims Adjustment and Judicial Review

§62.21 Claims adjustment.

(a) In accordance with the Agreement, the servicing agent shall arrange for the prompt adjustment and settlement and payment of all claims arising from policies of insurance issued under the program. Investigation of such claims may be made through the facilities of its subcontractors or insurance adjustment organizations, to the extent required and appropriate for the expeditious processing of such claims.

(b) All adjustment of losses and settlements of claims shall be made in accordance with the terms and conditions of the policy and Parts 61 and 62 of this subchapter.

§62.22 Judicial Review.

(a) Upon the disallowance by the Federal Insurance Administration or the servicing agent of any claim on grounds other than failure to file a proof of loss, or upon the refusal of the claimant to accept the amount allowed upon any such claim, after appraisal pursuant to policy provisions, the claimant within one year after the date of mailing by the Federal Insurance Administration or the servicing agent of the notice of disallowance or partial disallowance of the claim may, pursuant to 42 U.S.C. 4053, institute an action on such claim against the Director of the Federal Emergency Management Agency in the U.S. District Court for the district in which the insured property or the major portion thereof shall have been situated, without regard to the amount in controversy.

(b) Service of process for all judicial proceedings where a claimant is suing Director pursuant to 42 U.S.C. 4071 shall be made upon the appropriate United States Attorney, the Attorney General of the United States, and the Director of the Federal Emergency Management Agency.

PART 63—[RESERVED]

PART 64—COMMUNITIES ELIGIBLE FOR THE SALE OF INSURANCE

Sec.

Authority: Sec. 7(b), 79 Stat. 670; 42 U.S.C. 3535(d); Sec. 1361, 82 Stat. 587; 42 U.S.C. 4102; Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963), unless otherwise noted.

Source: 41 FR 46986, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

§64.1 Purpose of Part.

(a) 42 U.S.C. 4012(c), 4022, and 4102 require that flood insurance in the maximum limits of coverage under the regular program shall be offered in communities only after the Administrator has: (1) Identified the areas of special flood, mudslide (i.e., mudflow) or flood-related erosion hazards within the community under Part 65 of this subchapter; and/or (2) completed a risk study for the applicant community. A period of 15 years ending July 31, 1983, was allotted for this purpose. The priorities for conducting such risk studies are set forth in §§59.23 and 60.25 of this subchapter. A purpose of this Part is periodically to list those communities in which the sale of insurance under the regular program has been authorized.

(b) 42 U.S.C. 4056 authorizes an emergency implementation of the National Flood Insurance Program whereby, for a period ending on September 30, 1978, the Administrator may make subsidized coverage available to eligible communities prior to the completion of detailed risk studies for such areas. This Part also describes procedures under the emergency program and lists communities which become eligible under that program.

(National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4128); and Secretary's delegation of authority to Federal Insurance Administrator, 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))

[41 FR 46986, Oct. 26, 1976, as amended at 43 FR 7141, Feb. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979]

§64.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§64.3 Flood Insurance Maps.

(a) The following maps may be prepared by the Administrator for use in connection with the sale of flood insurance:

(1) Flood Insurance Rate Map (FIRM): This map is prepared after the risk study for the community has been completed and the risk premium rates have been established. It indicates the risk premium rate zones applicable in the community and when those rates are effective. The symbols used to designate those zones are as follows:

Zone symbol:	
A	Area of special flood hazard without water surface elevations determined.
A1-99	Area of special flood hazard with water surface elevations determined.
A0	Area of special flood hazards having shallow water depths and/or unpredictable flow paths between (1) and (3) ft.
V1-30	Area of special flood hazards, with velocity, that is inundated by tidal floods (coastal high hazard area).
V0	Area of special flood hazards having shallow water depths and/or unpredictable flow paths between (1) and (3) ft. and with velocity.
B	Area of moderate flood hazards.
C	Area of minimal hazards.
D	Area of undetermined but possible, flood hazards.
M	Area of special mudslide (i.e., mudflow) hazards.
N	Area of moderate mudslide (i.e., mudflow) hazards.
P	Area of undetermined, but possible, mudslide hazards.
E	Area of special flood-related erosion hazards.

Areas identified as subject to more than one hazard (flood, mudslide (i.e., mudflow), flood-related erosion) will be designated by use of the proper symbols in combination.

(2) Flood Hazard Boundary Map (FHBM). This map is issued by the Administrator delineating Zones A, M, and E within a community.

(b) Notice of the issuance of new or revised FHBMs or FIRMs is given in Part 65 of this subchapter. The mandatory purchase of insurance is required within designated Zones A, Al-99, A0, V1-30, V0, M, and E.

(c) The FHBM or FIRM shall be maintained for public inspection at the following locations:

(1) The Information Office of the State agency or agencies designated by statute or the respective Governors to cooperate with the Administrator in implementing the Program whenever a community becomes eligible for Program participation and the sale of insurance pursuant to this section or is identified as flood-prone pursuant to Part 65 of this subchapter;

(2) One or more official locations within the community in which flood insurance is offered, which shall be specified in Part 65 of this subchapter at the time identification of the community as flood-prone is announced by publication in the Federal Register;

(3) The NFIA servicing company for the State or area (additional copies may be obtained from the appropriate servicing company) (See §62.7);

(4) The official record copy of each official map shall be maintained in FIA files in Washington, D.C.

§64.4 Effect on community eligibility resulting from boundary changes, governmental reorganization, etc.

(a) When a community not participating in the Program acquires by means of annexation, incorporation, or otherwise, an area within another community participating in the Program, no new flood insurance shall be made available as of the effective date of annexation until the newly acquiring community participates in the Program. Until the effective date of participation, existing flood insurance policies remain in effect until the policy's date of expiration, but shall not be renewed.

(b) When a community participating in the Program acquires by means of annexation, incorporation, or otherwise, another area which was previously located in a community either participating or not participating in the Program, the community shall have six months from the date of acquisition to formally amend its flood plain management regulations in order to include all flood-prone areas within the newly acquired area. The amended regulations shall satisfy the applicable requirements in §60.3 of this subchapter based on the data previously provided by the Administrator. In the event that the newly acquired area was previously located in a community participating in the Program, the provisions of this section shall only apply if the community, upon acquisition, and pending formal adoption of the amendment to its flood plain management regulations, certifies in writing over the signature of a community official that within the newly acquired area the flood plain management requirements previously applicable in the area remain in force. In the event that the newly-acquired area was previously located in a community not participating in the Program, the provisions of the section shall only apply if the community, upon acquisition, and pending formal adoption of the amendments to its flood plain management regulations, certifies in writing over the signature of a community official that it shall enforce within the newly-acquired area the requirements of §60.3(b) of this subchapter. During the six month period, existing flood insurance policies shall remain in effect until their date of expiration may be renewed, and new policies may be issued. Failure to satisfy the applicable requirements in §60.3 shall result in the community's suspension from Program participation pursuant to §59.24 of this subchapter.

(c) When an area previously a part of a community participating in the Program becomes autonomous or becomes a portion of a newly autonomous community resulting from boundary changes, governmental reorganization, changes in state statutes or constitution, or otherwise, such new community shall be given six months from the date of its independence, to adopt flood plain management regulations within the special hazard areas subject to its jurisdiction and to submit its application for participation as a separate community in order to retain eligibility for the sale of flood insurance. The regulations adopted by such new community shall satisfy the applicable requirements in §60.3 of this subchapter based on the data previously provided by the Administrator. The provisions of this section shall only apply where the new community upon the date of its independence certifies in writing over the signature of a community official that, pending formal adoption of flood plain management regulations, the flood plain management requirements previously applicable in that area remain in effect. During the six month period, existing flood insurance policies shall remain in effect until their dates of expiration may be renewed, and new policies may be issued. Failure to satisfy the applicable requirements in §60.3 of this subchapter shall result in the community's suspension from Program participation pursuant to §59.24 of this subchapter.

(d) Where any community or any area within a community had in effect a FHBM or FIRM, but all or a portion of that community has been acquired by another community, or becomes autonomous, that map shall remain in effect until it is superseded by the Administrator, whether by republication as part of the map of the acquiring community, or otherwise.

(e) When a community described in paragraph (a), (b), (c), or (d) of this section has flood elevations in effect, no new appeal period under Parts 66, 67, and 68 of this subchapter will begin except as new scientific and technical data are available.

§64.5 Relationship of rates to zone designations.

(a) In order to expedite a community's qualification for flood insurance under the emergency program, the Administrator may authorize the sale of such insurance without designating any Zones A, M, or E within a community, provided the community has previously adopted flood plain management regulations meeting the requirements of §60.3(a), §60.4(a) or §60.5(a) of this subchapter. When the Administrator has obtained sufficient technical information to delineate Zones A, M, or E, he/she shall delineate the tentative boundaries on a FHBM.

(b) Upon the effective date of the FIRM, flood insurance will continue to be available throughout the entire community at chargeable rates (i.e., subsidized) for first layer coverage of existing structures, but will be only available at risk premium rates for all new construction and substantial improvements. Upon the effective date of a FIRM, second layer coverage is available only at risk premium rates for all structures.

(c) Detailed insurance information may be obtained from the servicing companies. See Part 62 of this subchapter.

§64.6 List of eligible communities.

The sale of flood insurance pursuant to the National Flood Insurance Program (42 U.S.C. 4001-4128) is authorized for the communities set forth under this section. Previous listings under this Part continue in effect until revised.

Note.—For references to FR pages showing lists of eligible communities, see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

PART 65—IDENTIFICATION AND MAPPING OF SPECIAL HAZARD AREAS

Authority: Sec. 7(d), 79 Stat. 670; 42 U.S.C. 3535(d), Sec. 1360, 82 Stat. 587, 42 U.S.C. 4101; Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963), unless otherwise noted.

Source: 41 FR 46987, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

§65.1 Purpose of Part.

42 U.S.C. 4101 authorizes the Administrator to identify and publish information with respect to all areas within the United States having special flood, mudslide (i.e., mudflow) and flood related erosion hazards. The purpose of this Part is to list those communities that have been identified by the Administrator as having such special flood, mudslide (i.e., mudflow) or flood-related erosion hazards. Additional communities will be added to this list from time to time as the necessary information becomes available. This Part also provides a list of communities for which detailed engineering data in the form of water surface elevation data for the flood with one percent chance of being equalled or exceeded in any given year and the flood insurance rate zones for the special hazard areas within those communities has been made available. Additionally, this Part contains information concerning the revision of Flood Hazard Boundary Maps (FHBM's) or Flood Insurance Rate Maps (FIRM's), and notice of administrative withdrawal of special flood hazard maps (i.e., FHMB's or FIRM's).

§65.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§65.3 List of communities with special hazard areas (FHBM's in effect).

Note.—For the list of communities and the designated A, M, and E zones issued under this Section and not carried in the Code of Federal Regulations, see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

§65.4 List of communities with detailed engineering data (FIRM's).

(a) *General.* This section provides a cumulative list of communities for which the Administrator already has in effect, or has scheduled to have in effect, a FIRM, thereby usually providing water surface elevations for all or portions of Zones A and V.

(b) The effective date of the most recent revision of the FIRM for the communities listed are entered as follows (which will not appear in the Code of Federal Regulations except for the page number at this entry in the Federal Register).

[42 FR 9110, Feb. 14, 1977. Redesignated at 44 FR 31177, May 31, 1979]

Note.—For a list of communities issued under this section and not carried in the CFR see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

§65.5 Requirement to submit new technical data.

A community's base flood elevations may increase or decrease resulting from physical changes affecting flooding conditions. Within six months of the date that such information becomes available, a community shall notify the Administrator of the changes by submitting technical or scientific data in accordance with this paragraph. Such submission is necessary so that upon confirmation of those physical changes affecting flooding conditions risk premium rates and flood plain management requirements will be based upon current data.

(a) The Chief Executive Officer (CEO) of a community participating in the Program shall submit to the Administrator technical or scientific information indicating that the base flood elevations on the community's FIRM do not accurately reflect flood risks as they currently exist. Such information shall include, but not necessarily be limited to:

(1) A topographic map exhibiting ground elevation contours in greater detail than maps available at the time of the flood insurance study, or exhibiting topographic or ground elevation changes since the flood insurance study was performed; and

(2) Hydrologic data which has become available since the flood insurance study was performed, such as photographs or historical records of a major flooding occurrence or a flood study or information developed by an appropriate authoritative source, such as a Federal or State agency, a County Water Control District, and a County, City or private registered professional engineer. Hydrologic information shall be of sufficient detail so that the hydrologic computations may be evaluated by the Administrator, or

(3) Information about flood control projects, such as stream channelization, construction of new dams, reservoirs, artificial canals, private levees, or flood protection systems. Such information shall:

(i) Be submitted at least six months prior to the expected completion date of the project, and

(ii) Include a complete plan of the project with cross sections and dimensions, together with a detailed map of the affected area indicating changes in base flood elevations caused by construction of the project, and

(iii) Be reflected on the community's FIRM only after the project has been completed, except as may be provided in this subchapter.

(b) The technical and scientific information indicating changes in base flood elevations shall be submitted to:

Engineering Division, Office of Flood Insurance, Federal Insurance Administration, Federal Emergency Management Agency, 1725 I Street, NW, Washington DC 20472.

(c) Upon receipt of the scientific or technical data, the Administrator shall (1) mail an acknowledgement to the CEO, and (2) notify the CEO within 90 days that:

(i) The base flood elevations on the effective FIRM are correct and shall not be modified; or

(ii) The flood elevations on the effective FIRM shall be modified, and new base flood elevations shall be established under the provisions of Part 67 of this subchapter; or

(iii) An additional 90 days is required to evaluate the scientific or technical data submitted.

§65.6 Administrative withdrawal of maps.

(a) *Flood Hazard Boundary Maps (FHBM's).*

The following is a cumulative list of withdrawals pursuant to this Part:

40 FR 5149
40 FR 17015
40 FR 20798
40 FR 46102
40 FR 53579
40 FR 56672
41 FR 1478
41 FR 50990
41 FR 13352
41 FR 17726
42 FR 8895
42 FR 29433
42 FR 46226
42 FR 64076
43 FR 24019
44 FR 815
44 FR 6383
44 FR 18485
44 FR 25636
44 FR 34120
44 FR 52835

(b) *Flood Insurance Rate Maps (FIRM's)*

The following is a cumulative list of withdrawals pursuant to this Part:

40 FR 17015
41 FR 1478
42 FR 49811
42 FR 64076
43 FR 24019
44 FR 25636
44 FR 52835

(National Flood Insurance Act of 1968 (title XIII of the Housing and Urban Development Act of 1968); effective Jan. 28, 1969 (33 FR 17804, Nov. 28, 1968), as amended, 42 U.S.C. 4001—4128; Executive Order 12127, 44 FR 19367; and delegation of authority to Federal Insurance Administrator, 44 FR 20963)

[44 FR 52836, Sept. 11, 1979]

Note.—For the list of communities issued under this section, and not carried in the CFR, see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

§65.7 List of communities with minimal hazard areas.

[43 FR 24022, June 2, 1978. Redesignated at 44 FR 31177, May 31, 1979]

Note.—For the list of communities issued under this section and not carried in the CFR see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

§65.8 List of communities with no special flood hazard areas.

[43 FR 36241, Aug. 16, 1978. Redesignated at 44 FR 31177, May 31, 1979]

Note.—For the list of communities issued under this section and not carried in the CFR see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

§65.9 List of communities with minimal flood hazard areas.

[44 FR 5079, Jan. 25, 1979. Redesignated at 44 FR 31177, May 31, 1979]

Note.—For the list of communities issued under this section and not carried in the CFR see the List of CFR Sections Affected appearing in the Finding Aids section of this volume.

PART 66—CONSULTATION WITH LOCAL OFFICIALS

Sec.

Authority: Sec. 205(a), 87 Stat. 983 (42 U.S.C. 4128); Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 41 FR 46988, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

§66.1 Purpose of part.

(a) The purpose of this Part is to comply with section 206 of the Flood Disaster Protection Act of 1973 (42 U.S.C. 4107) by establishing procedures for flood elevation determinations of Zones A1-99 and V1-30 within the community so that adequate consultation with the community officials shall be assured.

(b) The procedures in this Part shall apply when base flood elevations are to be determined or modified.

(c) The Administrator or his delegate shall:

(1) Specifically request that the community submit pertinent data concerning flood hazards, flooding experience, plans to avoid potential hazards, estimate of historical and prospective economic impact on the community, and such other appropriate data (particularly if such data will necessitate a modification of a base flood elevation).

(2) Notify local officials of the progress of surveys, studies, investigations, and of prospective findings, along with data and methods employed in reaching such conclusions; and

(3) Encourage local dissemination of surveys, studies, and investigations so that interested persons will have an opportunity to bring relevant data to the attention of the community and to the Administrator.

§66.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§66.3 Establishment of community case file and flood elevation study docket.

(a) A file shall be established for each community at the time initial consideration is given to studying that community in order to establish whether or not it contains flood-prone areas. Thereafter, the file shall include copies of all correspondence with officials in that community. As the community is tentatively identified, provided with base flood elevations, or suspended and reinstated, documentation of such actions by the Administrator shall be placed in the community file. Even if a map is administratively rescinded or withdrawn after notice under Part 65 of this subchapter or the community successfully rebuts its flood-prone designation, the file will be maintained indefinitely.

(b) A portion of the community file shall be designated a flood elevation study consultation docket and shall be established for each community at the time the contract is awarded for a flood elevation study. The docket shall include copies of (1) all correspondence between the Administrator and the community concerning the study, reports of any meetings among the Federal Insurance Administration representatives, property owners of the community, the state coordinating agency, study contractors or other interested persons, (2) relevant publications, (3) a copy of the completed flood elevation study, and (4) a copy of the Administrator's final determination.

(c) A flood elevation determination docket shall be established and maintained in accordance with Part 67 of this subchapter.

§66.4 Appointment of consultation coordination officer.

The Administrator shall appoint an employee of the Federal Emergency Management Agency, or other designated Federal employee, as the Consultation Coordination Officer (CCO) for each community when a contract is awarded for a Flood Elevation Study, and, in writing, shall advise the community and the appropriate state coordinating agency or official for the state in which the community is located of the designation of the CCO.

§66.5 Responsibilities of CCO.

(a) The CCO shall be responsible for arranging consultation among appropriate officials of a community in which any proposed Flood Insurance Study is undertaken, the state coordinating agency, and the organization under contract or the auspices of the Federal Insurance Administration undertaking the study.

(b) The CCO shall encourage local dissemination of surveys, studies, and investigations so that interested parties will have an opportunity to bring relevant data to the attention of the community and to the Administrator.

(c) The CCO shall be responsible for encouraging the submission of community information concerning the study by providing sample press releases or other materials to accomplish such purpose.

§66.6 Duties of CCO.

(a) The primary duty of a CCO is to provide consultation with appropriate officials of the community so that they may be fully informed of (1) the responsibilities placed on them by the Program, (2) the administrative procedures followed by the Federal Insurance Administration, (3) the community's role in developing the FIRM, and (4) the responsibilities of the community if it participates or continues to participate in the Program.

(b) Before the commencement of the community's proposed Flood Insurance Study, the CCO for the community in which the study is to be conducted, together with a representative of the organization undertaking the study, shall meet with officials of the community. The state coordinating agency shall be notified of this meeting and may attend it. At this meeting, the CCO shall inform the local officials of (1) the date when the study will commence, (2) the nature and purpose of the study, (3) the areas involved, (4) the manner in which the study shall be undertaken, (5) the general principles to be applied, and (6) the intended use of the data obtained.

(c) After a Flood Insurance Study has commenced in any community, the CCO for that community shall serve as a liaison among the local officials, the state coordinating agency, and the organization undertaking the study in order to keep all interested parties informed as to the progress of the study.

PART 67—APPEALS FROM PROPOSED FLOOD ELEVATION DETERMINATIONS

Authority: Sec. 1304(a), 82 Stat. 574 (42 U.S.C. 4012); Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 41 FR 46989, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

§67.1 Purpose of Part.

The purpose of this Part is to establish procedures implementing the provisions of section 110 of Flood Disaster Protection Act of 1973.

§67.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§67.3 Establishment and maintenance of a flood elevation determination docket (FEDD).

The Administrator shall establish a docket of all matters pertaining to flood elevation determinations. The docket files shall contain the following information:

(a) The name of the community subject to the flood elevation determination;

(b) A copy of the notice of the proposed flood elevation determination to the Chief Executive Officer (CEO) of the Community;

(c) A copy of the notice of the proposed flood elevation determination published in a prominent local newspaper of the community;

(d) A copy of the notice of the proposed flood elevation determination published in the Federal Register;

(e) Copies of all appeals by private persons received by the Administrator from the CEO;

(f) Copies of all comments received by the Administrator on the notice of the proposed flood elevation determination published in the Federal Register.

(g) A copy of the community's appeal or a copy of its decision not to appeal the proposed flood elevation determination;

(h) A copy of the flood insurance study for the community;

(i) A copy of the FIRM for the community;

(j) Copies of all materials maintained in the flood elevation study consultation docket; and

(k) A copy of the final determination with supporting documents.

§67.4 Proposed flood elevation determination.

The Administrator shall propose flood elevation determinations in the following manner:

(a) Publication of the proposed flood elevation determination for comment in the Federal Register;

(b) Notification by certified mail, return receipt requested, of the proposed flood elevation determination to the CEO; and

(c) Publication of the proposed flood elevation determination in a prominent local newspaper at least twice during the ten day period immediately following the notification of the CEO.

§67.5 Right of appeal.

(a) Any owner or lessee of real property, within a community where a proposed flood elevation determination has been made pursuant to section 1363 of the National Flood Insurance Act of 1968, as amended, who believes his property rights to be adversely affected by the Administrator's proposed determination, may file a written appeal of such determination with the CEO, or such agency as he shall publicly designate, within ninety days of the second newspaper publication of the Administrator's proposed determination.

§67.6 Basis of appeal.

The sole basis of an appeal under this Part shall be the possession of knowledge or information indicating that the elevations proposed by the Administrator are scientifically or technically incorrect.

§67.7 Collection of appeal data.

(a) Appeals by private persons to the CEO shall be submitted within ninety (90) days following the second newspaper publication of the Administrator's proposed flood elevation determination to the CEO or to such agency as he may publicly designate and shall set forth scientific or technical data that tend to negate or contradict the Administrator's findings.

(b) Copies of all individual appeals received by the CEO shall be forwarded, as soon as they are received, to the Administrator for information and placement in the Flood Elevation Determination Docket.

(c) The CEO shall review and consolidate all appeals by private persons and issue a written opinion stating whether the evidence presented is sufficient to justify an appeal on behalf of such persons by the community in its own name.

(d) The decision issued by the CEO on the basis of his review, on whether an appeal by the community in its own name shall be made, shall be filed with the Administrator not later than ninety days after the date of the second newspaper publication of the Administrator's proposed flood elevation determination and shall be placed in the FEDD.

§67.8 Appeal procedure.

(a) If a community appeals the proposed flood elevation determination, the Administrator shall review and take fully into account any technical or scientific data submitted by the community that tend to negate or contradict the information upon which his/her proposed determination is based.

(b) The Administrator shall resolve such appeal by consultation with officials of the local government, or by administrative hearings under the procedures set forth in Part 68 of this subchapter or by submission of the conflicting data to an independent scientific body or appropriate Federal agency for advice.

(c) The final determination by the Administrator where an appeal is filed shall be made within a reasonable time.

(d) Nothing in this section shall be considered to compromise an appellant's rights granted under §67.12.

(e) The Administrator shall make available for public inspection the reports and other information used in making the final determination. This material shall be admissible in a court of law in the event the community seeks judicial review in accordance with §67.12.

§67.9 Final determination in the absence of an appeal by the community.

(a) If the Administrator does not receive an appeal from the community within the ninety days provided, he shall consolidate and review on their own merits the individual appeals which, in accordance with §67.7 are filed within the community and forwarded by the CEO.

(b) The final determination shall be made pursuant to the procedures in §67.8 and, modifications shall be made of his proposed determination as may be appropriate, taking into account the written opinion, if any, issued by the community in not supporting such appeals.

§67.10 Rates during pendency of final determination.

(a) Until such time as a final determination is made and proper notice is given, no person within a participating community shall be denied the right to purchase flood insurance at the subsidized rate.

(b) After the final determination and upon the effective date of a FIRM, risk premium rates will be charged for new construction and substantial improvements. The effective date of a FIRM shall begin no later than six months after the final flood elevation determination.

§67.11 Notice of final determination.

The Administrator's notice of the final flood elevation determination for a community shall be in written form and published in the Federal Register, and copies shall be sent to the CEO, all individual appellants and the State Coordinating Agency.

§67.12 Appeal to District Court.

(a) An appellant aggrieved by the final determination of the Administrator may appeal such determination only to the United States District Court for the District within which the community is located within sixty days after receipt of notice of determination.

(b) During the pendency of any such litigation, all final determinations of the Director shall be effective for the purposes of this title unless stayed by the court for good cause shown.

(c) The scope of review of the appellate court shall be in accordance with the provisions of 5 U.S.C. 706, as modified by 42 U.S.C. 4104(b).

PART 68—ADMINISTRATIVE HEARING PROCEDURES

Authority: Sec. 1304(a), 82 Stat. 574 (42 U.S.C. 4012); Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 41 FR 46990, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

§68.1 Purpose of Part.

The purpose of this Part is to establish procedures for appeals of the Administrator's base flood elevation determination, whether proposed pursuant to section 1363(e) of the Act (42 U.S.C. 4104) or modified because of changed conditions or the availability of additional newly acquired scientific or technical information.

§68.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§68.3 Right to administrative hearings.

An administrative hearing under this Part shall only be held if a community appeals the Administrator's flood elevation determination established pursuant to §67.8 of this subchapter, or otherwise, and the Administrator has determined that such appeal cannot be resolved by consultation with officials of the community, or by submission of the conflicting data to an independent scientific body or appropriate Federal agency for advice.

§68.4 Judge.

Each hearing shall be conducted by an Administrative Law Judge (hereinafter "Judge") certified by the Civil Service Commission or by a Hearing Officer (hereinafter "Judge") designated by the Director.

§68.5 Establishment of docket.

The General Counsel shall establish a docket for appeals referred to him by the Administrator for administrative hearings. This docket shall include, for each appeal, copies of all materials contained in the FEDD file on the matter, copies of all correspondence in connection with the appeal, all motions, orders, statements, and other legal documents, a transcript of the hearing, and the judge's final determination.

§68.6 Time and place of hearing.

(a) The time and place of each hearing shall be designated by the judge for that hearing. He shall promptly advise the Administrator and the General Counsel of such designation.

(b) The judge's notice of the time and place of hearing shall be sent by the Flood Insurance Docket Clerk by registered or certified mail, return receipt requested, to all appellants. Such notice shall include a statement indicating the nature of the proceedings and their purpose and all appellants' entitlement to counsel. Notice of the hearing must be sent no less than 30 days before the date of hearing unless such period is waived by all appellants.

§68.7 Conduct of hearings.

(a) The judge shall be responsible for the fair and expeditious conduct of proceedings.

(b) The Administrator shall be represented by the General Counsel or his designee.

(c) One administrative hearing shall be made for any one community unless the judge for good cause shown grants a separate appeal or appeals.

(d) The CEO or his designee shall represent all appellants from that community; provided that any appellant may petition the judge to allow such appellant to make an appearance on his own behalf. Such a petition shall be granted only upon a showing of good cause.

(e) The Administrator shall assure that a transcribed verbatim record is made of the proceeding which shall be available for inspection by any appellant. An appellant may order copies of the transcribed verbatim record directly from the reporter and shall be responsible for payments.

§68.8 Scope of review.

Review at administrative hearings shall be limited to an examination of knowledge or information presented by each appellant indicating that elevations proposed by the Administrator are scientifically or technically incorrect.

§68.9 Admissible evidence.

(a) Legal rules of evidence shall not be in effect at administrative hearings. However, only evidence relevant to issues within the scope of review under §68.8 shall be admissible.

(b) The community's FEDD file shall be admissible.

(c) Documentary and testimonial evidence shall be admissible.

(d) Admissibility of non-expert testimony shall be within the discretion of the judge.

(e) The community's statement of reasons for appealing shall be admissible.

(f) All testimony shall be under oath.

§68.10 Burden of proof.

The burden shall be on appellants to prove that the flood elevation determination is not scientifically or technically correct.

§68.11 Right of judge to obtain scientific or technical advice.

The judge may submit conflicting technical or scientific data to an independent scientific body or appropriate Federal agency for advice.

§68.12 Determination.

The judge shall make a written determination on the evidence presented at the hearing within 30 days after the conclusion of the hearing.

§68.13 Relief.

The sole relief which shall be granted under this Part is a modification of the Administrator's proposed determination by the judge in accordance with his determination under §68.12. This modification shall be binding on the Administrator.

PART 69—[RESERVED]

PART 70—PROCEDURE FOR MAP CORRECTION

Mapping Deficiencies Unrelated to Community-Wide Elevation Determinations

Sec.

Authority: Sec. 1304(a), 82 Stat. 574 (42 U.S.C. 4011); Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 41 FR 46991, Oct. 26, 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

Mapping Deficiencies Unrelated to Community-Wide Elevation Determinations

§70.1 Purpose of Part.

The purpose of this Part is to provide an administrative procedure whereby the Federal Insurance Administrator (Administrator) will review the scientific or technical submissions of an owner or lessee of property who believes his property has been inadvertently included in designated A, A0, A1-99, V0 and V1-30 Zones, as a result of the transposition of the curvilinear line to either street or to other readily identifiable features. The necessity for this part is due in part to the technical difficulty of accurately delineating the curvilinear line on either a FHBM or FIRM. Where there has been a final base flood elevation determination, any alteration of the topography shall not be subject to this procedure. Appeals of such determinations are subject to the provisions of Part 67 of this subchapter.

§70.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§70.3 Right to submit technical information.

(a) Any owner or lessee of property (applicant) who believes his property has been inadvertently included in a designated A, A0, A1-99, V0 and V1-30 Zones on a FHBM or a FIRM, may submit scientific or technical information to the Administrator for his/her review.

(b) Scientific and technical information for the purpose of this Part may include, but is not limited to the following:

(1) An actual copy of the recorded plat map bearing the seal of the appropriate recordation official (e.g. County Clerk, or Recorder of Deeds) indicating the official recordation and proper citation (Deed or Plat Book Volume and Page Numbers), or an equivalent identification where annotation of the deed or plat book is not the practice.

(2) A topographical map showing (i) ground elevation contours, (ii) the total area of the property in question, (iii) the location of the structure or structures located on the property in question, (iv) the elevation of the lowest floor (including basement) of the structure or structures and (v) an indication of the curvilinear line which represents the area subject to inundation by a base flood. The curvilinear line should be based upon information provided by any appropriate authoritative source, such as a Federal Agency, the appropriate state agency (e.g. Department of Water Resources), a County Water Control District, a County or City Engineer, a Federal Insurance Administration Flood Insurance Study, or a determination by a Registered Professional Engineer;

(3) A copy of the FHBM or FIRM indicating the location of the property in question;

(4) A certification by a Registered Professional Engineer or Licensed Land Surveyor of the type of structure and that the lowest floor (including basement) of the

structure is above the base flood level. Where there has been a final flood elevation determination, and fill has altered the topography, such certification should include the date that the fill was placed on the property.

§70.4 Review by the Administrator.

The Administrator, after reviewing the scientific or technical information submitted under the provisions of §70.3, shall notify the applicant in writing of his/her determination within 60 days from the date of receipt of the applicant's scientific or technical information that:

(a) The property is within a designated A, A0, A1-99, V0 or V1-30 Zone, and shall set forth the basis of such determination; or

(b) The property should not be included within a designated A, A0, A1-99, V0, or V1-30 Zone and that the FHBM or FIRM will be modified accordingly; or

(c) An additional 60 days is required to make a determination.

§70.5 Letter of Map Amendment.

Upon determining from available scientific or technical information that a FHBM or a FIRM requires modification under the provisions of §70.4(b), the Administrator shall issue a Letter of Map Amendment which shall state:

(a) The name of the Community to which the map to be amended was issued;

(b) The number of the map;

(c) The identification of the property to be excluded from a designated A, A0, A1-99, V0 or V1-30 Zone.

§70.6 Distribution of Letter of Map Amendment.

(a) A copy of the Letter of Map Amendment shall be sent to the applicant who submitted scientific or technical data to the Administrator.

(b) A copy of the Letter of Map Amendment shall be sent to the local map repository with instructions that it be attached to the map which the Letter of Map Amendment is amending.

(c) A copy of the Letter of Map Amendment shall be sent to the map repository in the state with instructions that it be attached to the map which it is amending.

(d) A copy of the Letter of Map Amendment will be sent to any community or governmental unit that requests such Letter of Map Amendment.

(e) A copy of the Letter of Map Amendment shall be sent to the National Flood Insurers Association.

(f) A copy of the Letter of Map Amendment will be maintained by the Federal Insurance Administration in its community case file.

§70.7 Notice of Letter of Map Amendment.

(a) The Administrator shall publish a notice in the Federal Register that the FIRM for a particular community has been amended by letter determination pursuant to this Part.

(b) The Administrator shall not publish a notice in the Federal Register that the FHBM for a particular community has been amended by letter determination pursuant to this Part. The Letter of Map Amendment provided under §§70.5 and 70.6 serves to inform the parties affected.

(National Flood Insurance Act of 1968 (Title XIII of Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17304, November 28, 1968), as amended; 42 U.S.C. 4001-4128; and Secretary's delegation of authority to Federal Insurance Administrator 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))
[42 FR 56953, Oct. 31, 1977. Redesignated at 44 FR 31177, May 31, 1979]

§70.8 Premium refund after Letter of Map Amendment.

A Standard Flood Insurance Policyholder whose property has become the subject of a Letter of Map Amendment under this Part may cancel the policy within the current policy year and receive a premium refund under the conditions set forth in §62.5 of this subchapter.

PARTS 71-74—[RESERVED]

PART 75—EXEMPTION OF STATE-OWNED PROPERTIES UNDER SELF-INSURANCE PLAN

Subpart A—General

Authority: Sec. 7(d), 79 Stat. 670 7(d); 42 U.S.C. 3535(d); and 42 U.S.C. 4128; Reorganization Plan No. 3 of 1978 (43 FR 41943) and Executive Order 12127, dated March 31, 1979 (44 FR 19367) and delegation of authority to Federal Insurance Administrator (44 FR 20963).

Source: 41 FR 46991, Oct. 26 1976, unless otherwise noted. Redesignated at 44 FR 31177, May 31, 1979.

Subpart A—General

§75.1 Purpose of Part.

The purpose of this Part is to establish standards with respect to the Administrator's determinations that a State's plan of self-insurance is adequate and satisfactory for the purposes of exempting such State, under the provisions of section 102(c) of the Act, from the requirement of purchasing flood insurance coverage for State-owned structures and their contents in areas identified by the Administrator as A, A0, M, V, V0, and E Zones, in which the sale of insurance has been made available, and to establish the procedures by which a State may request exemption under section 102(c).

§75.2 Definitions.

The definitions set forth in Part 59 of this subchapter are applicable to this Part.

§75.3 Burden of proof.

In any application made by a State to the Administrator for certification of its self-insurance plan, the burden of proof shall rest upon the State making application to establish that its policy of self-insurance is adequate and equals or exceeds the standards provided in this Part.

Subpart B—Standards for Exemption

§75.10 Applicability.

A State shall be exempt from the requirement to purchase flood insurance in respect to State-owned structures and, where applicable, their contents located or to be located in areas identified by the Administrator as A, A0, M, V, V0 and E Zones, and in which the sale of flood insurance has been made available under the National Flood Insurance Act of 1968, as amended, provided that the State has established a plan of self-insurance determined by the Administrator to equal or exceed the standards set forth in this subpart.

§75.11 Standards.

(a) In order to be exempt under this Part, the State's self insurance plan shall, as a minimum:

(1) Constitute a formal policy or plan of self-insurance created by statute or regulation authorized pursuant to statute.

(2) Specify that the hazards covered by the self-insurance plan expressly include the flood and flood-related hazards which are covered under the Standard Flood Insurance Policy.

(3) Provide coverage to state-owned structures and their contents equal to that which would otherwise be available under a Standard Flood Insurance Policy.

(4) Consist of a self-insurance fund and/or a commercial policy of insurance or reinsurance for which provision is made in statute or regulation and which is funded by periodic premiums or charges allocated for state-owned structures and their contents in areas identified by the Administrator as A, A0, M, V, V0, and E Zones. The person or persons responsible for such self-insurance fund shall report on its status to the chief executive authority of the State, or to the legislature, or both, not less frequently than annually. The loss experience shall be shown for each calendar or fiscal year from inception to current date based upon loss and loss adjustment expense incurred during each separate calendar or fiscal year compared to the premiums or charges for each of the respective calendar or fiscal years. Such incurred losses shall be reported in aggregate

by cause of loss under a loss coding system adequate, as a minimum, to identify and isolate loss caused by flood, mudslide (i.e., mudflow) or flood-related erosion. The Administrator may, subject to the requirements of paragraph (a)(5) of this section, accept and approve in lieu of, and as the reasonable equivalent of the self-insurance fund, an enforceable commitment of funds by the State, the enforceability of which shall be certified to by the State's Attorney General, or other principal legal officer. Such funds, or enforceable commitment of funds in amounts not less than the limits of coverage which would be applicable under Standard Flood Insurance Policies, shall be used by the State for the repair or restoration of State-owned structures and their contents damaged as a result of flood-related losses occurring in areas identified by the Administrator as A, A0, M, V, V0, and E Zones.

(5) Provide for the maintaining and updating by a designated State official or agency not less frequently than annually of an inventory of all State-owned structures and their contents within A, A0, M, V, V0, and E Zones. The inventory shall: (i) Include the location of individual structures; (ii) include an estimate of the current replacement costs of such structures and their contents, or of their current economic value; and (iii) include an estimate of the anticipated annual loss due to flood damage.

(6) Provide the flood loss experience for State-owned structures and their contents based upon incurred losses for a period of not less than the 5 years immediately preceding application for exemption, and certify that such historical information shall be maintained and updated.

(7) Include, pursuant to §60.12 of this subchapter, a certified copy of the flood plain management regulations setting forth standards for State-owned properties within A, A0, M, V, V0, and E Zones.

(b) The Administrator shall determine the adequacy of the insurance provisions whether they be based on available funds, an enforceable commitment of funds, commercial insurance, or some combination thereof, but has discretion to waive specific requirements under this Part.

§75.12 Application by a State for exemption.

Application for exemption made pursuant to this Part shall be made by the Governor or other duly authorized official of the State accompanied by sufficient supporting documentation which certifies that the plan of self-insurance upon which the application for exemption is based meets or exceeds the standards set forth in §75.11.

§75.13 Review by the Administrator.

(a) The Administrator may return the application for exemption upon finding it incomplete or upon finding that additional information is required in order to make a determination as to the adequacy of the self-insurance plan.

(b) Upon determining that the State's plan of self-insurance is inadequate, the Administrator shall in writing reject the application for exemption and shall state in what respects the plan fails to comply with the standards set forth in §75.11 of this subpart.

(c) Upon determining that the State's plan of self-insurance equals or exceeds the standards set forth in §75.11 of this subpart, the Administrator shall certify that the State is exempt from the requirement for the purchase of flood insurance for State-owned structures and their contents located or to be located in areas identified by the Administrator as A, A0, M, V, V0, and E Zones. Such exemption, however, is in all cases provisional. The Administrator shall review the plan for continued compliance with the criteria set forth in this Part and may request updated documentation for the purpose of such review. If the plan is found to be inadequate and is not corrected within ninety days from the date that such inadequacies were identified, the Administrator may revoke his certification.

(d) Documentation which cannot reasonably be provided at the time of application for exemption shall be submitted within six months of the application date. The Administrator may revoke his certification for a State's failure to submit adequate documentation after the six month period.

§75.14 States exempt under this Part.

The following States have submitted applications and adequate supporting documentation and have been determined by the Administrator to be exempt from the requirement of flood insurance on State-owned structures and their contents because they have in effect adequate State plans of self-insurance: Maine, Georgia, Oregon, and Florida.

(National Flood Insurance Act of 1968 (Title XIII of the Housing and Urban Development Act of 1968), effective January 28, 1969 (33 FR 17804, November 28, 1968), as amended (42 U.S.C. 4001-4128); and Secretary's delegation of authority to Federal Insurance Administrator, 34 FR 2680, February 27, 1969, as amended (39 FR 2787, January 24, 1974))

[43 FR 7141, Feb. 17, 1978. Redesignated at 44 FR 31177, May 31, 1979]

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availability should also be taken into consideration. Modeling objectives should be formulated to answer two fundamental questions:

1. What is the character and magnitude of the problem?

2. What is the method of analysis to achieve a solution to the problem?

Common runoff quantity and quality modeling objectives include:

Temporal and spatial characterization of nonpoint source runoff quality for prioritizing management programs;

Generation of data for input to receiving water quality models;

Assessment of BMP options for control of stormwater runoff;

Frequency and statistical analysis of exceedances of water quality criteria; and

Evaluation of the costs of various management alternatives.

The first and second objectives listed above assess the character and magnitude of nonpoint source pollutant impacts. The three remaining objectives are related to analysis and management techniques.

2.0 HYDROLOGIC CONSIDERATIONS

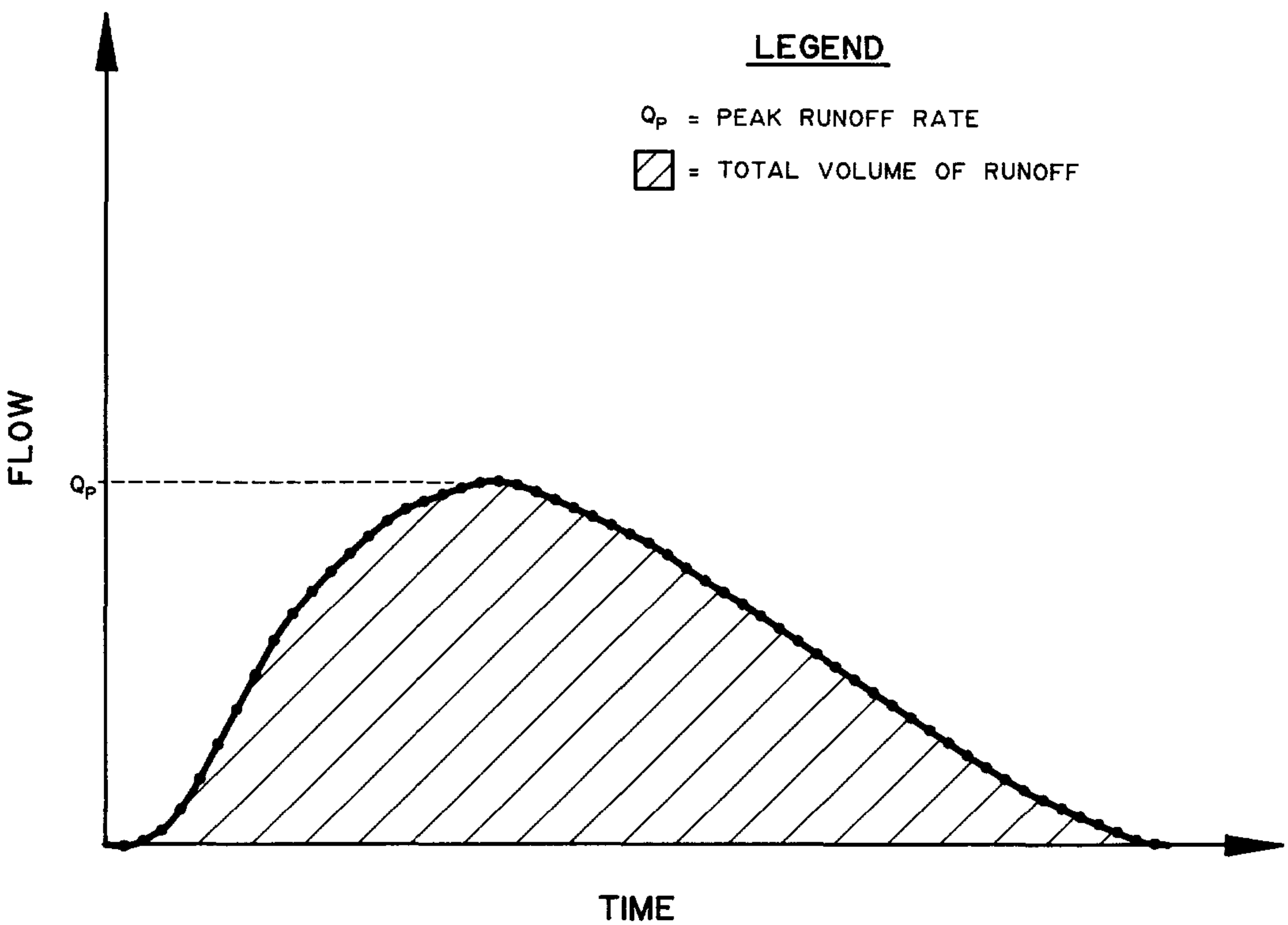
2.1 HYDROLOGIC MODELING FOR DRAINAGE CONTROL

The determination of runoff volumes and peak discharge rates for major design storms (e.g., 10-, 25-, and 100-year event) have traditionally been the primary focus of stormwater management planning and design in the past. The high cost of drainage channels, detention facilities and storm sewers have required accurate estimates of direct runoff to achieve the most cost-effective designs.

Extensive research efforts by governmental and private organizations have led to the development of numerous techniques to estimate runoff peaks and volumes. These techniques range from simple rainfall-runoff formulae and regression equations to highly sophisticated hydrologic simulation models. Traditionally, the recent advances in micro-computer technology have also aided in the development of methodologies for estimating runoff peaks and volumes.

In 1986, the Nueces County Stormwater Management Master Plan was completed (HDR, 1986). This document addressed flooding and drainage problem areas throughout Nueces County. Among the hydrological methods used in the 1986 Master Plan to calculate instantaneous peak discharge values for key points along drainageways included the U.S. Geological Survey Method (USGS, 1977) and the Cypress Creek Method (USDA, 1965). Peak discharge values were used to design drainage facilities.

Various other hydrologic models are currently used to assess drainage related issues. The Rational Method is a commonly used method for determining peak discharges for drainage design in urban watersheds. Peak discharge is calculated from watershed area, average rainfall intensity and a runoff coefficient representing the rainfall-runoff relationship for the study area. However, this method calculates only one point on a runoff hydrograph (peak runoff rate) and does not provide shape characteristics of the total hydrograph. As shown in Figure 2-1, a hydrograph is characterized not only by the peak runoff rate, but by a time series of points that can be continuously analyzed



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RUNOFF HYDROGRAPH

FIGURE NO. 2-1

to determine the total volume of runoff for a given storm. Therefore, the Rational Method is inappropriate for use in water quality modeling efforts since total annual or seasonal runoff quantities would be required.

Unit hydrograph and regional frequency correlations are also commonly used to determine runoff peaks and quantities for large storm events. Design runoff quantity model results are usually input or are contained as submodels to hydraulic programs that calculate peak stage and backwater elevations for drainage and flood control analyses. Similar to the Rational Method, these models are drainage oriented and have no inherent water quality applications. Regional frequency methods are primarily used to predict magnitude and frequency of floods along gaged streams. These single event, design storm runoff methodologies are inappropriate for estimating nonpoint pollution generation since water quality results will focus on annual average loadings, which take into consideration all rainfall events, including both small, frequent storms as well as large, infrequent storms.

To demonstrate the significance of small storm events in relation to annual runoff, an analysis of records obtained from the National Climactic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) for the Corpus Christi area was performed to determine the occurrence probabilities associated with specific rainfall amounts. Figure 2-2 presents the cumulative distribution of daily rainfall based on forty-one years of data (from January 1948 to December 1988). The data was screened to include only rainfall events of sufficient magnitude to generate runoff. The minimum rainfall depth for Corpus Christi was taken as 0.1 inch. Occurrence probabilities were then computed cumulatively, as daily rainfall increased from 0.1 to 8.0 inches. Examination of Figure 2-2 reveals that, over 90% of annual rainfall comes from storms of depth less than the one-year storm event. In the City of Corpus Christi, which averages 30.8 inches of rainfall per year, 75% of all runoff generating rainfall events each produce less than two inches of rainfall. This suggests that capturing runoff from "smaller" rainfall events will be sufficient to capture "most" of the rainfall that occurs on an average annual basis. It also demonstrates the usefulness of annual average runoff amounts (as opposed to large, single storm event rainfall amounts) for the

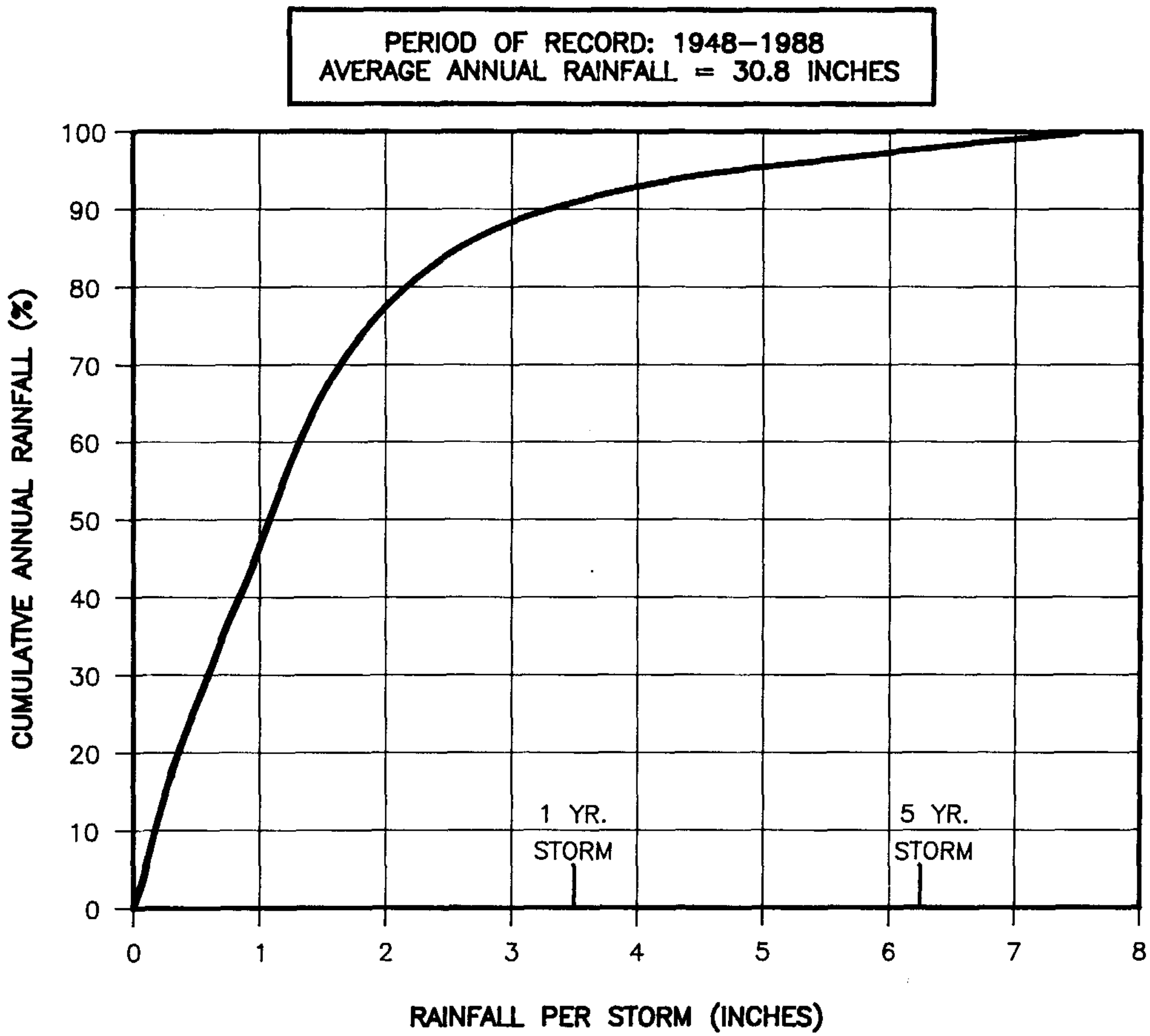

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FIGURE NO. 2-2

calculation of total pollutant loadings and the design of pollution control facilities (BMPs). Appendix A contains a technical paper, written recently by CDM staff, which further describes the design methodology for water quality applications.

A water quality approach which focuses on small frequent storms is in contrast to flood and drainage control design criteria applied in the City and County, which use the five and 25-year storm event peak discharge for facility capacity design.

2.2 HYDROLOGIC MODELING FOR STORMWATER POLLUTION MANAGEMENT

In the field of stormwater pollution management, a great deal of additional research and practical experience equivalent to that gained for flood control will be required before event-specific or peak pollution projections can be reliably simulated and event-specific pollution control criteria established. In other words, it is inappropriate at this time to require simulation of instantaneous stormwater pollution concentrations and develop control programs for specific events. Hydrologic simulation techniques for stormwater pollution studies must be established accordingly.

Stormwater simulation models generally have distinct submodels for hydrologic and water quality analyses and, thus, linkage to a separate hydrologic model is usually inappropriate. Most of these models first simulate the hydrologic/ hydraulic processes of the system, calculating the amount of rainfall converted to runoff using continuous rainfall records as input. Rainfall inputs may be at hourly, 15-minute or shorter intervals. However, only hourly rainfall data is typically available on a long-term basis. During storm events, the rainfall inputs are distributed among various storage compartments (surface depressions, soil infiltration, retention), and hydrologic/hydraulic processes are represented mathematically.

Nonpoint pollution loading factors are usually based on annual runoff volumes and event mean pollutant concentrations. Runoff volumes may be estimated using volumetric runoff coefficients (i.e. ratios of runoff to rainfall volume, not peak) applied to the impervious and pervious fractions of each land use category. Long-term monitoring records from local U.S. Geological Survey (USGS) stream gages and National Weather Service (NWS) rain gages can be used to calculate average annual runoff.

Runoff volumes may also be estimated by using regression equation models. Regression equations relating yearly and seasonal values of depth of runoff to average watershed precipitation have been developed by statistically analyzing observed data from several urban watersheds. Additionally, the same methodologies have been employed for relating peak discharge values to depth of runoff. A limitation of the regressional model is that it is watershed specific and may not easily be extrapolated to a large area or adjacent watersheds.

Therefore, it is recommended that runoff volumes be estimated using volumetric runoff coefficients to define a single, cumulative average annual pollution load estimate for each requisite constituent. The coefficients will be based on:

- land use;
- percent imperviousness; and
- soil type.

Runoff coefficients can be calibrated using available regression equations and measured rainfall-runoff data for the Corpus Christi area. During future master plan activities, additional rainfall-runoff data will become available from proposed wet weather monitoring. Refinement to the runoff coefficients can be made on a continual basis as this data becomes available.

3.0 MODELING METHODS

3.1 OVERVIEW

Available analytical techniques for simulation of urban runoff quality range from simple to very complex. The three general categories of nonpoint source runoff water quality models are:

1. Nonpoint Pollution Loading Factors;
2. Statistical/Regression Models; and
3. Water Quality Simulation Models.

A simple nonpoint source modeling technique utilizes pollutant loading factors. Pollutant loading factors (e.g., lbs/ac/yr) are typically based upon relationships between land use/impervious surface to long-term pollutant loadings. Complex continuous simulation models are also available which predict pollutant concentrations during individual storm events, as well as intervening dry periods. Continuous simulation models are typically "piggybacked" onto hydrologic simulation models.

Appendix B contains a recent evaluation of available stormwater pollution models prepared by Dr. Wayne Huber of the University of Florida. A synopsis of the modeling approaches described there are presented in the next sections. A representative model from each of the above categories is also described. Advantages and disadvantages for each method are then presented.

3.2 NONPOINT POLLUTION LOADING FACTORS

Nonpoint pollution monitoring studies throughout the U.S. over the past 10 years have shown that annual "per acre" discharges of urban stormwater pollution (e.g., nutrients, metals, BOD, fecal coliforms) are positively related to the amount of imperviousness in the land use (i.e. the more imperviousness the greater the nonpoint pollution load). Nonpoint pollution loading factors typically associate a long-term average pollutant export rate (e.g., lbs/ac/yr) to a land use (e.g., residential, commercial, urban). Nonpoint pollution loading factors are typically derived from available literature values and transferred to the area of interest by adjusting for local hydrologic conditions.

Models employing nonpoint pollution loading factors are typically restricted to the constituents for which there are considerable loading data reported in the literature, for example: total-P, total-N, sediment, and selected heavy metals (e.g., lead and zinc). Nationally, nonpoint pollutant loading factors have been developed for land use categories, under the National Urban Runoff Program (NURP), which can be extrapolated to local conditions to an accuracy suitable for conceptual management planning. These categories include urban (residential, commercial, industrial), agricultural (pasture, crop land), and other undeveloped land (forest, idle land).

Extensive monitoring of local stormwater events (typically 15 to 20 events per land use) can also be used to establish loading factors for a specific area. These factors are more accurate than national factors.

Continued master plan activities will require estimates of the annual cumulative pollutant load from all outfalls from the City's storm drainage system into receiving waters (not just major outfalls) and the event mean concentration (EMC) of the cumulative discharge from all outfalls during a "representative" storm. EMCs are defined as the total pollutant mass divided by the total runoff volume over the representative storm. Pollutants to be estimated include: BOD_5, COD, TSS, dissolved solids, total-N, ammonia, organic-N, total-P, dissolved-P, cadmium, copper, lead and zinc. For future master planning efforts, these estimates are to be accompanied by a description of the procedures used to estimate loads and concentrations, including a description of the representative storm, discharge monitoring, modeling, data analysis, and calculation methods.

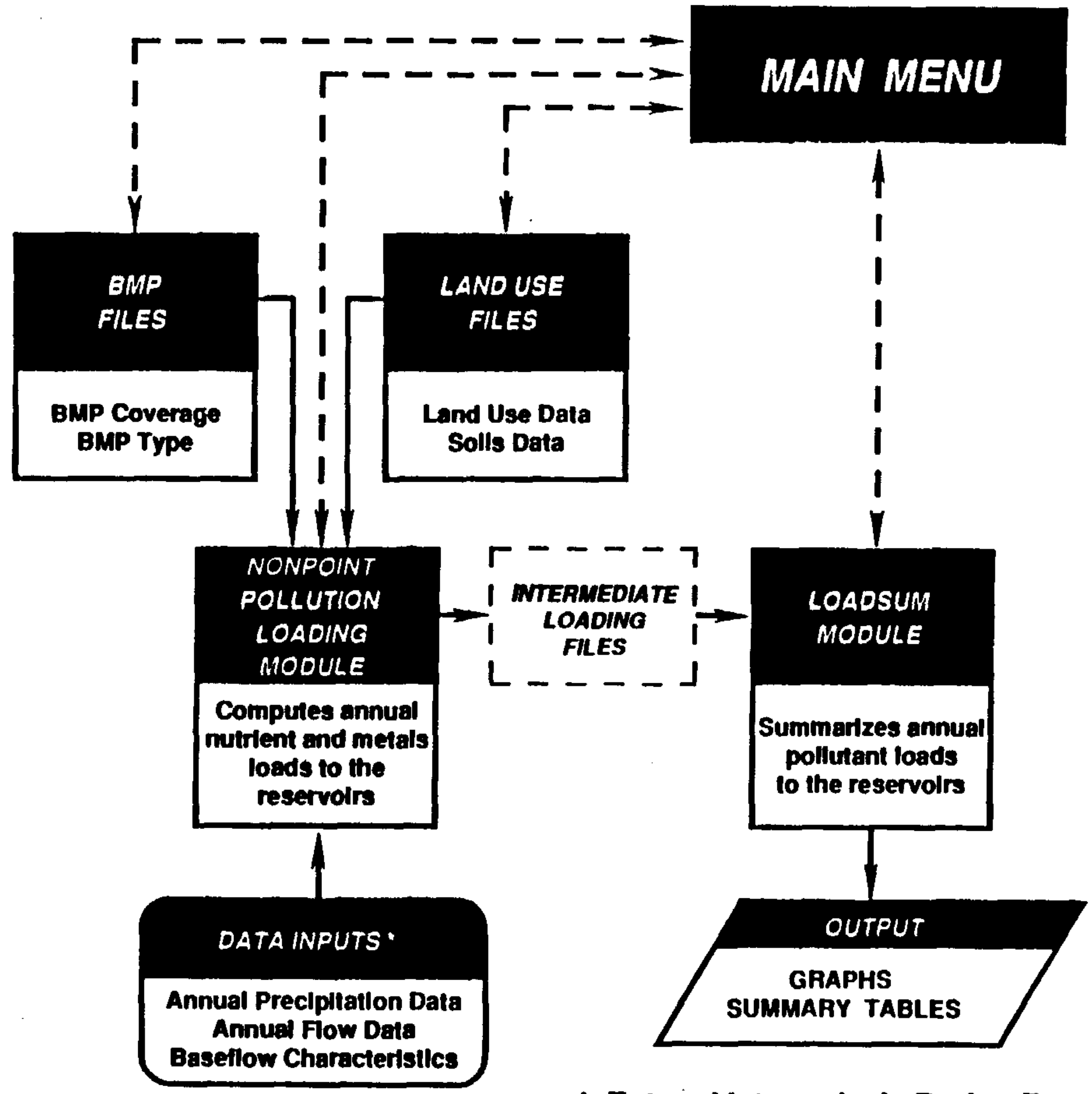
Recently, CDM has developed the Watershed Management Model (WMM) for the Florida Department of Environmental Regulation (DER) for use specifically for stormwater quality management planning. The model is based on nonpoint pollution loading factors that relate land use patterns and percent imperviousness in a watershed to "per acre" pollutant loadings. The loading factors for different land use categories are based on annual runoff volumes and EMCs for different pollutants. Runoff volumes may be estimated using runoff coefficients applied to the impervious and pervious fractions of each land use category. Long-term monitoring records from local USGS stream gages and NWS rain gages can be used to calculate average annual runoff.

The surface runoff and baseflow contributions are computed for average annual flows and for pollutant loads. The pollutants evaluated with the model include total nitrogen, total phosphorus, lead, zinc, and other constituents whose load must be projected under the NPDES permitting program. Data required to use the model include land use projections, soil types, average annual precipitation, annual flow, annual baseflow, average baseflow pollutant concentrations, and stormwater event mean concentrations (EMCs) for each pollutant and land use evaluated.

The WMM consists of three major computational modules, four data files, and three supplemental program files, and was developed using the Lotus 1-2-3 spreadsheet program for the IBM-AT or compatible computer. Figure 3-1 depicts the interaction between the main computational modules and supporting data programs (CDM, 1991).

The BMP database files contain information that describes BMP coverages and types. The model has the ability to perform a systemwide analysis of BMPs and can be used to estimate pollution load reductions under alternative nonstructural and structural BMP employment strategies. The model is configured to evaluate various watershed-wide scenarios which may be specified by the user. For example, an "existing" condition scenario can be modeled to establish a baseline for comparison with various future alternative scenarios which implement different BMP employment strategies.

The WMM provides a basis for the evaluation of the water quality benefits and relative costs of alternate management strategies. Watershed protection strategies may be identified and evaluated for nonstructural controls, including land use controls and buffer zones, and for structural BMPs, including on-site and regional detention basins.



* Entered Interactively During Program Execution

SCHEMATIC OF WATERSHED MANAGEMENT MODEL

CDM
environmental engineers, scientists, planners, & management consultants

FIGURE NO. 3-1

Combinations of nonstructural and structural controls can be evaluated to develop a watershed management plan.

3.3 STATISTICAL/REGRESSION MODELS

Statistical or probabilistic methods typically assume lognormal statistical parameters for stormwater flows and pollutant concentrations. Many hydrologic and water quality databases exhibit a skewed distribution that can be approximated by lognormal assumptions. For example, analyses of the nationwide EPA NURP database on urban nonpoint source loadings indicated that the underlying distribution could be adequately characterized by lognormal assumptions. Before utilizing a statistical model, the adequacy of the lognormal assumption should be evaluated for available local flow and loading databases.

Given probability distribution for model inputs (e.g., flows and concentrations), statistical methods developed by EPA (Di Toro, 1984) calculate the probability distribution of the resulting receiving water concentrations. The frequency with which any particular target concentration is exceeded during wet weather can be calculated.

Statistical models are appropriate as a screening tool, which yield approximate results and predictions of the relative changes in water quality among modeled scenarios with varying land use, but do not efficiently evaluate pollution load reductions achieved under BMP employ strategies.

Regression models relate nonpoint pollution loads or concentrations to various explanatory or independent variables. These variables typically include drainage area, imperviousness, mean annual rainfall, and land use. The USGS has developed a series of multiple linear regression models for estimating storm runoff pollutant loads and mean concentrations for urban watersheds across the U.S. (Driver and Tasker, 1988). The USGS regression equations are based on monitoring data collected under the EPA NURP program between 1978 and 1983, as well as additional urban runoff databases collected by USGS. The USGS identified three statistically different regions throughout the U.S. based on the following mean annual rainfall volumes: 1) less than 20 inches/year; 2) 20 to 40 inches/year; and 3) greater than 40 inches/year.

Variables used in the USGS regression models of storm loads include the following (Driver and Tasker, 1988).

Physical and land use characteristics:

1. Total contributing drainage area (square mile)
2. Impervious area as a percent of total drainage area
3. Industrial land use as a percent of total drainage area
4. Commercial land use as a percent of total drainage area
5. Residential land use as a percent of total drainage area
6. Nonurban land use as a percent of total drainage area
7. Population density in people per square mile

Climatic characteristics:

1. Total storm rainfall (inches)
2. Duration of each storm (minutes)
3. Maximum 24-hour precipitation intensity with a 2-year recurrence interval (inches)
4. Mean annual rainfall (inches)
5. Mean annual nitrogen load in precipitation (lbs/ac)
6. Mean minimum January temperature (°F)

Regression models were developed which considered all of the explanatory variables listed above which appeared to be correlated to storm runoff loads. In addition, simplified three-variable models were also developed for storm event loads. These simplified models considered only: 1) total rainfall; 2) drainage area; and 3) impervious area. The USGS linear regression models assume the urban runoff water quality data is lognormally distributed. These models are typically applied to relatively small watersheds. Recently, a draft paper published by the USGS outlines a simple accumulation procedure to apply regression methods to larger watersheds. This draft paper is included herein as Appendix C. USGS recommends application of this model to watersheds no larger than three to four square miles in area.

Statistical and regression models allow the user to associate confidence limits or prediction error with model projections. Models projections can be compared to available Corpus Christi area sampling data to assess the adequacy of models for estimating pollutant loading. Statistical/regression techniques are usually watershed specific and models may not easily be extrapolated to a large region or adjacent watersheds.

3.4 WATER QUALITY SIMULATION MODELS

Water quality simulation models continuously balance water and pollutant mass within a given system. These models typically operate on time intervals ranging from a day to less than an hour, and can require extensive amounts of input data. The EPA Storm Water Management Model (SWMM) and the Hydrocomp Simulation Program (HSPF) are examples of large computer programs intended to be comprehensive in their coverage of stormwater issues. SWMM was originally developed to simulate runoff from a design rainstorm applied to a highly urbanized watershed. HSPF was designed to simulate a continuous record of drainage from predominantly rural watersheds.

Stormwater simulation models generally have distinct submodels for hydrologic and water quality analyses. In order to simulate stormwater pollution runoff, it is first necessary to be able to adequately simulate the hydrologic/hydraulic processes of the system. Most hydrologic submodels calculate the amount of rainfall converted to runoff using continuous rainfall records as input. Rainfall inputs may be at hourly, 15-minute, or shorter intervals. During storm events, the rainfall inputs are distributed among various storage compartments and hydrologic/hydraulic processes are represented mathematically. In the SWMM model, flow routing is accomplished by Manning's equation or a similar technique. Water quality simulation modeling is less well understood than hydrologic/hydraulic modeling. Modeling stormwater quality has generally been approached by use of routines describing pollutant buildup and washoff. Pollutant buildup is assumed to occur during dry weather and pollutant washoff occurs during rainfall events. Most models apply a pollutant accumulation rate that decreases over time. This is consistent with the limited available field data. Suspended solids are assumed to be the primary indicator of pollutant washoff. For urban (impervious) areas, the most widely used form of solids washoff assumes exponential decay. For nonurban (pervious) areas, modified versions of the Universal Soil Loss Equation (USLE) are typically used to estimate the rate of sediment removal. The USLE is an empirical relationship derived from field plot monitoring and has been used to predict annual soil losses from fields.

Some success has been achieved at calibrating pollutant buildup and washoff factors for small watersheds with detailed, site-specific data. When this type of data is available, pollutographs for individual events from these small watersheds can be simulated with some success. Little success has been achieved at simulating accurate pollutographs from large watersheds without extensive watershed-wide calibration parameter data, however. Because of this lack of detailed water quality data, simulation models have seldom achieved more accuracy at projecting long-term watershed-wide pollutions loading statistics than the more simplistic loading factor and statistical models.

4.0 COMPARISON OF MODELING APPROACHES

4.1 EVALUATION

Characteristics of the three general water quality modeling approaches are presented in Table 4-1. Examples of each type of model and the type of simulations that may be performed are also presented. Continued master plan efforts will require estimate of the annual cumulative storm event loads from all outfalls and estimates of the event mean concentrations from a representative storm event. All three model types can provide annual loads as well as single EMC estimates. However, the degree of difficulty will vary depending on the type of modeling approach that is implemented.

The requirements of the master plan are primarily oriented to obtain screening/ planning estimates. This is an appropriate application for both NPS loading factors and statistical/regression models. Although a water quality simulation model (e.g., HSPF, SWMM) could also provide planning/screening information, the additional level of complexity in setting up and operating a simulation model is probably not warranted. Simulation models may prove useful for determining water quality standards compliance as local stormwater pollution data becomes available.

Transferability refers to the degree of additional refinement that is required to convert to a more sophisticated modeling technique. For example, NPS loading factors and statistical/regression models show a high and medium level of transferability, respectively. This means that additional data, analyses, and parameters must be obtained in order to convert from a simplistic to a more complex model. For instance, NPS loading factors and statistical/regression techniques are applied primarily for screening purposes and to develop management scenarios with relative ease and quickness, while simulation models are more appropriate for design purposes. Therefore, simulation models show a low level of transferability.

Local water quality monitoring data is useful for model calibration and/or verification under any of the three modeling approaches. Simulation models involve a far greater

TABLE 4-1

COMPARISON OF WATER QUALITY MODELING APPROACHES

	NPS Loading Factors	Statistical/ Regression	Water Quality Simulation
Example	CDM-NPS	FHWA, USGS	SWMM, HSPF
Simulation Type	Annual/Seasonal	Annual/Single Event	Single Event/ Continuous
Application	Screening/ Planning	Screening Planning	Research/ Design
Subarea Size	Large	Large	Small
Model Complexity	Low	Medium-Low	High
Level of Transferability	High	Medium	Low
Local Data Requirements	Low-Medium	Medium	High
Cost	Low	Medium-Low	High
Prediction Uncertainty	Fair	Fair	Poor (without calibration data)
Available on Microcomputer	Yes	Yes	Yes
Linkage to GIS	Possible (land use)	Possible (land use)	Yes (map info)
Suitable for Other Analyses	No	No	Yes (flooding, sewer design, etc.)
Systemwide Analysis of BMPs	Yes	Yes	Yes (difficult)
Detailed BMP Design	No	No	Yes

number of parameters and coefficients that must be appropriately adjusted to ensure that the model produces reasonable results. Therefore, simulation models are much more dependent on the availability of a large local water quality monitoring database.

Cost and level of complexity refer to the general requirements under each modeling approach for model installation, staff training, data requirements, and computer hardware. Simulation models are generally at the extreme high end of the cost and complexity range, while the NPS loading factors and the statistical/regression methods are in the lower portion of the range.

Prediction uncertainty refers to the level of confidence that can be ascribed to water quality predictions produced under each modeling approach. NPS loading factors are appropriate to systemwide long-term analyses of relative changes which are fairly well documented in the literature. Statistical/regressional models will include associated error terms or confidence limits. Simulation models which consider poorly understood inter-event and intra-event phenomena will be associated with the highest prediction uncertainty in the absence of local water quality monitoring data.

Linkage to a GIS presumes that the modeling approach will involve very detailed spatial information. While this is possible under the NPS loading factors and the statistical/-regression approaches, it would involve an additional level of detail which may be beyond the appropriate model resolution. Simulation models will already include a complex array of spatial information (e.g., channel network, slopes, land use, etc.) which can easily be incorporated into a GIS. In addition, simulation models can be used to perform other types of analyses. For example, the SWMM model could be used to solve flooding and other drainage problems, in addition to performing water quality analyses.

The primary intent of this stormwater master plan is to ensure that a stormwater management program is implemented which mitigates stormwater quality problems to the "maximum extent practicable". While any of the modeling approaches can be used to perform analyses of BMPs, only simulation models can be used to perform detailed design of BMPs.

The pollution loading and simulation modeling approaches can be used to perform analyses of BMPs, while only simulation models can be used to perform detailed design of BMPs.

4.2 DATA REQUIREMENTS

Table 4-2, illustrates a summary of data requirements for each of the modeling approaches discussed in this report. The intent of the table is not to represent a comprehensive statement of data needs, but only to serve as a planning guide to aid in the selection of a modeling approach. The data requirements are listed by three major sub-groupings: physical characteristics, hydrologic characteristics, and water quality parameters.

A complete data set for most models can be separated into two basic categories. First, there are the data required to describe the physical properties and characteristics of the prototype. For example, this data may include rainfall information, imperviousness, runoff properties, drainage area and other quantity related parameters. This first category of data constitutes a fundamental list that is needed to make the model function.

Additionally, quality prediction parameters will be required. These may include: representative event mean concentrations, regression relationships, constituent medians, coefficients of variation, and buildup and washout parameters. A second category of data is required for calibration and verification of more complex models. This data is characterized as measured or observed and may be obtained from historical records or monitoring and sampling programs. The data type in this category may include: rainfall, runoff, and quality samples for a given area.

TABLE 4-2

DATA REQUIREMENTS

	NPS Loading Factors	Statistical/ Regression	Water Quality Simulation
Physical Characteristics			
Land Use	Yes	Yes	Yes
Drainage Area	Yes	Yes	Yes
Percent Impervious	Yes	Yes	Yes
Population Density	No	Yes	No
Detailed Basin Parameters (slope, length, roughness coefficients)	No	No	Yes
Hydrologic Characteristics			
Mean Annual Rainfall	Yes	Yes	No
Hyetograph	No	No	Yes
Base Flow	Yes	No	Yes
Runoff Coefficients	Yes	No	No
Water Quality Parameters			
Event Mean Concentrations	Yes	No	No
Build Up - Wash Off Parameters	No	No	Yes
Allowances for Continuous, Non-Stormwater Point Source Discharges	Yes	No	Yes

Local water quality monitoring data is useful for model calibration and/or verification under any of the three modeling approaches. Simulation models involve a far greater number of parameters and coefficients that must be appropriately adjusted to ensure that the model produces reasonable results. Therefore, simulation models are much more dependent on the availability of a large local water quality monitoring database.

5.0 RECOMMENDATIONS

5.1 MODELING RECOMMENDATIONS

The purpose of the modeling requirements outlined for this master plan is to: 1) provide systemwide estimates of annual pollutant loadings and the event mean concentrations of pollutants in discharges resulting from a representative storm; and 2) provide current estimates of seasonal pollutant loadings and event mean concentrations.

These requirements are primarily management oriented and are designed to provide specific information to jurisdictions regarding potential problem areas. These requirements also allow for the preliminary evaluation of appropriate stormwater runoff controls without requiring a comprehensive sampling program (i.e. monitoring all outfalls). Therefore, a nonpoint pollution loading factor model is recommended for current master planning activities. The NPS loading factor model can provide planning level information regarding cumulative stormwater loading rates, and the effectiveness of best management practices at reduced loading rates.

Loading factor models are screening tools which can provide quick estimates of pollutant loads and concentrations without an expensive data collection effort. This modeling technique is easily implemented on personal computer spreadsheet software, is easily accessible, and may be modified to reflect future conditions. Most importantly, these techniques may also assess the individual and cumulative effect of implementing BMP's to optimize potential management strategies.

Application of simulation models is not warranted under current master plan efforts since these models will require far more input data and will involve a much greater level of effort to provide reliable information. Simulation models, such as SWMM or HSPF, may be appropriate in the future as more local monitoring data becomes available. The SWMM model can be applied to analyze flooding problems as well as water quality problems. Simulation models should be considered for design of stormwater BMP facilities particularly if these facilities are intended to achieve water quality and flooding improvements.

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APPENDIX A

THE HYDROLOGY OF URBAN RUNOFF QUALITY MANAGEMENT

by Larry A. Roesner, F. ASCE[1], Edward H. Burgess, M. ASCE[2], and John A. Aldrich, A.M. ASCE[3]

Abstract

Recent regulatory requirements to reduce pollutant discharges from municipal storm sewer systems have intensified the need for approaches to developing design parameters, such as the selection of a design storm, which can be applied to urban stormwater quality management facilities. Examination of six U.S. cities in areas with widely varying climatic conditions reveals that most rainfall occurs during small storms. Hydrologic simulations using long-term rainfall records of these areas indicate that a reasonable design storm is on the order of the 1-month to 4-month storm, and a unit storage volume of roughly 0.2 to 0.9 inches will provide effective pollutant capture. Detention basins which capture these smaller storms can be provided to control urban stormwater pollutants. It may be possible to retrofit existing flood control basins for this purpose; however, water quality control basins employ a significantly different storage strategy and should serve relatively large (typically over 50 acres) areas.

Introduction

In November 1990, the U.S. Environmental Protection Agency (USEPA) released its final rules and regulations regarding the permitting of stormwater discharges from municipal storm sewer systems. One of the permitting requirements is that municipalities develop a master plan to reduce the pollutants in urban runoff to the "maximum extent practicable" (MEP). The development of a workable definition of MEP in practical terms is an important prerequisite to the implementation of master plans for the reduction of urban stormwater pollutants.

One way to approach this issue is to examine the hydrology of urban runoff with respect to the type or size of storm that should be used for the design of treatment systems. By treatment systems we mean those measures typically referred to as "best management practices." These include swales, buffer strips, infiltration basins and trenches, and dry and wet detention ponds. General guidelines for the design of many of these types of facilities can be found elsewhere (Roesner, Urbonas, and Sonnen, 1989; Livingston, 1988; Schueler, 1987; and Resource Planning Associates, 1989). This paper examines the hydrology of urban runoff to provide insights as to the selection of the design storm that should be used for sizing those facilities.

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Long-Term Rainfall Characteristics

Hydrologists typically are extremists. We look at the infrequent events: either large storms for drainage and flood protection, or drought periods for water supply development. But what characteristics are representative of the storms which produce most rainfall on a long-term basis?

Figure 1 presents the cumulative distribution of daily rainfall based upon 40 years of data for both Orlando, FL, and Cincinnati, OH. The data have been screened to include only rainfall events of sufficient magnitude to generate runoff. For Orlando, the minimum rainfall depth was taken as 0.1 inches; for Cincinnati, it was set at 0.06 inches. Occurrence probabilities were then computed cumulatively, as daily rainfall increased from 0.1 inches to 2.0 inches. Examination of Figure 1 reveals that, on most days, rainfall comes from storms of less than one inch of rainfall. In Orlando, which averages 52 inches of rainfall per year, 90 percent of all runoff-generating rainfall events each produce less than 1.4 inches of rainfall, while in Cincinnati, which has 40 inches per year of precipitation, 90 percent of the rainfall events each produce less than 0.8 inches of rainfall. By contrast, the 2-year, 24-hour storm in Orlando produces 5.0 inches of precipitation; in Cincinnati, it produces 2.9 inches.

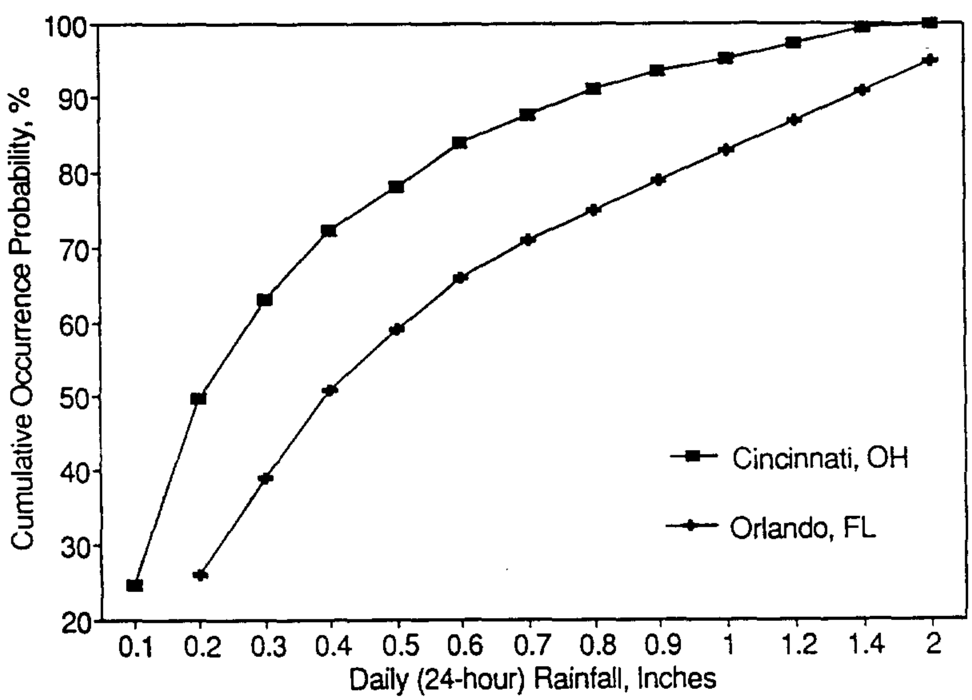

Figure 1: Average Annual Rainfall Distribution

This suggests that capturing runoff from the "smaller" storms may be sufficient to capture "most" of the rainfall runoff which occurs. To quantify the terms "smaller" and "most," long-term simulations of runoff were examined for six U.S. cities, as discussed below.

Capture of Stormwater Runoff

The computer model STORM (Storage, Treatment, Overflow, Runoff Model) is a simplified hydrologic model that translates a time series of hourly rainfall into runoff, then routes the runoff through detention storage. The model computes the statistics of a number of variables, both dependent and independent (for further information see Hydrologic Engineering Center, 1976, and Roesner, et. al. 1974). Of interest here are percent of runoff captured by various size detention basins and the frequency of overflow of these basins. To examine the effectiveness of various size basins in capturing runoff, STORM was applied to historical hourly rainfall time series for six cities: Butte, MT, Chattanooga, TN, Cincinnati, OH, Detroit, MI, San Francisco, CA, and Tucson, AZ. Runoff was simulated for typical urban development in each city. Table 1 shows, for each city, the average annual rainfall and the area-weighted runoff coefficient. These values are based on long-term rainfall records of periods on the order of 40 to 60 years.

Table 1: Hydrologic Parameters Used in STORM

City (1)	Average Annual Rainfall (inches) (2)	Runoff Coefficient (3)
Butte, MT	14.6	0.44
Chattanooga, TN	29.5	0.63
Cincinnati, OH	39.9	0.50
Detroit, MI	35.0	0.47
San Francisco, CA	19.3	0.65
Tucson, AZ	11.6	0.50

For each city the capture efficiency of basins of various sizes was tested with STORM. The outflow rate for each basin size was computed assuming the full storage volume was drained completely within a period of 24 hours after runoff ceased. This 24-hour drawdown time was used because it is well-established that, in order for a detention basin to be effective as a runoff treatment device, the detention time must be 24 hours or greater (Grizzard *et al.*, 1986).

The results of these analyses are shown in Figures 2a and 2b. Figure 2a shows that less than 1.0 inch of storage (0.08 ac-ft per acre of watershed) is required to capture 90 percent of the runoff (by volume, on an average annual basin) in each of the cities; for Cincinnati, Detroit, Tucson, and Butte, less than 0.5 inches of storage (0.04 acre-ft per acre of watershed) is required to capture 90 percent of the runoff.

One simplistic approach to establishing the most cost-effective basin size is to represent it as that which is located on the "knee of the curve" for capture efficiency. For each city, this point has been estimated in Table 2. For practical purposes, it can be assumed that the percent pollutant mass captured by a detention basin is directly proportional to the percent of runoff volume captured. Thus, the knee of the pollutant capture curve is at the same storage volume as the knee of the volume capture curve; thus if MEP is defined as "most cost-effective" capture of pollutants, Column 2 in Table 2 then defines the detention basin size required to meet MEP in each city. Alternatively, if MEP were defined as 90 percent capture of runoff, the required detention basin volume for each city would be that shown in Column 3 of the table.

Design Storm

Figure 2b shows the average annual frequency with which a basin of a particular size would overflow in each of the six cities. For each of the cities, the detention basin sized to capture 90 percent of the runoff is indicated by a solid circle on the curve. Except for San Francisco and Tucson, each of these basins will overflow at least six times per year, or more often than once in two months. Even for San

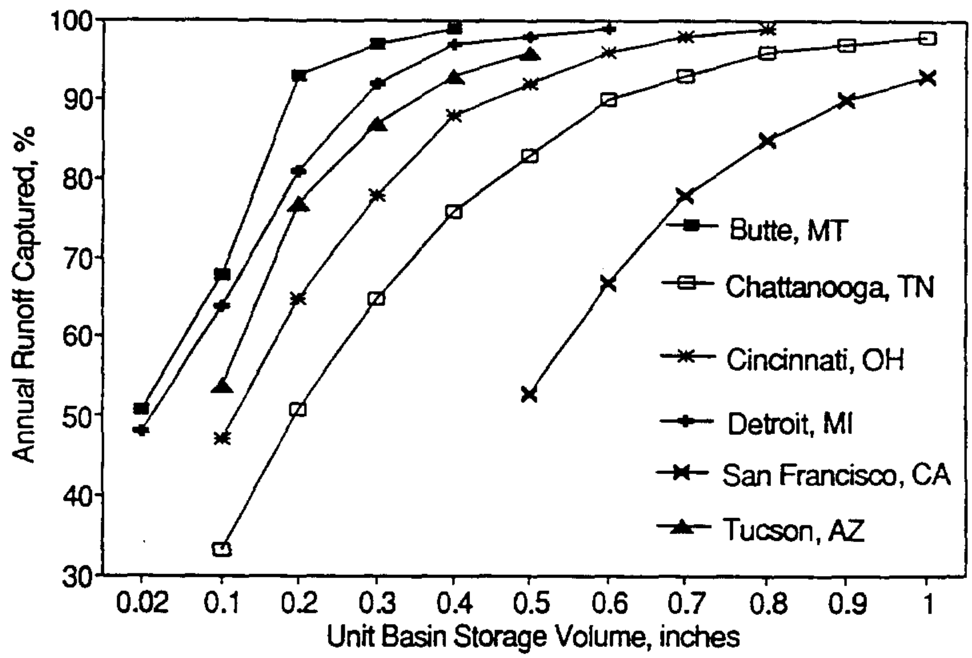

Figure 2a: Runoff Capture Efficiency Versus Unit Storage Volume

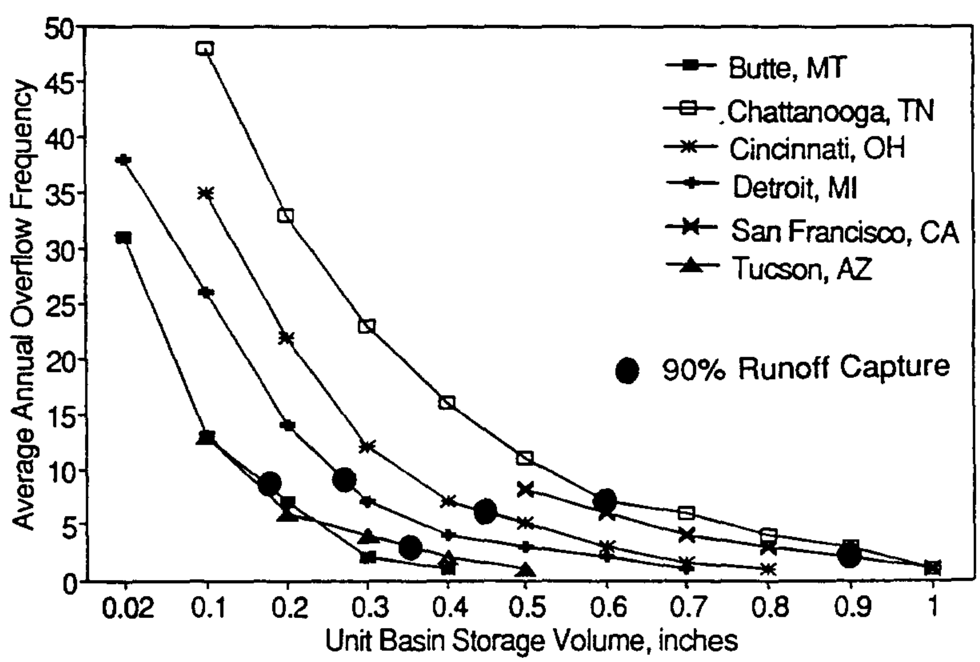

Figure 2b: Basin Overflow Frequency Versus Unit Storage Volume

Table 2: Unit Storage Volume to Achieve MEP Pollutant Reduction

City (1)	Cost-Effective Storage Volume (2)		Storage Volume Required for 90% Runoff Capture (3)	
	Inches (4)	Ac-Ft/Acre (5)	Inches (6)	Ac-Ft/Acre (7)
Butte, MT	0.25	0.021	0.18	0.015
Chattanooga, TN	0.50	0.042	0.60	0.050
Cincinnati, OH	0.40	0.033	0.45	0.038
Detroit, MI	0.30	0.025	0.27	0.023
San Francisco, CA	0.80	0.067	0.90	0.075
Tucson, AZ	0.30	0.025	0.35	0.029

Francisco and Tucson, the overflow frequency would be three times or more per year. If the design storm for 90% capture is defined as that storm that just fills the basin, without overflowing it, then the design storm for each city would be that shown in Table 3. For the most cost-effective basins, shown in Column 2 of Table 2, the design storm will be even smaller (more frequent).

Table 3: Design Storm for 90 Percent Capture of Runoff

City (1)	Overflow Frequency	
	Design Storm (2)	Times/Year (3)
Butte, MT	2-month	6
Chattanooga, TN	1.2-month	10
Cincinnati, OH	1.5-month	8
Detroit, MI	1-month	12
San Francisco, CA	3-month	4
Tucson, AZ	4-month	3

Figures 2a and 2b and Tables 2 and 3 demonstrate that most of the runoff in urban areas is generated by small storms, *i.e.*, storms smaller than the 4-month storm, and generally produces less than 0.5 inches of runoff. Storm water quality management appears feasible in this context. Swales, infiltration basins and detention facilities can be sized to accommodate these flows. It may be possible to retrofit some existing detention basins with small, low level outlets to provide the extended detention period (at least 24 hours) required for treatment of small storms. The next section addresses hydrologic considerations for designing detention basins for pollutant capture.

Implications for Detention Basin Design

Stormwater detention has been implemented in developing urban areas for several decades, usually as open earthen or grassed impoundment areas or basins designed to control the peak rate of discharge from one or more design storm events. These basins provide flood control benefits—typically compensating for the impacts of land development by reducing the peak rates of post-development stormwater runoff to pre-development peak rates by providing storage for the excess flows. The storage volume required to accommodate the reduced discharge rate controlled by the basin outflow structures is depicted in a conceptual manner on Figure 3 as the shaded area at the upper portion of the idealized stormwater runoff hydrograph. Stormwater detention for this purpose is sometimes referred to as "peak shaving," since the objective is to reduce the peak rate of runoff to control flooding from relatively intense (infrequent, *e.g.*, at least two-year and typically ten-year or greater) storms. Generally, the runoff from smaller storms passes through the basin, and the basin outflow structures have very little influence on the character of the discharge hydrograph.

Stormwater detention for water quality control has not been as widely implemented and employs an entirely different storage strategy. An important distinction is that while peak runoff rate is the key parameter for flood control, runoff volume is significant for water quality control. Basins constructed for water quality control must capture and detain almost all runoff for the design storm; however, the design storm is a much smaller event, as demonstrated above.

The distinction between these two storage strategies is represented on Figure 3, which shows that, while a flood control basin will capture the peak portion of the hydrograph for an intense storm event, the water quality control basin will capture only the initial runoff at the same location from the same event, as depicted by the shaded area at the left on the hydrograph. However, this represents the entire runoff volume from many of the more frequent smaller storms and, for larger storms, represents the initial washoff of pollutants, that portion of the runoff which is typically observed to contain the highest concentration of pollutants.

The extended (24-hour) drawdown time typically used for water-quality detention requires a significantly smaller outlet control structure (typically provided by a small-diameter pipe) than is required for flood control for the same tributary area. This is illustrated in Figure 4, which shows the required orifice (pipe) diameter as a function of tributary area, assuming 0.5 inches of storage is provided in a 5-foot-deep basin. This graph suggests that water-quality control basins must serve relatively large areas, as the runoff from a tributary drainage area of over 60 acres is released through a 6-inch outlet pipe and, for an 8-inch outlet pipe, over 100 acres must be tributary to the basin. The outlet pipe diameter becomes excessively small (and therefore susceptible to plugging) for smaller tributary areas.

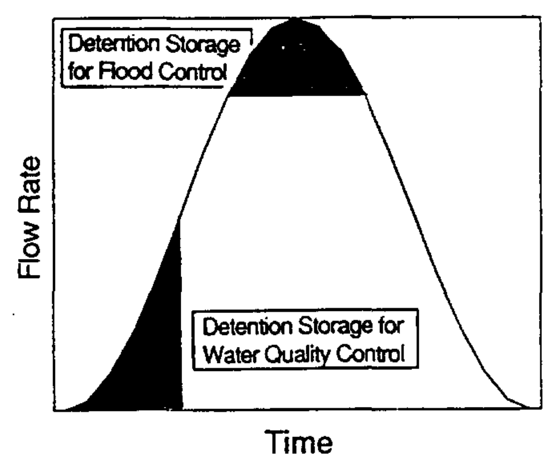

Figure 3: Storage Strategies for Flood Control & Pollutant Capture

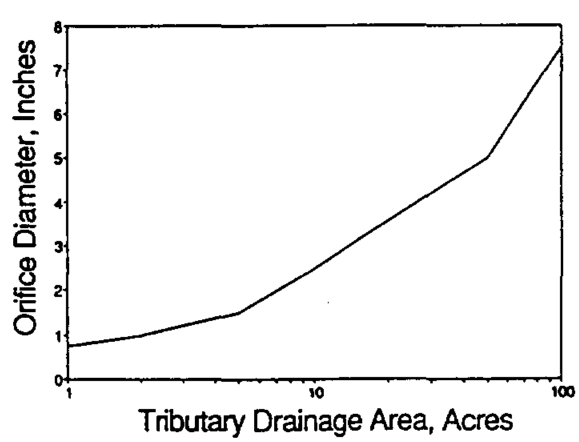

Figure 4: Orifice Sizing to Control Detention Basin Discharge Rate

Caution should be exercised when retrofitting the small outlet control conduit for water-quality detention in an existing flood-control detention facility. In particular, the flood control performance of the basin must be evaluated for larger storms (*e.g.*, the 10-year, 25-year, and 100-year storms) with the modified outlet. Typically, the flood control outlet must be modified, not only to accommodate the extended detention for smaller storms but also to compensate for the decreased outflow rate at lower basin stages during larger storms. In addition, the basin may need to be modified to increase the storage volume available for flood control.

Conclusions

While the development of water quality management master plans for cities required by USEPA to obtain stormwater discharge permits will be a challenge and the cost considerable, a high percentage of the annual runoff can be captured and subjected to best management practices by orienting the plan toward capture of small storms, e.g. the 1- to 3-month storm. For most cities this will result in treatment of over 90 percent of the runoff. For each city, however, hydrologic analyses similar to those shown here are recommended to better define the required capture volume and design storm.

The relatively small storms which should be used for design of detention basins and other facilities for controlling urban runoff pollutants suggests that excessively large or unreasonably costly facilities will not be required. The hydrologic and hydraulic conditions which control the performance of water-quality detention basins dictate that relatively large tributary drainage areas be served by these basins. Retrofitting existing flood-control detention basins to provide water-quality control, while potentially feasible, must be carefully analyzed on a case-specific basis to determine the modifications required and the resulting basin performance in flood control mode.

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APPENDIX B

AMERICAN SOCIETY OF CIVIL ENGINEERS

Seminar on

URBAN STORM WATER QUALITY MANAGEMENT
Orlando, Florida
March 8-9, 1990

CURRENT METHODS FOR MODELING OF NONPOINT SOURCE WATER QUALITY

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CONTENTS

URBAN MODELING OBJECTIVES AND CONSIDERATIONS

Studies and projects involving urban stormwater runoff quality can relate to many problems. In the broadest sense, water quality studies may be performed to protect the environment under various state and federal legislation. For example, Section 405 of the Clean Water Act will eventually require analysis of stormwater outfalls in all urban areas in the U.S. In a narrower sense, a study may address a particular water quality issue in a particular receiving water, such as bacterial contamination of a beach, release of oxygen demanding material into a stream or river, unacceptable aesthetics of an open channel receiving urban runoff, eutrophication of a lake, contamination of basements from surcharged sewers due to wet-weather flooding , etc.

By no means should it be assumed that every water quality problem requires a water quality modeling effort. Some problems may be strictly mostly hydraulic in nature, e.g., the basement flooding problem. That is, the solution may often reside primarily in a hydrologic or hydraulic analysis in which the concentration or load of pollutants is irrelevant. In some instances, local or state regulations may prescribe a nominal "solution" without recourse to any water quality analysis as such. For example, stormwater runoff in Florida is considered "controlled" through retention or detention with filtration of the runoff from the first inch of rainfall for areas of 100 ac or less. Other problems may be resolved through the use of measured data without the need to model. In other words, many problems do not require water quality modeling at all.

If a problem does require modeling, particular modeling objectives will probably result. Models may be used for objectives such as the following:

1. Characterize the urban runoff as to temporal and spatial detail, concentration/load ranges, etc.

2. Provide input to a receiving water quality analysis, e.g., drive a receiving water quality model.

3. Determine effects, magnitudes, locations, combinations, etc. of control options.

4. Perform frequency analysis on quality parameters, e.g., to determine return periods of concentrations/loads.

5. Provide input to cost-benefit analyses.

Objectives 1 and 2 characterize the magnitude of the problem, and objectives 2 through 5 are related to the analysis and solution of the problem. Computer models allow some types of analysis, such as frequency analysis, to be performed that could rarely be performed otherwise since periods of quality measurements in urban areas are seldom very long. It should always be borne in mind, however, that use of measured data is usually preferable to use of simulated data, particularly for objectives 1 and 2 in which accurate concentration values are needed. In general, models are <u>not</u> good substitutes for good field sampling programs. On the other hand, models can sometimes be used to extend and extrapolate measured data.

Careful consideration should be given to objective number 2. The first urban runoff quality model (SWMM) inadvertently overemphasized the concept of simulation of detailed intra-storm quality variations, e.g., production of a "pollutograph" (concentration vs. time) at 5 or 10 minute intervals during a storm for input to a receiving water quality model. But the fact is that the quality response of most receiving waters is insensitive to such short-term variations, as illustrated in Table 1. In most instances, the total storm load will suffice to determine the receiving water response, eliminating the necessity of becoming embroiled in calibration against detailed pollutographs. Instead, only the total storm loads need be matched, a much easier task. Simulation of short time increment changes in concentrations and loads is generally necessary only for analysis of control options, such as storage or high-rate treatment, whose efficiency may depend on the transient behavior of the quality constituents.

Table 1. Required Temporal Detail for Receiving Water Analysis (After Driscoll, 1979, and Hydroscience, 1979)

Type of Receiving Water	Key Constituents	Response Time
Lakes, Bays	Nutrients	Weeks - Years
Estuaries	Nutrients, OD* Bacteria	Days - Weeks
Large Rivers	OD, Nitrogen	Days
Streams	OD, Nitrogen Bacteria	Hours - Days Hours
Ponds	OD, Nutrients	Hours - Weeks
Beaches	Bacteria	Hours

*OD = oxygen demand, e.g., BOD, that affects dissolved oxygen.

Any consideration of water quality modeling means that some additional data will be required for model input. As described later, such requirements may be as simple as a constant concentration or much more complex. Data may be obtained from existing studies or their acquisition may require extensive field monitoring. For some conceptualizations of the urban quality cycle, e.g., buildup and washoff, it may not be routinely possible to physically measure fundamental input parameters, and such parameters will only be obtained through model calibration. Involvement in acquisition of quality data, be it through literature reviews or field surveys, profoundly escalates the level of effort required for the study. Details on data requirements for urban areas will be deferred until modeling techniques are described.

OVERVIEW OF AVAILABLE MODELING OPTIONS

Introduction

Several quality modeling options exist for simulation of quality in urban storm and combined sewer systems. These have been reviewed by Huber (1985; 1986) and range from simple to involved, although some "simple" methods, e.g., the EPA statistical methods, can incorporate quite sophisticated concepts. The principal methods available to the contemporary engineer are outlined generically below, in a rough order of complexity. Their data requirements are summarized again in a following section. The methods are:

1. Constant concentration or unit loads
2. Spreadsheet
3. Statistical
4. Rating curve or regression
5. Buildup/washoff

Constant Concentration or Unit Loads

As its name implies, constant concentration means that all runoff is assumed to have the same, constant concentration at all times for a given pollutant. At its very simplest, an annual runoff volume can be multiplied by a concentration to produce an annual runoff load. However, this option may be coupled with a hydrologic model, wherein loads (product of concentration and flow) will vary if the model produces variable flows. This option may be quite useful because it may be used with any hydrologic or hydraulic model to produce loads, merely by multiplying by the constant concentration. For instance, the highly sophisticated SWMM Extran Block may be used for hydraulic analysis of sewer system, prediction of overflows and diversions to receiving waters, etc., yet it performs no quality simulation as such. In many instances, it may be most important to get the volume and timing of such overflows and diversions correctly, and simply estimate loads by multiplying by a concentration.

An obvious question is what (constant) concentration to use? Early (pre-1977) concentration and other data are summarized in publications such as Manning et al. (1977) and Lager et al. (1977). The more recent EPA NURP studies (EPA, 1983) have produced a large and invaluable data base from which to select numbers, but the 30 city coverage of NURP will most often not include a site representative of the area under study. Nonetheless, a large data base does exist from which to review concentrations. Another option is to use measured values from the study area. This might be done from a limited sampling program. However, the NURP study conclusively demonstrated the variation that exists in event mean concentrations (EMCs, total storm event load divided by total storm event runoff volume) at a site, within a city, and within a region or the country as a whole. Thus, while use of a constant concentration may produce load variations, EMC variations will not be replicated. These variations may be important in the study of control options and receiving water responses.

Unit loads are perhaps an even simpler concept. These consist of values of mass per area per time, typically lb/ac-yr or kg/ha-yr, for various pollutants, although other normalizations such as lb/curb-mile are sometimes encountered. Annual (or other time unit) loads are thus produced upon multiplication by the contributing area. Such loadings are obviously highly site-specific and depend upon both demographic and hydrologic factors. They must be based on an average or "typical" runoff volume and cannot vary from year to year, but they can conveniently be subject to reduction by best management practices (BMPs), if the BMP effect is known. Although early EPA references provide some information for various land uses (EPA, 1973; EPA, 1976a; McElroy et al., 1976), unit loading rates are exceedingly variable and difficult to transpose from one area to another. Constant concentrations can sometimes be used for this purpose, since mg/l x 0.2265 = lb/ac per inch of runoff. Thus, if a concentration estimate is available, the annual loading rate, for example, may be calculated by multiplying by the inches per year of runoff. Finally, the Universal Soil Loss Equation (Wischmeier and Smith, 1958; Heaney et al., 1975)) was developed to estimate tons per acre per year of sediment loss from land surfaces. If a pollutant may be considered as a fraction ("potency factor") of suspended solids concentration or load, this offers another option for prediction of annual loads. Lager et al. (1977), Manning et al. (1977) and Zison (1980) provide summaries of such values.

Spreadsheets

Microcomputer spreadsheet software, e.g., Lotus, Quatro, Excel, is now ubiquitous in engineering practice. Very extensive and highly sophisticated engineering analysis is routinely implemented on spreadsheets, and water quality simulation is no exception. The spreadsheet most definitely may be used to automate and extend the concept of the constant concentration or unit load idea. In the usual manifestation of this spreadsheet application, runoff volumes are calculated very simplistically, usually using a runoff coefficient times a rainfall depth. The coefficient may vary according to land use, or an SCS procedure may be used, but the hydrology is inherently simplistic in the spreadsheet predictions. The runoff volume is then multiplied by a constant concentration to predict runoff loads. Alternatively, unit loads are input directly and then multiplied by corresponding land use areas. The advantage of the spreadsheet is that a mixture of land uses (with varying concentrations or loads) may easily be simulated, and an overall load and flow-weighted concentration obtained from the study area (Walker et al., 1989). The study area itself may range from a single catchment to an entire urban area, and "delivery ratios" can be added to simulate loss of pollutants along drainage pathways between the simulated land use and the receiving waters. The relative contributions of different land uses may be easily identified, and handy spreadsheet graphics tools used for display of the results.

As an enhancement, control options may be simulated by application of a constant removal fraction for an assumed BMP. Although spreadsheet computations can be amazingly complex, BMP simulation is rarely more complicated than a simple removal fraction because anything further would require simulation of the dynamics of the removal device (e.g., a wet detention pond), which is usually beyond the scope of the hydrologic component of the spreadsheet model. Nonetheless, if simple BMP removal fractions can be believed, the spreadsheet can easily be used to estimate the effectiveness of control options. Loads with and without controls can be estimated and problem areas, by contributing basin and land use, can be determined. Since most engineers are familiar with spreadsheets, such models can be developed in-house in a logical manner.

The spreadsheet approach is best suited to estimation of long-term loads, such as annual or seasonal, because very simple prediction methods generally perform better over a long averaging time and poorly at the level of a single storm event. Hence, although the spreadsheet could be used at the microscale (at or within a storm event) it is most often applied for much longer time periods. It is harder to obtain the variation of predicted loads and concentrations using the spreadsheet method because this can ordinarily only be done by varying the input concentrations or rainfall values. A Monte Carlo simulation may be attempted (i.e., systematic variation of all input parameters according to an assumed frequency distribution) if the number of such parameters is not too large. These results may then be used to estimate the range and/or frequency distribution of predicted loads and concentrations.

In a generic sense, the spreadsheet idea may used in methods programmed in other languages, e.g., Fortran. For example, comprehensive assessments of coastal zone pollution from urban areas are made by NOAA (1987) by assembling land use data with different runoff coefficients, predicting daily and seasonal runoff volumes from daily rainfall, and predicting seasonal pollutant loads using constant concentrations. Although the demographic data base and use of magnetic tapes may dictate use of mainframes, the computational concept is still that of a spreadsheet.

Again, the question arises of what concentrations or unit loads to use, this time potentially for multiple land uses and subareas. And again, the NURP data base will usually be the first one to turn to, with the possibility of local monitoring to augment it.

Statistical Method

The so-called "EPA Statistical Method" is somewhat generic and until recently was not implemented in any off-the-shelf model or even very well in any single report (Hydroscience, 1979; EPA, 1983). A new FHWA study (Driscoll et al., 1989) partially remedies this situation. The concept is straightforward, namely that of a derived frequency distribution for EMCs. This idea has been used extensively for urban runoff quantity (e.g., Howard, 1976; Loganathan and Delleur, 1984; Zukovs et al., 1986) but not as much for quality predictions.

The EPA Statistical Method utilizes the fact that EMCs are not constant but tend to exhibit a lognormal frequency distribution. When coupled with an assumed distribution of runoff volumes (also lognormal), the distribution of runoff loads may be derived. When coupled again to the distribution of streamflow, an approximate (lognormal) probability distribution of in-stream concentrations may be derived (Di Toro, 1984) -- a very useful result, although assumptions and limitations of the method have been pointed out by Novotny (1985) and Roesner and Dendrou (1985). Further analytical methods have been developed to account for storage and treatment (Di Toro and Small, 1979; Small and Di Toro, 1979). The method was used as the primary screening tool in the EPA NURP studies (EPA, 1983) and has also been adapted to combined sewer overflows (Driscoll, 1981) and highway-related runoff (Driscoll et al., 1989). This latter publication is one of the best for a concise explanation of the procedure and assumptions and includes spreadsheet software for easy implementation of the method.

A primary assumption is that EMCs are distributed lognormally at a site and across a selection of sites. The concentrations may thus be characterized by their median value and by their coefficient of variation (CV = standard deviation divided by the mean). There is little doubt that the lognormality assumption is good (Driscoll, 1986), but similar to the spreadsheet approach, the method is then usually combined with weak hydrologic assumptions, e.g., prediction of runoff using a runoff coefficient. (The accuracy of a runoff coefficient increases as urbanization and imperviousness increase.) However, since many streams of concern in an urban area consist primarily of stormwater runoff during wet weather, the ability to predict the distribution of EMCs is very useful for assessment of levels of exceedance of water quality standards. The effect of BMPs can again be estimated crudely through constant removal fractions that lower the EMC median, but it is harder to determine the effect on the coefficient of variation. Overall, the method has been very successfully applied as a screening tool.

Input to the method as implemented for the FHWA (Driscoll et al., 1989) includes statistical properties of rainfall (mean and coefficient of variation of storm event depth, duration, intensity and interevent time), area, and runoff coefficient for the hydrologic component, plus EMC median and coefficient of variation for the pollutant. Generalized rainfall statistics have already been calculated for many locations in the U.S. Otherwise, the EPA SYNOP model (EPA, 1976b; Hydroscience, 1979; EPA, 1983; Woodward-Clyde, 1989) must be run on long-term hourly rainfall records. If receiving water impacts are to be evaluated, the mean and CV of the streamflow are required plus the upstream concentration. A Vollenweider-type lake impact analysis is also provided based on phosphorus loadings.

As with the first two methods discussed, the choice of median concentration may be difficult, and the Statistical Method requires a coefficient of variation as well. Fortunately, from NURP and highway studies, CV values for most urban runoff pollutants are fairly consistent, and a value of 0.75 is typical. If local and/or NURP data are not available or inappropriate, local monitoring may be required, as in virtually every quality prediction method. The estimation of the whole EMC frequency distribution for a pollutant is a definite advantage of the Statistical Method over some applications of constant concentration and simple spreadsheet approaches. Frequency analyses of water quantity and quality parameters may also be performed on the output of continuous simulation models such as HSPF, SWMM and STORM. The derived distribution approach of the Statistical Method avoids the considerable effort required for continuous simulation at the expense of simplifying assumptions that may or may not reflect the prototype situation adequately.

Regression -- Rating Curve Approaches

With the completion of the NURP studies in 1983, there are measurements of rainfall, runoff and water quality at well over 100 sites in over 30 cities. Some regression analysis has been performed to try to relate loads and EMCs to catchment, demographic and hydrologic characteristics (e.g., McElroy et al., 1976; Miller et al., 1978; Brown, 1984), the best of which are recent results of the USGS (Tasker and Driver, 1988; Driver and Tasker, 1988), to be described briefly below. Regression approaches have also been used to estimate dry-weather pollutant deposition in combined sewers (Pisano and Queiroz, 1977), a task at which no model is very successful. What are termed "rating curves" herein are just a special form of regression analysis, in which concentration and/or loads are related to flow rates and/or volumes. This is an obvious exercise attempted at most monitoring sites and has a historical basis in sediment discharge rating curves developed as a function of flow rate in natural river channels.

A rating curve approach is most often performed using total storm event load and runoff volume although intra-storm variations can sometimes be simulated in this manner as well (e.g., Huber and Dickinson, 1988). It is usually observed (Huber, 1980; EPA, 1983; Driscoll et al., 1989) that concentration (EMC) is poorly or not correlated with runoff flow or volume, implying that a constant concentration assumption is adequate. Since the load is the product of concentration and flow, load is usually well correlated with flow regardless of whether or not concentration correlates well. This manifestation of spurious correlation (Bensen, 1965) is often ignored in urban runoff studies. If load is proportional to flow to the first power (i.e., linear), then the constant concentration assumption holds; if not, some relationship of concentration with flow is implied. Rating curve results can be used by themselves for load and EMC estimates and can be incorporated into some models (e.g., SWMM, HSPF).

Rainfall, runoff and quality data were assembled for 98 urban stations in

30 cities (NURP and other) in the U.S. for multiple regression analysis by the USGS (Driver and Tasker, 1988; Tasker and Driver 1988). Thirty-four multiple regression models (mostly log-linear) of storm runoff constituent loads and storm runoff volumes were developed, and 31 models of storm runoff EMCs were developed. Regional and seasonal effects were also considered. The two most significant explanatory variables were total storm rainfall and total contributing drainage area. Impervious area, land use, and mean annual climatic characteristics also were significant explanatory variables in some of the models. Models for estimating loads of dissolved solids, total nitrogen, and total ammonia plus organic nitrogen (TKN) generally were the most accurate, whereas models for suspended solids were the least accurate. The most accurate models were those for the more arid Western U.S., and the least accurate models were those for areas that had large mean annual rainfall.

These USGS equations represent the best generalized regression equations currently available for urban runoff quality prediction. Note that such equations do not require preliminary estimates of EMCs or local quality monitoring data except for the very useful exercise of verification of the regression predictions. Regression equations only predict the mean and do not provide the frequency distribution of predicted variable, a disadvantage compared to the statistical approach. (The USGS documentation describes procedures for calculation of statistical error bounds, however.) Finally, regression approaches, including rating curves, are notoriously difficult to apply beyond the original data set from which the relationships were derived. That is, they are subject to very large potential errors when used to extrapolate to different conditions. Thus, the usual caveats about use of regression relationships continue to hold when applied to prediction of urban runoff quality.

Buildup and Washoff

In the late 1960s, a Chicago study by the American Public Works Association (1969) demonstrated the (assumed linear) buildup of "dust and dirt" and associated pollutants on urban street surfaces. During a similar time frame, Sartor and Boyd (1972) also demonstrated buildup mechanisms on the surface as well as an exponential washoff of pollutants during rainfall events. These concepts were incorporated into the original SWMM model (Metcalf and Eddy et al., 1971) as well as into the STORM, USGS and HSPF models to a greater or lesser degree (Huber, 1985). "Buildup" is a term that represents all of the complex spectrum of dry-weather processes that occur between storms, including deposition, wind erosion, street cleaning, etc. The idea is simply that all such processes lead to an accumulation of solids and other pollutants that are then "washed off" during storm events.

Although ostensibly physically based, models that include buildup and washoff mechanisms really employ conceptual algorithms because the true physics is related to principles of sediment transport and erosion that are poorly understood in this framework. Furthermore, the inherent heterogeneity of urban surfaces leads to use of average buildup and washoff parameters that may vary significantly from what may occur in an isolated street gutter, for example. Thus, except in rare instances of measurements of accumulations of surface solids, the use of buildup and washoff formulations inevitably results in a calibration exercise against measured end-of-pipe quality data. It then holds that in the absence of such data, inaccurate predictions can be expected.

Different models offer different options for conceptual buildup and washoff mechanisms, with SWMM having the greatest flexibility. In fact, with calibration, good agreement can be produced between predicted and measured concentrations and loads with such models, including intra-storm variations that cannot be duplicated with most of the methods discussed earlier. (When a rating curve is used in SWMM instead of buildup and washoff, it is also possible to simulate intra-storm variations in concentration and load.) A survey of linear buildup rates for many pollutants by Manning et al. (1977) is probably the best source of generalized buildup data, and some information is available in the literature to aid in selection of washoff coefficients (Huber 1985; Huber and Dickinson, 1988). However, such first estimates may not even get the user in the ball park (i.e., quality -- not quantity -- predictions may be off by more than an order of magnitude); the only way to be sure is to use local monitoring data for calibration and verification. Thus, as for most of the other quality prediction options discussed herein, the buildup-washoff model may provide adequate comparisons of control measures, ranking of loads, etc. but cannot be used for prediction of absolute values of concentrations and loads, e.g., to drive a receiving water quality model, without adequate calibration and verification data. Since buildup and washoff are somewhat appealing conceptually, it is somewhat easier to simulate potential control measures such as street cleaning and surface infiltration using these mechanisms than with, say, a constant concentration or rating curve method. In the relatively unusual instance in which intra-storm variations in concentration and load must be simulated, as opposed to total storm event EMC or load, buildup and washoff also offer the most flexibility. This is sometimes important for the design of storage facilities in which first-flush mechanisms may be influential.

As mentioned above, generalized data for buildup and washoff are sparse (Manning et al., 1977) and such measurements are almost never conducted as part of a routine monitoring program. For buildup, normalized loadings, e.g., mass/day-area or mass/day per curb-length, or just mass/day, are required, along with an assumed functional form for buildup vs. time, e.g., linear, exponential, Michaelis-Menton, etc. For washoff, the relationship of washoff (mass/time) vs. runoff rate must be assumed, usually in the form of a power equation. When end-of-pipe concentration and load data are all that are available, all buildup and washoff coefficients end up being calibration parameters.

Related Mechanisms

In the discussion above, washoff is assumed proportional to the runoff rate, as for sediment transport. Erosion from pervious areas may instead be proportional to the rainfall rate. HSPF does the best job of including this mechanism in its algorithms for erosion of sediment from pervious areas. SWMM includes a weaker algorithm based on the Universal Soil Loss Equation (Wischmeier and Smith, 1958; Heaney et al., 1975).

Many pollutants, particularly metals and organics, are adsorbed onto solid particles and are transported in particulate form. The ability of a model to include "potency factors" (HSPF) or "pollutant fractions" (SWMM) enhances the ability to estimate the concentration or load of one constituent as a fraction of that of another, e.g., solids (Zison, 1980).

The groundwater contribution to flow in urban areas can be important in areas with unlined and open channel drainage. Of the urban models discussed, HSPF far and away has the most complex mechanisms for simulation of subsurface water quality processes in both the saturated and unsaturated zones. Although SWMM includes subsurface flow routing, the quality of subsurface water can only be approximated at present using a constant concentration.

The precipitation load may be input in some models (SWMM, HSPF), usually as a constant concentration. Point source and dry-weather flow (baseflow) loads and concentrations can also be input to SWMM, STORM and HSPF to simulate background conditions. Other quality sources of potential importance include catchbasins (SWMM) and snowmelt (SWMM, STORM, HSPF).

Scour and deposition within the sewer system can be very important in combined sewer systems and some separate storm sewer systems. The state of the art in simulation of such processes is poor (Huber, 1985). SWMM offers a crude but calibratable attempt at simulation of such processes.

SUMMARY OF DATA NEEDS

In application of most models, there are two fundamental types of data requirements. First, there are the data needed simply to make the model function, that is, input parameters for the model. These typically include rainfall information, area, imperviousness, runoff coefficient and other quantity prediction parameters, plus quality prediction parameters such as constant concentration, constituent median and CV, regression relationships, buildup and washoff parameters, etc. In other words, each model will have a fundamental list of required input data.

The second type of information is required for calibration and verification of more complex models, namely, sets of measured rainfall, runoff and quality samples with which to test the model. Such data exist (e.g., Huber et al., 1982; Driver et al. (1985), Noel et al., 1987) but seldom for the site of interest. If the project objectives absolutely require such data (e.g., if a model must be calibrated in order to drive a receiving water quality model), then expensive local monitoring may be necessary.

This summary will relate primarily to <u>quality</u> prediction and not represent a comprehensive statement of data needs for <u>quantity</u> prediction. However, since rainfall and runoff are required for virtually every study, certain quantity-related parameters are also necessary. Data needs for various methods are described in Table 2.

Table 2. Data Needs for Various Quality Prediction Methods

Method	Data	Potential Source
Unit Load	Mass per time per unit tributary area.	Derive from constant concentration and runoff; literature values.
Constant Concentration	Runoff prediction mechanism (simple to complex).	Existing model; runoff coefficient or simple method.
	Constant concentration for each constituent.	NURP; local monitoring.
Spreadsheet	Simple runoff prediction mechanism.	E.g., runoff coefficient, perhaps as function of land use.
	Constant concentration or concentration range, or unit loads.	NURP; local monitoring; see above.
	Removal fractions for controls.	NURP; Schueler (1987); local and state publications.
Statistical	Rainfall statistics.	NURP; Driscoll et al. (1989); Woodward-Clyde (1989); EPA SYNOP model.
	Area, imperviousness.	Local data.
	Pollutant median and CV.	NURP; Driscoll (1986); Driscoll et al. (1989); local monitoring.
	Receiving water characteristics and statistics.	Local or generalized data.
Regression	Storm rainfall, area, imperviousness, land use.	Local data.
Rating Curve	Measured flow rates/volumes and quality EMCs/loads.	NURP; local data.
Buildup	Loading rates and rate constants.	Literature values*.
	Street cleaning removals.	Literature values.
Washoff	Power relationship with runoff.	Literature values*.

*Usually must be calibrated using end-of-pipe monitored quality data.

OVERVIEW OF URBAN QUALITY MODELING

Modeling Fundamentals

Modeling caveats and an introduction to modeling are presented by several authors including James and Burges (1982), Kibler (1982), Huber (1985, 1986) and summarized in a recent manual of practice (WPCF, 1989). Space does not permit a full presentation here; a few items are highlighted below.

1. Have a clear statement of project objectives. Verify the need for quality modeling. (Perhaps the objectives can be satisfied without quality modeling.)

2. Use the simplest model that will satisfy the project objectives. Often a screening model, e.g., regression or statistical, can determine whether more complex simulation models are needed.

3. To the extent possible, utilize a quality prediction method consistent with available data. This would often rule against buildup-washoff formulations, although these might still be useful for detailed simulation, especially if calibration data exist.

4. Only predict the quality parameters of interest and only over a suitable time scale. That is, storm event loads and EMCs will usually represent the most detailed prediction requirement, and seasonal or annual loads will sometimes be all that are required. Do not attempt to simulate intra-storm variations in quality unless it is necessary.

5. Perform a sensitivity analysis on the selected model and familiarize yourself with the model characteristics.

6. If possible, calibrate and verify the model results. Use one set of data for calibration and another independent set for verification. If no such data exist for the application site, perhaps they exist for a similar catchment nearby.

Operational Models

Implementation of an off-the-shelf model or method will be easiest if the model can be characterized as "operational" in the sense of:

1. Documentation. This should include a user's manual, explanation of theory and numerical procedures, data needs, data input format, etc. Documentation most often separates the many computerized procedures found in the literature from a model that can be accessed and easily used by others.

2. Support. This is sometimes provided by the model developer but often by a federal agency such as the HEC or EPA.

3. Experience. Every model must be used a "first time" but it is best to rely on a model with a proven track record.

The models described below are all operational in this sense. New methods and models are constantly under development and should not be neglected simply because they lack one of these characteristics, but the user should be aware of potential difficulties if any characteristic is lacking.

Surveys of Urban Models

Several publications, often somewhat out of date, provide reviews of available models. Some models (e.g., SWMM, STORM, HSPF) have persisted for many years and are included in both older and newer reviews, while other models (e.g., USGS, Statistical, spreadsheet) are more recent. Reviews that consider surface runoff quality models include Huber and Heaney (1982), Kibler (1982), Whipple et al. (1983), Barnwell (1984, 1987), Huber (1985, 1986), Bedient and Huber (1988), Viessman et al. (1989), and WPCF (1989). HEC models are described in detail by Feldman (1981). Descriptions of EPA nonpoint source water quality models are provided by Ambrose et al. (1988) and Ambrose and Barnwell (1989).

URBAN RUNOFF QUALITY SIMULATION MODELS AND METHODS

Introduction

Four models (USGS, HSPF, STORM, SWMM) will be described briefly at this point. These four models essentially make up the best choice of full-scale simulation models for urban areas. Other models have been adapted from SWMM (e.g., FHWA, RUNQUAL) and STORM (e.g., SEMSTORM) and given modified names, but the principles are fairly similar. Still other models, such as the Illinois State Water Survey ILLUDAS model (Terstriep and Stall, 1974) have sometimes been adapted for water quality simulation for a specific project (Noel and Terstriep, 1982), but such modifications and quality procedures remain undocumented, and the quality model cannot be considered operational. Finally, there are many models well known in the hydrologic literature, such as those developed by the HEC and SCS, that might be useful in the hydrologic aspect of water quality studies but that do not simulate water quality directly. This review is limited to models that directly simulate water quality.

A general comparison of model attributes is given in Table 3. This table includes the EPA Statistical Method since with the publication of the recent FHWA study, it can be considered a formalized procedure (Driscoll et al., 1989). The constant concentration, unit load, spreadsheet, and regression approaches described earlier are more generic in nature and not included in Table 3, but their attributes were provided in the earlier text.

DR3M-QUAL

A version of the USGS Distributed Routing Rainfall Runoff Model that includes quality simulation (DR3M-QUAL) is available from that agency for general use (Alley and Smith, 1982a, 1982b). Runoff generation and subsequent routing use the kinematic wave method, and parameter estimation assistance is included in the model. Quality is simulated using buildup and washoff functions, with settling of solids in storage units dependent on a particle size distribution. The model has been used in some of the NURP studies that were conducted by the USGS (Alley, 1986). No microcomputer version is available.

HSPF

The Hydrological Simulation Program - Fortran (HSPF) is the culmination of hydrologic routines that originated with the Stanford Watershed Model in

Table 3. Comparison of Model Attributes

Attribute	Model: DR3M-QUAL	HSPF	Statistical[a]	STORM	SWMM
Sponsoring agency	USGS	EPA	EPA	HEC	EPA
Simulation type[b]	C,SE	C,SE	N/A	C	C,SE
No. pollutants	4	10	Any	6	10
Rainfall/runoff analysis	Y	Y	N[c]	Y	Y
Sewer system flow routing	Y	Y	N/A	N	Y
Full, dynamic flow routing equations	N	N	N/A	N	Y[d]
Surcharge	Y[e]	N	N/A	N	Y[d]
Regulators, overflow structures, e.g., weirs, orificies, etc.	N	N	N/A	Y	Y
Special solids routines	Y	Y	N	N	Y
Storage analysis	Y	Y	Y[f]	Y	Y
Treatment analysis	Y	Y	Y[f]	Y	Y
Suitable for screening (S), design (D)	S,D	S,D	S	S	S,D
Available on microcomputer	N	Y	Y[g]	N	Y
Data and personnel requirements[h]	Medium	High	Medium	Low	High
Overall model complexity[i]	Medium	High	Medium	Medium	High

[a]EPA procedure.
[b]C - continuous simulation, SE - single event simulation.
[c]Runoff coefficient used to obtain runoff volumes.
[d]Full dynamic equations and surcharge calculations only in Extran Block of SWMM.
[e]Surcharge simulated by storing excess inflow at upstream end of pipe. Pressure flow not simulated.
[f]Storage and treatment analyzed analytically.
[g]FHWA study, Driscoll et al. (1989)
[h]General requirements for model installation, familiarization, data requirements, etc. To be interpretted only very generally.
[i]Reflection of general size and overall model capabilities. Note that complex models may still be used to simulate very simple systems with attendant minimal data requirements.

1966 and eventually incorporated many nonpoint source modeling efforts of the EPA Athens laboratory (Johanson et al., 1984). This model is a mainstay of non-urban as well as urban nonpoint source modeling. The user's manual includes information on all hydrologic and water quality routines, including the IMPLND (impervious land) segment for use in urban area. Additional guidelines for application are provided by Donigian et al. (1984). The model has special provisions for management of time series that result from continuous simulation. A microcomputer version is available.

STORM

The first significant use of continuous simulation in urban hydrology came with the Storage, Treatment, Overflow, Runoff Model (STORM), developed by the Corps of Engineers, Hydrologic Engineering Center (HEC, 1977; Roesner et al., 1974) for application to the San Francisco master plan for CSO pollution abatement. The HEC also provides application guidelines (Abbott, 1977). The current (1977) version includes dry-weather flow input for combined sewer simulation. The support of the HEC led to the wide use of STORM for planning purposes, especially for evaluation of the trade-off between treatment and storage as control options for CSOs (e.g., Heaney et al., 1977). Statistics of long-term runoff and quality time series permit optimization of control measures.

STORM utilizes simple runoff coefficient, SCS and unit hydrograph methods for generation of hourly runoff depths from hourly rainfall inputs. No flow routing is performed, but runoff may be routed through a constant-rate treatment device, with excess flow diverted to a storage device. Flows exceeding the treatment rate cause CSOs when storage is filled. The buildup and washoff formulations are used for simulation of six pre-specified pollutants. However, the model can be manipulated to provide loads for arbitrary conservative pollutants (e.g., Najarian et al., 1986). The model is hampered somewhat by lack of an operational microcomputer version. However, various individual consultants have adapted the nonproprietary code to their own project needs.

SWMM

The original version of the Storm Water Management Model (SWMM) was developed for EPA as a single-event model, specifically for the analysis of CSOs (Metcalf and Eddy et al., 1971), but its scope has vastly broadened since the original release. Version 4 (Huber and Dickinson, 1988; Roesner et al., 1988) of the model performs both continuous and single-event simulation throughout the whole model, can simulate backwater, surcharging, pressure flow and looped connections (by solving the complete dynamic wave equations) in its Extran Block, and has a variety of options for quality simulation, including traditional build-up and wash-off formulations as well as rating curves and regression techniques. Subsurface flow routing (constant quality) may be performed in the Runoff Block in addition to surface quantity and quality routing, and treatment devices may be simulated in the Storage/Treatment Block using removal functions and sedimentation theory. A hydraulic design routine is included for sizing of pipes, and a variety of regulator devices may be simulated, including orifices (fixed and variable), weirs, pumps, and storage. A bibliography of SWMM usage is available (Huber et al., 1986) that contains many references to case studies.

SWMM is segmented into the Runoff, Transport, Extran, Storage/Treatment and Statistics blocks for rainfall-runoff, routing, and statistical computations. Water quality may be simulated in all blocks except Extran, and metric units are optional. Since the model is non-proprietary, portions have been adapted for various specific purposes and locales by individual consultants and other federal agencies, e.g., FHWA. A microcomputer version is available.

Discussion

The four models discussed briefly here do not represent all of the modeling options available but are certainly the most notable, widely used and most operational. Selection from among these four models is often made on the basis of personal preference and familiarity. For example, various in-house versions of STORM are still used by consultants even though the "official" HEC version has not been updated since 1977, because these versions have been adapted to the needs of the firm and because 'TORM has proven to provide useful continuous simulation results. The USGS DR3M-QUAL model has perhaps been used the least by persons outside that agency, but has worked satisfactorily in several NURP applications. Support for both STORM and DR3M-QUAL would be minimal.

HSPF and SWMM are probably the most versatile and applicable of the four models, with the nod to SWMM if the urban hydrology and hydraulics must be simulated in detail. On the other hand, the water quality routines for sediment erosion, pollutant interaction and groundwater quality are superior in HSPF. Both models appear somewhat overwhelming in terms of size to the novice user, but only the components of interest of either model need be used in a given study, and the catchment schematization can often be coarse for purposes of simulation of water quality at the outlet. Thus, although the installation of these models on a microcomputer may occupy several megabytes of a hard disk, they may be applied in simple ways (i.e., applied to a simplified schematization of the catchment) with a significant reduction in data requirements. Furthermore, the several quality modeling options within SWMM permit simple conceptual water quality simulation using constant concentration and rating curves as well as the more formidable buildup-washoff methods.

Regression, spreadsheet and statistical methods are most useful as screening tools. Indeed if the Statistical Method, say, indicates that there should be no water quality problem (as defined by exceedance of a specified concentration level with a specified frequency), then more detailed water quality simulation is probably not required at all.

BRIEF CASE STUDIES

Introduction

How are quality processes being simulated in current on-going studies of urban runoff quality problems? Below, the author draws upon personal knowledge of a few such studies (listed alphabetically).

Boston

CH2M-Hill (Gainesville, FL) used continuous SWMM modeling for the development of TSS and BOD loads from CSOs to Boston Harbor. After first estimates from Sartor and Boyd (1972) and Pitt (1979), buildup and washoff functions were calibrated to estimates of annual totals based on monitoring. A "typical" five years of hourly precipitation data selected from 40 years of available record were input to SWMM to develop CSO loads, and the effectiveness of street cleaning and catchbasin cleaning BMPs was studied using the model.

Delevan Lake, Wisconsin

A joint project of the USGS (Madison) and the University of Wisconsin investigated suspended solids and phosphorus loads to 1800-ac Delevan Lake in southeastern Wisconsin (Walker et al., 1989). A spreadsheet approach was implemented using Multiplan, with unit load estimates for the surrounding basin (agricultural, urban, industrial). The Universal Soil Loss Equation was used for sediment loads from agricultural areas. Some calibration was possible using measurements on four tributaries. The cost-effectiveness of agricultural control options was evaluated based on cost estimates for various agricultural BMPs.

Hackensack River Basin

Pollution problems in the lower and estuarine portion of the Hackensack River in New Jersey are being studied by Najarian and Associates (Eatontown, NJ) using SWMM coupled with monitoring data from four CSO and five storm sewered areas. The pollutants of primary interest are BOD and ammonia for input to a dynamic receiving water quality model of the river and estuary, with emphasis upon the relative contributions of CSOs, separate storm sewered areas and point sources. Although rating curve results were very good predictors for the monitored catchments from which they were derived, it was found that they could not be extrapolated (transferred) to the ungaged catchments. Hence, Michaelis-Menton buildup and exponential washoff parameters were calibrated for the basins and transferable generalized coefficients developed as a function of land use. Intra-storm variations were simulated in order to use SWMM to drive a short time increment dynamic model of the river and estuary.

Jacksonville

Camp, Dresser and McKee (Jacksonville) will use SWMM for quantity predictions and both a spreadsheet and SWMM or STORM with constant concentrations for load estimates to the St. Johns River. The constant concentrations are based on NURP and limited Florida data. If SWMM or STORM is used to drive a receiving water quality model for the river, local data will be used for better calibration. At the moment, CDM feels that both quantity and quality control options can be compared on the basis of present data, with a minimum of expensive local sampling.

Orlando

To help alleviate nonpoint source pollution to lakes downstream from the Boggy Creek Watershed south of Orlando, Camp, Dresser and McKee (Orlando) developed a spreadsheet model to assess nutrient loadings resulting from existing and future land uses (Camp, Dresser and McKee, 1987). Runoff coefficients were calibrated to match measured creek runoff volumes, and EMCs as a function of land use were estimated from sampling in Orlando and Tampa. An overall calibration factor was used to obtain agreement between the total estimated TN and TP loads produced by the product of flows and EMCs for the various land uses and measured annual nutrient loads in Boggy Creek. Thus, relative contributions from various land uses remained the same while the overall loads were adjusted. BMP removal efficiencies were applied in conjunction with changing land uses to obtain control strategies for future watershed development.

Providence

SWMM is being used by Greeley and Hanson (Philadelphia) to simulate CSO loads from Providence using three monitored storms for calibration and verification. Quality is being simulated using constant concentration in the Runoff Block and the quality routing routines in the Transport Block. SWMM may be used to drive a receiving water model before the project is completed. Extran is also being used to simulate some of the overflow hydraulics.

San Francisco Bay

Woodward-Clyde (Oakland) is using SWMM to simulate loads from the Santa Clara Valley into South San Francisco Bay. Measured runoff and flow data are being used to calibrate the Runoff Block quantity routines, and constant concentrations are being used (no buildup or washoff) based on one year of monitoring of a selection of land use types. The model may not be used to drive a receiving water model but it will be used to compare alternatives to reduce loads of toxics to the Bay.

Tallahassee

The Northwest Florida Water Management District (Havana, FL) is using SWMM to develop the stormwater master plan for Tallahassee and Leon County. Extensive use of the model has already been made for quantity predictions. The present plan is to develop rating curve relationships on the basis of considerable quality monitoring data gathered during the study for input into SWMM. BMPs will also be studied with the model, especially storage. Final control decisions will be made on the basis of 28-year SWMM simulations using 15-min rainfall data.

SUMMARY AND URBAN RUNOFF QUALITY MODELING RECOMMENDATIONS

Simulation of urban runoff quality will increase in importance as regulation and control of nonpoint sources increases in the next several years. The implementation of Section 405 of the Clean Water Act is especially important if stormwater outfalls will be required to have NPDES permits. The EPA is currently establishing guidelines for data collection, quality monitoring and forms of analysis such that urban areas can meet their obligations under these regulations.

Some form of modeling will almost assuredly become part of routine analyses performed at some portion of the thousands upon thousands of CSO and stormwater discharge locations around the country. Several modeling options exist, but none of them are truly "deterministic" in the sense of fully characterizing the physical, chemical and biological mechanisms that underlie conceptual buildup, erosion, transport and degradation processes that occur in an urban drainage system. Even if fully deterministic models were available, it is doubtful that they could be routinely applied without calibration data. But this is essentially true of almost all methods. Because a method is simple, e.g., constant concentration, does not make it more correct. Rather, the assumption is made that there will be some error in prediction regardless of the method, and there may be no point in compiling many hypothetical input parameters for a more complex model lacking a guarantee of a better prediction. For example, a study in Denver showed that regression equations could predict about as well as DR3M-QUAL given the available quality information (Ellis and Lindner-Lunsford, 1986). But physically-based (conceptual) models do have certain advantages, discussed below.

Physically-based models depend upon conceptual buildup and washoff processes incorporated into the quality algorithms. Such models have withstood the test of time and have been applied in major urban runoff quality studies. However, the relative lack of fundamental data on buildup and washoff parameters has led to simpler methods more often being applied, starting with the assumption of a constant concentration and becoming more complex. For example, the derived distribution approach of the EPA Statistical Method provides very useful screening information with minimal data -- but more than are required by just assuming a constant concentration. With the mass of NURP and other data, regression approaches are now more viable but still subject to the usual restrictions of regression analysis. Spreadsheets are ubiquitous on microcomputers and serve as a convenient mechanism to implement several of the simple approaches, especially those that rely upon sets of coefficients, unit loads and/or EMCs as a function of land use or other demographic information.

Minimal data requirements and ease of application are the principal advantages of simpler simulation methods (constant concentration, unit loads, statistical, regression). However, in spite of their more complex data requirements, conceptual models (DR3M-QUAL, HSPF, STORM, SWMM) have advantages in terms of simulation of routing effects and control options as well as superior statistical properties of continuous time series. For example, the EPA Statistical Method assumes that stream flow is not correlated with the urban runoff flow. This may or may not be true in a given situation, but it is not necessary to require such an assumption when running a model such as HSPF or SWMM. The four conceptual models discussed in detail all have a means of simulating storage and treatment effects. Other than a constant removal, this is difficult to do with the simpler methods. The conceptual models generally have very much superior hydrologic and hydraulic simulation capabilities (not true for STORM except that it can also use real rainfall hyetographs as input). This alone usually leads to better prediction of loads (product of flow times concentration). It should also be borne in mind that even complex models such as SWMM and HSPF can be run with minimal quality (and quantity) data requirements, such as using only a constant concentration. Finally, some of the case studies imply that transferability of coefficients and parameters is easier with buildup and washoff than with rating curve and constant concentration methods.

If a more complex conceptual model is to be applied, which one should it be from among the four described herein? SWMM is certainly the most widely used and probably the most versatile for urban areas, but all have their advocates. HSPF may be more appropriate in areas with more open space where groundwater contributions increase in importance or where rainfall-induced erosion occurs or where quality interactions are important along the runoff pathway. The simplicity of STORM remains attractive, and various consultants have utilized their own version as a planning tool. The USGS DR3M-QUAL model has been successfully applied in several USGS studies but has not seen much use outside the agency. It contains useful techniques for quality calibration. SWMM and HSPF retain limited support from the EPA Center for Exposure

Assessment Modeling (CEAM) at Athens, Georgia. Unfortunately, this support is limited mainly to distribution and implementation on a computer system. Extra-mural support for the model developers is highly desirable for maintenance and improvements, especially in light of the predominant use of these two models in nonpoint source studies in the U.S. STORM and DR3M-QUAL will remain useful, but it is unlikely that either of these two models will enjoy enhancements or support from their sponsoring agencies in the near future.

What is a reasonable approach to simulation of urban runoff quality? The main idea is to use the simplest approach that will address the project objectives at the time. This usually means to start simple with a screening tool such as constant concentration (usually implemented in a spreadsheet) or regression or statistical approach. If these methods indicate that more detailed study is necessary or if they are unable to address all the aspects of the problem, e.g., the effectiveness of control options, then one of the more complex models must be run. No method currently available (or likely to be available) can predict absolute (accurate) values of concentrations and loads without local calibration data, including complex buildup and washoff models. Thus, if a study objective is to provide input loads to a receiving water quality model, local site-specific data will probably be required. On the other hand, several methods and models might be able to compare the relative contributions from different source areas, say, or to determine the relative effectiveness of control options (if the controls can be characterized by simple removal fractions). When used for purposes such as these, the methods, including buildup and washoff models, can usually be initiated on the basis of NURP and/or the best currently available source of quality data.

When properly applied and their assumptions respected, models can be tremendously useful tools in analysis of urban runoff quality problems. Methods and models are evolving that utilize the large current data base of quality information. As increasing attention is paid to urban runoff problems in the future, the methods and models can only be expected to improve.

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APPENDIX C

Estimation of Mean Urban Stormwater Loads at Unmonitored Sites by Regression

by Gary D. Tasker[1], Edward J. Gilroy[2] and Marshall E. Jennings[3]

Abstract

A regression-based model for estimating stormwater quality that may be useful at the planning level has been favorably compared to the widely used event-mean-concentration method. The regression model uses explanatory variables, such as drainage area, basin imperviousness, mean annual rainfall, and mean minimum January temperature, to explain variation in mean annual or seasonal load for an urbanized area.

The regression model is based on data collected for the Nationwide Urban Runoff Program (*NURP*) during 1979-1983 at basins of less than about 0.8 square miles. Strictly speaking, the model is applicable only to relatively small areas. However, a simple accumulation procedure presented herein can be used to extend application of the model to much larger areas to make the method practical for many planning and regulatory applications. The accumulation procedure not only allows one to make an estimate of mean annual or seasonal load for a relatively large urban area, but it also provides an estimate of confidence intervals for the loads. Although the calculations can be tedious, a computer program is available to make most of the necessary computations.

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Introduction

Urban planners and engineers need information on the quality of runoff at specific sites if they are to adequately plan for the effects of storm runoff from urban areas. Because collection and analysis of urban storm-runoff data are expensive and time consuming, there is a need for a technique to transfer constituent load information presently available at other sites to the site of interest. This was the reason for development of models (Driver and Tasker, 1990, Table 10) that relate constituent load data collected at urban sites throughout the United States for the Nationwide Urban Runoff Program (*NURP*) during 1979-83 to physical, land-use, and meteorological characteristics of urban watersheds. The Nationwide Regression Equations (*NRE*) method compared favorably with the median event-mean-concentration method (Jennings and Tasker, 1989).

Technically, the *NRE* method is limited to basins of less than about 0.8 square miles, while interest often lies in larger sites. This paper shows how the regression model may be used to estimate expected loads at unmonitored sites larger than 0.8 square miles and how to determine confidence limits for mean loads based on the regression model results. A computer program is available to make most of the somewhat tedious calculations.

The Nationwide Regression Equations Method

The *NRE* method is based on the assumption that explanatory variables, such as drainage area, basin imperviousness, mean annual rainfall, mean minimum January temperature, and general land-use categories, can explain regional variation in annual or seasonal storm loads. The regression equations were found to account for 20 to 65 percent of the total variation in observed loads. Coefficients for the regression equations were estimated by a generalized-least-squares (*GLS*) regression method that accounts for cross correlation and differences in reliability of sample estimates between sites. The method is described in references Stedinger and Tasker (1985) and Tasker and Driver (1988). The dependent variable in these equations is mean constituent load for a storm. It is not the load for any particular storm, but the mean load that would be obtained if one measured loads for many storms events at a site. An estimate of the mean annual or mean seasonal load is obtained by multiplying the mean load for a storm estimated from the equations by the average number of storms, n_s, per year or season, respectively.

Regression equations to estimate mean load for a storm, *W*, associated with a storm event were developed for ten constituents: chemical oxygen demand (*COD*), suspended solids (*SS*), dissolved solids (*DS*), total nitrogen (*TN*), total ammonia plus organic nitrogen as nitrogen (*TKN*), total phosphorus (*TP*), dissolved phosphorous (*DP*), total recoverable copper (*CU*), total recoverable lead (*PB*), and total recoverable zinc (*ZN*). These equations are of the form

$$W = 10^{\{b_0 + b_1 (DA)^{0.5} + b_2 (IA) + b_3 (MAR) + b_4 (MJT) + b_5 (X2)\}} (BCF),$$

where $b_0, \ldots, b_5$ are regression coefficients, *DA* is drainage area, in square miles; *IA* is impervious area, in percent; *MAR* is mean annual rainfall, in inches; *MJT* is mean minimum January temperature, in degrees Fahrenheit; *X2* is an indicator variable that is equal to 1 if commercial and industrial land use combined exceed 75 percent of the total area and 0 otherwise; and *BCF* is a bias correction factor. The bias correction factor is applied because the regression coefficients were estimated using log transformed data (Duan, 1983). Final values of the coefficients that were significant at the 95 percent level are shown in table 1.

A 90 percent confidence interval for the mean load for a storm at a particular unmonitored site, indexed by *i*, can be computed by

$$\{Y_i/T_i, Y_iT_i\},$$

where $Y_i = W_i/(BCF)$ and

$$T_i = 10^{\{t_{0.05,df}(V_{pi}^{0.5})\}},$$

in which $t_{0.05,df}$ is the critical value of the t-distribution for df degrees of freedom and V_{pi} is the variance of prediction at the unmonitored site i (Tasker and Driver, 1988). Given a row vector of basin characteristics at site *i*, $\mathbf{x}_i$, the variance of prediction at site i can be estimated as

$$V_{pi} = V_m + \mathbf{x}_i \mathbf{U} \mathbf{x}_i'$$

in which the matrix $\mathbf{U}$ for each equation is given in Tasker and Driver (1988, Table 5, p. 1100), and the model error variance, V_m, and degrees of freedom, *df*, are given in table 1. The variance of prediction, V_{pi}, is computed for the load in log units. The standard deviation of predicted load, in pounds, can be approximated, assuming lognormal distribution of load, by

$$S_L = W\{exp(5.302V_{pi}) - 1\}^{0.5}$$

(Aitchison and Brown, 1957).

An interactive computer program is available to calculate the expected value of mean load for a storm for the 10 constituents given the appropriate basin characteristics along with the 90 percent confidence interval and standard deviation of the load, S_L. An example of a computer calculation for *TKN* at a site with drainage area of 0.19 square miles, 50 percent impervious area, 30 inches mean annual rainfall, a mean minimum January temperature of 20 degrees F, and 30 percent commercial and industrial land use is shown in figure 1.

It is important in using the *NRE* method of prediction at an unmonitored site to determine if the calculation represents an extrapolation beyond the data used to calibrate the models because there is no reason to believe that the regression models apply outside the region of the calibration data. The computer program prints out a warning if the prediction at site i represents an extrapolation. A prediction is considered an extrapolation if $\mathbf{x}_i \mathbf{U} \mathbf{x}_i'$ computed for the prediction site exceeds the largest value of $\mathbf{x}_j \mathbf{U} \mathbf{x}_j'$ computed for all the observations in the original data (Montgomery and Peck, 1982, p. 142).

Application of Regression Equations to Large Areas

Estimate of Mean Annual or Seasonal Load

Because the regression equations were based on data collected at sites smaller than about 0.8 square miles, the method should not be applied directly to basins larger than 0.8 square miles. However, a larger basin can be subdivided into subbasins of less than 0.8 square miles. The mean annual load is then computed for each subbasin and summed to provide an estimate of mean annual load at the larger basin. For large basins the number of subbasins required could make the computations burdensome. The subdivision process can be greatly simplified by dividing the area into subareas of equal size with identical values for basin characteristics for each subbasin. The subbasins should have drainage areas of about 0.2 square miles. This allows the mean load for a storm estimate for the subbasins to be made at a value where prediction errors are relatively small. In this method it is not necessary to identify actual subbasin boundaries on a map. For example, suppose an estimate of mean annual load for *TKN* is desired at a site that is 9.5 square miles, 50 percent impervious area, 30 percent commercial and industrial, has a mean annual rainfall of 30 inches, a mean minimum January temperature of 20 degrees F, and an average of 55 storms per year. The 9.5 square mile area is divided into 50 hypothetical subbasins of 0.19 square miles, 50 percent impervious area, and less than 75 percent commercial and industrial land use. Using the results from figure 1 for each subbasin and summing the 50 subbasins gives an estimated mean *TKN* load for a storm of

$$\text{Mean } TKN \text{ load for a storm} = 50W(TKN) = 50(4.54) = 227 \text{ pounds.}$$

The mean annual load, L_a, is estimated as

$$L_a = 227 \text{ pounds per storm x 55 storms per year} = 12{,}500 \text{ pounds per year.}$$

Confidence Interval for the Sum of Mean Annual Loads

Let D_l denote the difference between the sum of estimated mean annual loads at *n* subbasins and the sum of true mean annual loads at *n* subbasins, L_t. The variance of D_l can be approximated by

$$Var(D_l)= \Sigma\mu_i^2 \exp[\sigma_e^2] + \Sigma\Sigma\mu_i\mu_j - \Sigma\mu_i^2 + \Sigma\Sigma\mu_i\mu_j \exp[.5(h_{ii}+h_{jj}+2h_{ij})] - 2(\Sigma\mu)^2,$$

where σ_e is the standard error of the regression model error, in natural log units, μ_i is the true mean load, in pounds, h_{ij} is the natural log equivalent of $\mathbf{x}_i \mathbf{U}\, \mathbf{x}_j'$, and the summations are over *n* subbasins (Gilroy, Hirsch, and Cohn, 1990).

For *n* identical subbasins and substituting $n_s W_i$ for μ_i, the standard deviation of D_l is approximately

$$SD(D_l)=n^{.5} n_s W_i \{(\exp[V_e]-1) + n(\exp[2h_{ii}]-1)\}^{.5}, \qquad \text{[Eqn. 1]}$$

where $V_e = 5.302V_m$ is the natural log equivalent of estimated model error variance. When *n* is not small (say, 15 or more), D_l may be considered approximately normal, and a 100(1-α) percent confidence interval for L_t computed as

$$\{nn_s W_i - z_{\alpha/2} SD(D_l)\ ,\ nn_s W_i + z_{\alpha/2} SD(D_l)\}, \qquad \text{[Eqn. 2]}$$

where $z_{\alpha/2}$ is the 100(1-α/2) percentile of a standard normal distribution.

Example

For the example in figure 1, a 90 percent confidence interval of mean *TKN* load for the sum of 50 identical subbasins would be calculated as follows:

a. For a 90 percent confidence interval $z_{\alpha/2} = 1.645$

b. From figure 1, $W = 4.54$, $V_e = 0.5299$, $h_{ii} = 0.0278$

c. From equation (1), $SD(D_l) = 3330$

d. From equation (2), the 90 percent confidence interval for the mean annual load would be {7000, 18000}.

Summary

The *NRE* method of estimating the expected value of mean load for a storm for ten constituents can be used to estimate mean annual storm loads at unmonitored sites if a few easily obtained basin characteristics are known. The basin characteristics include drainage area, impervious area, mean annual rainfall, mean minimum January temperature, and area of commercial and industrial land use. In addition to an estimate of mean load, confidence interval estimates can be made to give the user an idea of the uncertainty in the load estimate. A computer program is available to make most of the somewhat tedious calculations and to print a warning if the predicted load represents an extrapolation beyond the calibration data. A scheme of summing predictions for small areas can be used to make load predictions for large urban basins. The summing scheme assumes that mean annual load for a large basin can be computed as the sum of mean annual loads for subbasins. Although this scheme has not been verified by observed data, it is hoped that some future study will validate the method through comparison of predictions with observed data.

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Table 1. Nationwide regression equations for estimating mean load for a storm at unmonitored urban sites. [From Driver and Tasker, 1990, p. 29]

CONSTITUENT	Regression Constant B_0	Regression Coefficient for square root of Area, B_1	Regression Coefficient for Impervious Area B_2	Regression Coefficient for Mean Annual Rainfall B_3	Regression Coefficient for Mean Minimum January Temp. B_4	Regression Coefficient for Land-Use Factor B_5	Bias Correction Factor BCF	Model Error Variance V_m	Deg. of Freedom
COD	1.1174	2.0069	0.0051				1.298	0.0912	56
SS	1.5430	1.5906		0.0264	-0.0342		1.521	.1697	43
DS	1.8449	2.5468			- .0297		1.251	.0961	10
TN	- .2433	1.6383	.0061			-0.4442	1.345	.1190	37
TKN	- .7282	1.6123	.0064	.0226	- .0210	- .4345	1.277	.0999	45
TP	-1.3884	2.0825		.0234	- .0213		1.314	.0918	47
DP	-1.3661	1.3955					1.469	.1384	26
CU	-1.4824	1.8281			- .0141		1.403	.1303	27
PB	-1.9679	1.9037	.0070	.0128			1.365	.1246	52
ZN	-1.6302	2.0392	.0072				1.322	.0961	31

Program to calculate loads
ENTER constiuent to be estimated
Acceptable answers are COD, SS, DS, TN, TKN, TP, DP, CU, PB, or ZN
ENTER two blanks to quit.
TKN
ENTER site id if any
EXAMPLE SITE
ENTER drainage area, in square miles
0.19
ENTER impervious area, in percent
50.0
ENTER mean annual rainfall, in inches
30.0
ENTER mean minimum January temperature, in degree s Fahrenheit
20.0
ENTER 1 if commercial and industrial land use exceeds 75 percent
0

For EXAMPLE SITE
Storm load for total ammonia plus organic nitrogen as nitrogen, TKN

Mean	*90 percent CI*		*Std. Dev.*	*Variance of natural*	
	Upper	*Lower*	*of Load*	*log of errors*	
(pounds)	*(pounds)*	*(pounds)*	*(pounds)*	*Ve*	*hii*
4.54	*12.45*	*1.01*	*3.92*	*0.5299*	*0.0278*

Figure 1. Example of computer program calculation of mean load for a storm. Computer prompts and results are in italics, and user responses are in bold type.

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 BACKGROUND

A comprehensive water quality management program places an emphasis on the control of nonpoint source (NPS) pollution to enhance and protect local water resources. Control of urban stormwater runoff in the City of Corpus Christi is necessary to reduce stormwater pollutant loadings delivered to valuable receiving waters in the area, such as Corpus Christi and Oso Bays. Stormwater pollution encompasses a wide range of parameters, including nutrients, metals, organics, oils, greases, bacteria and solids.

In Task 2.I.B.(1), techniques for the quantification of runoff and corresponding amounts of stormwater pollution generated from areas tributary to storm sewer system outfall points were evaluated. Several hydrologic models were reviewed and an NPS model selected based on various criteria, including model suitability to support further development of the current Regional Stormwater Master Plan. To compare future results of NPS modeling, a database of historical stormwater quality data is needed. Also, local receiving water quality data may be indicative of existing stormwater impacts and will provide data for water quality trend analysis.

1.2 PURPOSE

The purpose of this report is to: 1) list "receiving waters" (bodies of water that receive stormwater runoff) for the Master Plan study area; 2) list existing water quality for each receiving water identifying nonpoint source pollutants affecting receiving waters; and 3) demonstrate the application of the NPS model.

In the study area, receiving waters have been listed which are found wholly or partially within the City limits of Corpus Christi and its extraterritorial jurisdictional area which extends into unincorporated parts of Nueces County. Receiving waters were identified in Task 2.I.A of this Master Plan as part of the Mapping Data Collection Plan. Major outfalls of the municipal storm sewer system which convey runoff to these water bodies have been field located according to the referenced mapping plan. The receiving waters addressed herein are:

- Corpus Christi Bay
- Nueces Bay
- Oso Bay
- Upper Laguna Madre
- Nueces River
- Oso Creek
- West Oso Creek
- Port of Corpus Christi Inner Harbor

1.3 RECEIVING WATER QUALITY DATA

Water quality in local bays and rivers is governed by a variety of factors. Point source discharges for process waters, brine discharges and wastewater treatment plant effluents; nonpoint sources such as stormwater runoff and septic tank effluents; spills in or near the bays; and pollution entering the bay from outside the region -- all have an impact on water quality. Obviously, stormwater runoff is only one of many sources of pollution entering local receiving waters. Existing receiving water quality is described in Section 2.0 in an attempt to identify pollutants of major concern and gauge the potential impacts of stormwater discharges from the storm sewer system.

1.4 STORMWATER QUALITY DATA

Since receiving water quality alone does not provide a direct correlation to the impacts of stormwater pollution, a review of existing stormwater quality data has been conducted and presented in Section 3.0. As shown, very little stormwater quality data from the storm sewer system exists for the Corpus Christi area. To obtain more data in the future, a storm event monitoring plan has been developed in Task 2.I.B.(2)(c) of this Master Plan.

1.5 NONPOINT SOURCE (NPS) MODEL

To quantify stormwater runoff and associated pollutant generation from areas tributary to storm sewer system outfall points, an NPS Model was selected as described in Task 2.I.B.(1). In Section 4.0 of this report, the Watershed Management Model (WMM) is reviewed in detail and input/output parameters explained. A preliminary model application is also presented for demonstration purposes.

2.0 RECEIVING WATERS

2.1 OVERVIEW

As stated in Section 1.2, the following receiving waters are included in this study:

- Corpus Christi Bay
- Nueces Bay
- Oso Bay
- Upper Laguna Madre
- Nueces River
- Oso Creek
- West Oso Creek
- Port of Corpus Christi Harbor

Reported existing water quality was investigated for each. Major sources of water quality data were: 1) The State of Texas Water Quality Inventory, LP 90-06, published by the Texas Water Commission in June 1990; 2) the Nonpoint Source Water Pollution Assessment Report for the State of Texas and Nonpoint Source Water Pollution Management Report for the State of Texas, published by the Texas Water Commission in 1988 and 1990 (draft updates); and 3) the Texas Statewide Monitoring Network (SMN) database maintained by the Texas Water Commission (TWC). Other sources of data included Federal, State and local resources. Also, a copy of all intensive surveys conducted by the TWC in the study area during the last ten years was obtained and reviewed for information pertinent to this study.

The State of Texas Water Quality Inventory is prepared by the State pursuant to Section 305(b) of the Clean Water Act (CWA), and as required by Federal guidelines for the preparation of subsequent water quality assessment/management reports. The inventory summarizes water quality for the majority of water bodies in Texas, including streams, reservoirs, bays and estuaries. Using criteria established by the U.S. Environmental Protection Agency (EPA), "use support" of the State's waters have been determined for fishable and swimmable purposes based on both evaluated and/or monitored assessments. Use support for "evaluated" waters are determined by the best professional judgement of knowledgeable biologists, whereas "monitored" waters rely on existing fixed station monitoring data, short-term intensive surveys and/or biological surveys.

Per EPA criteria, a station is considered not fishable if more than 10% of the dissolved oxygen measurements are less than 3.0 mg/L. A station is considered not swimmable if the geometric mean of each station's fecal coliform bacteria level is greater than 200 organisms/100 mL and/or 10% of the measurements were greater than 400 organisms per 100 mL, based on a minimum of four samples taken per 30-day period.

Designated uses have been established by the TWC for all receiving waters evaluated in this master plan, except Oso Creek and West Oso Creek.

In accordance with Section 319 of the Federal Clean Water Act, the State also prepares and submits nonpoint source water pollution assessments and management reports. A statewide list of nonpoint source affected waters has been compiled detailing the cause of inclusion on the list and extent of concern.

Criteria for determination of nonpoint source pollution impacting a water body are listed by the TWC as follows:

Problem Status		Criteria
Known	-	Standards, designated uses or fishable, swimmable goals impacted
Potential	-	Water quality data shows water quality parameters or criteria occasionally exceeded; stream standards not violated
Concern	-	Information other than water quality data is insufficient to determine severity, extent, or source of loadings; stream standards not violated

Corpus Christi Bay and Nueces Bay are included on the state master list of nonpoint source affected waters (see Sections 2.3.1 and 2.3.2). The remaining receiving waters evaluated in this Master Plan do not appear on the NPS affected list.

Information is available from numerous Federal, State and local agencies, including U.S. Environmental Protection Agency (EPA), U.S. Geological Survey (USGS), Texas Water Commission (TWC), Texas Water Development Board (TWDB), and Texas Department of Health (TDH) data. The Texas Water Commission maintains the Statewide Monitoring Network (SMN), a comprehensive water resources database. In the absence of reported water quality information, this database was accessed to provide raw water quality data for the receiving waters under study.

2.2 TEXAS SURFACE WATER QUALITY STANDARDS

Before existing water quality conditions are detailed, a summary of current surface water quality standards in the State of Texas is presented. These standards are included for reference and comparison to the existing water quality data presented in Section 2.3.

The Texas Water Commission has the sole and exclusive authority to establish and revise water quality standards for the State of Texas. These standards are established and reviewed on a periodic basis pursuant to Section 26.023 of the Texas Water Code and Section 303(c) of the Federal Pollution Control Act. The purposes of the Texas Surface Water Quality Standards are to define the State's water quality objectives, to designate classified stream segments and the desirable water uses associated with the classified segments, and to establish numerical and general water quality criteria, which are a function of desirable uses and natural stream conditions.

On June 25, 1991, revised surface water quality standards for the State of Texas (31 TAC 307.2-307.10) were published in the Texas Register. These standards became effective on July 10, 1991. General surface water quality criteria are contained in Section 307.4 and are applicable to all surface waters of the State, unless specifically excepted. General criteria are detailed for:

- Aesthetic parameters
- Radiological parameters
- Toxic parameters
- Nutrient parameters
- Temperatures
- Salinity
- Dissolved oxygen/aquatic life uses
- Bacteria

Numerical criteria are established for toxic materials in Section 307.6 for which adequate toxicity information is available and which have the potential for creating adverse water quality impacts. These criteria are shown in Table 2-1. Human health protection criteria for specific parameters are also designated and shown in Table 2-2.

Numerical criteria and water uses are also specified for certain site-specific areas. Among the eight receiving waters studied in this report, all but Oso Creek and West Oso Creek have site-specific criteria and designated water uses. A summary of site-specific criteria and water uses for study area receiving waters are shown in Table 2-3.

2.3 EXISTING WATER QUALITY

Reported existing water quality data for each of the receiving waters in the study area is listed below.

2.3.1 CORPUS CHRISTI BAY

Corpus Christi Bay encompasses approximately 123 square miles. Designated water uses for the bay are: contact recreation, exceptional quality aquatic habitat and shellfish waters.

TABLE 2-1

CRITERIA IN WATER FOR SPECIFIC TOXIC MATERIALS - AQUATIC LIFE PROTECTION
(All values are listed or calculated in micrograms per liter)
(Hardness concentrations are input as milligrams per liter)

Parameter	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria
Aldrin	3.0	--	1.3	--
Aluminum (d)	991	--	--	--
Arsenic (d)	360	190	149	78
Cadmium (d)	$e^{(1.128[\ln(hardness)]-1.6774)}$	$e^{(0.7852[\ln(hardness)]-3.490)}$	45.62	10.02
Carbaryl	2.0	--	613	--
Chlordane	2.4	0.0043	0.09	0.004
Chloropyrifos	0.083	0.041	0.011	0.0056
Chromium(Tri) (d)	$e^{(0.8190[\ln(hardness)]+3.688)}$	$e^{(0.8190[\ln(hardness)]+1.561)}$	--	--
Chromium(Hex) (d)	16	11	1,100	50
Copper (d)**	$e^{(0.0422[\ln(hardness)]-1.3844)}$	$e^{(0.8545[\ln(hardness)]-1.386)}$	16.27	4.37
Cyanide*	45.78	10.69	5.6	5.6
DDT	1.1	0.0010	0.13	0.0010
Demeton	--	0.1	--	0.1
Dieldrin	2.5	0.0019	0.71	0.0019
Endosulfan	0.22	0.056	0.034	0.0087
Endrin	0.18	0.0023	0.037	0.0023
Guthion	--	0.01	--	0.01
Heptachlor	0.52	0.0038	0.053	0.0036
Hexachloro-cyclohexane (Lindane)	2.0	0.08	0.16	--
Lead (d)	$e^{(1.273[\ln(hardness)]-1.460)}$	$e^{(1.273[\ln(hardness)]-4.705)}$	140	5.6
Malathion	--	0.01	--	0.01
Mercury (d)	2.4	1.3	2.1	1.1

TABLE 2-1

CRITERIA IN WATER FOR SPECIFIC TOXIC MATERIALS - AQUATIC LIFE PROTECTION
(Continued)

Parameter	Fresh Acute Criteria	Fresh Chronic Criteria	Marine Acute Criteria	Marine Chronic Criteria
Methoxychlor	--	0.03	--	0.03
Mirex	--			
Nickel (d)	$e^{(0.8460[\ln(\text{hardness})]+3.3612)}$	$e^{(0.8460[\ln(\text{hardness})]+1.1645)}$	119	13.2
Total PCBs	2.0	0.014	10	0.03
Parathion	0.065	0.013	--	--
Phenanthrene	30	30	7.7	4.6
Pentachlorophenol	$e^{[1.005(\text{pH})-4.830]}$	$e^{[1.005(\text{pH})-5.290]}$	15.14	9.56
Selenium (d)	20	5	564	136
Silver, as free ion (d)	0.92	0.49	7.2	0.92
Toxaphene	0.78	0.0002	0.21	0.0002
Tributlytin	0.13	0.024	0.24	0.043
2,4,5-Trichlorophenol	136	64	259	12
Zinc (d)	$e^{(0.8473[\ln(\text{hardness})]+0.8604)}$	$e^{(0.8473[\ln(\text{hardness})]+0.7614)}$	98	89

* Amenable to Chlorination

(d) Indicates that the criteria for a specific parameter are for the dissolved portion in water. All other criteria are for total recoverable concentrations.

** In designated oyster waters an acute marine copper criterion of 4.37 micrograms per liter applies outside of the mixing zones of permitted discharges, and specific mixing zones for copper will not encompass oyster reefs containing live oysters.

SOURCE: Texas Register, June 25, 1991.
Texas Surface Water Quality Standards (31 TAC Chapter 307).

TABLE 2-2

CRITERIA IN WATER FOR SPECIFIC TOXIC MATERIALS - HUMAN HEALTH PROTECTION

Compound	A Water and Fish (µg/L)	B FW Fish Only (µg/L)	C SW Fish Only (µg/L)
Aldrin	0.0312	0.0327	0.0218
Alpha-hexachlorocyclohexane	0.645	0.997	0.665
Arsenic (d)	50*	--	--
Barium (d)	1,000*	--	312
Benzene	5*	312	208
Benzidine**	0.0011	0.0035	0.0023
Beta-Hexachlorocyclohexane	2.26	3.49	2.33
Bis(chloromethyl)ether	0.0207	1.59	1.06
Cadium (d)	10*	--	--
Carbon Tetrachloride	5*	182	121
Chlordane***	0.0210	0.0213	0.0213
Chlorobenzene	1,305	4,947	3.298
Chloroform	100*	12,130	8,087
Chromium (d)	50*	--	--
Cresols	4,049	46,667	31,111
DDD	0.297	0.299	0.199
DDE	0.0544	0.0545	0.0363
DDT	0.0527	0.0528	0.0352
2,4-D	100*	--	--
Danitol	0.709	0.721	0.481

TABLE 2-2

CRITERIA IN WATER FOR SPECIFIC TOXIC MATERIALS -
HUMAN HEALTH PROTECTION
(Continued)

Compound	A Water and Fish (µg/L)	B FW Fish Only (µg/L)	C SW Fish Only (µg/L)
Dibromochloromethane	1,590	15,354	10,236
1,2-Dibromoethane	0.0518	1.15	0.769
Dieldrin**	0.0012	0.0012	0.0008
p-Dichlorobenzene (1,4-Dichlorobenzene)	75*	--	--
1,2-Dichloroethane	5*	1,794	1,196
1,1-Dichloroethylene	7*	87.4	58.3
Dicofol	0.215	0.217	0.144
Dioxins/Furans (TCDD Equivalents)**	0.0000010	0.0000010	0.0000007
Compound — Equivalency Factors 2,3,7,8-TCDD — 1.0 2,3,7,8-PeCDD — 0.5 2,3,7,8-HxCDD — 0.1 2,3,7,8-TCDF — 0.1 1,2,3,7,8-PeCDF — 0.05 2,3,4,7,8-PeCDF — 0.5 2,3,7,8-HxCDF — 0.1			
Endrin	0.2*	--	--
Fluoride	4,000*	--	--
Gamma Hexachlorocyclohexane (Lindane)	4*	16.0	10.7
Heptachlor**	0.0177	0.0181	0.0120
Heptachlor Epoxide	1.08	7.39	4.92
Hexachlorobenzene	0.0129	0.0129	0.0086
Hexachlorobutadiene	9.34	11.2	7.48
Hexachloroethane	84.4	94.1	62.7
Hexachlorophene	0.0531	0.0532	0.0355

TABLE 2-2

CRITERIA IN WATER FOR SPECIFIC TOXIC MATERIALS - HUMAN HEALTH PROTECTION (Continued)

Compound	A Water and Fish (µg/L)	B FW Fish Only (µg/L)	C SW Fish Only (µg/L)
Lead (d)	5.00	25.0	3.85
Mercury***	0.0122	0.0122	0.0250
Methoxychlor	100*	--	--
Methyl Ethyl Ketone	4,411	886,667	591,111
Mirex	0.0171	0.0189	0.0126
Nitrate-N	10,000*	--	--
Nitrobenzene	41.8	721	481
n-Nitrosodiethylamine	0.0382	7.68	5.12
N-Nitroso-di-n-Butylamine	1.84	13.5	8.98
PCBs	0.0013	0.0013	0.0009
Pentachlorobenzene	1.09	1.11	0.739
Pentachlorophenol	129	136	90.5
Pyridine	88.1	13,333	8.889
Selenium (d)	10*	--	--
Silver (d)	50*	--	--
1,2,4,5-Tetrachlorobenzene	1.43	1.52	1.01
Tetrachloroethylene	597	1,832	1,221
Toxaphene**	0.0440	0.0445	0.0297
2,4,5-TP (Silvex)	10*	--	--
2,4,5-Trichlorophenol	2,767	4,021	2,681
Trichloroethylene	5*	--	--
1,1,1-Trichloroethane	200*	--	--
TTHM (Total Trihalomethanes)	100*	--	--
Vinyl Chloride	2*	94.5	63.0

TABLE 2-2

CRITERIA IN WATER FOR SPECIFIC TOXIC MATERIALS - HUMAN HEALTH PROTECTION
(Continued)

* Based on maximum contaminant level specified by the Texas Department of Health in 25 TAC §337 (relating to Drinking Water Standards).

** Calculations based on measured bioconcentration factors, and no lipid content correction factor was applied.

*** Calculations based on USFDA Action Levels for fish tissue concentrations.

(d) Indicates that the criteria for a specific parameter are for the dissolved portion in water. All other criteria are for total recoverable concentrations.

SOURCE: Texas Register, June 25, 1991.
Texas Surface Water Quality Standards (31 TAC Chapter 307).

TABLE 2-3

SITE SPECIFIC WATER USES
AND NUMERICAL CRITERIA

Receiving Water	Uses		Criteria			
	Recreation [1]	Aquatic Life [2]	Dissolved Oxygen (mg/L)	pH Range	Fecal Coliform (#/100 mL) [3]	Temperature (°F) Not to exceed
Nueces River Tidal	CR	E	5.0	6.5-9.0	200	95
Corpus Christi Bay	CR	E/O	5.0	6.5-9.0	14	95
Nueces Bay	CR	E/O	5.0	6.5-9.0	14	95
Redfish Bay	CR	E/O	5.0	6.5-9.0	14	95
Corpus Christi Inner Harbor	NCR	I	3.0	6.5-9.0	200	95
Oso Bay	CR	E/O	5.0	6.5-9.0	14	95
Laguna Madre	CR	E/O	5.0	6.5-9.0	14	95

1) CR = Contact recreation
NCR = Noncontact recreation

2) E = Exceptional quality aquatic habitat
I = Intermediate quality aquatic habitat
O = Oyster waters

3) Thirty-day geometric mean not to exceed

SOURCE: Texas Register, June 25, 1991.
Texas Surface Water Quality Standards (31 TAC Chapter 307).

TABLE 2-4

REPORTED WATER QUALITY [1]
CORPUS CHRISTI BAY

Parameter	Criteria	Number Samples	Minimum	Maximum	Mean	Number of Values Outside Criteria	Mean Values Outside Criteria
Dissolved Oxygen (mg/L)	5.0	62	4.9	8.9	6.8	1	4.9
Temperature (F)	95.0	64	56.9	88.5	74.2	0	0
pH	6.5-9.0	63	7.4	8.6	8.2	0	0
Chloride (mg/L)	n/a	58	13,634	23,400	18,281	0	0
Sulfate (mg/L)	n/a	60	780	3,207	2,384	0	0
Total Dissolved Solids (mg/L) [2]	n/a	64	9,525	28,750	24,088	0	0
Fecal Coliforms (#/100 mL)	14	18	2	40	3	1	40

[1] Table illustrates the four years of water quality information for Segment 2481.

[2] Total dissolved solids were estimated by multiplying specific conductance by 0.50.

SOURCE: Texas Water Commission

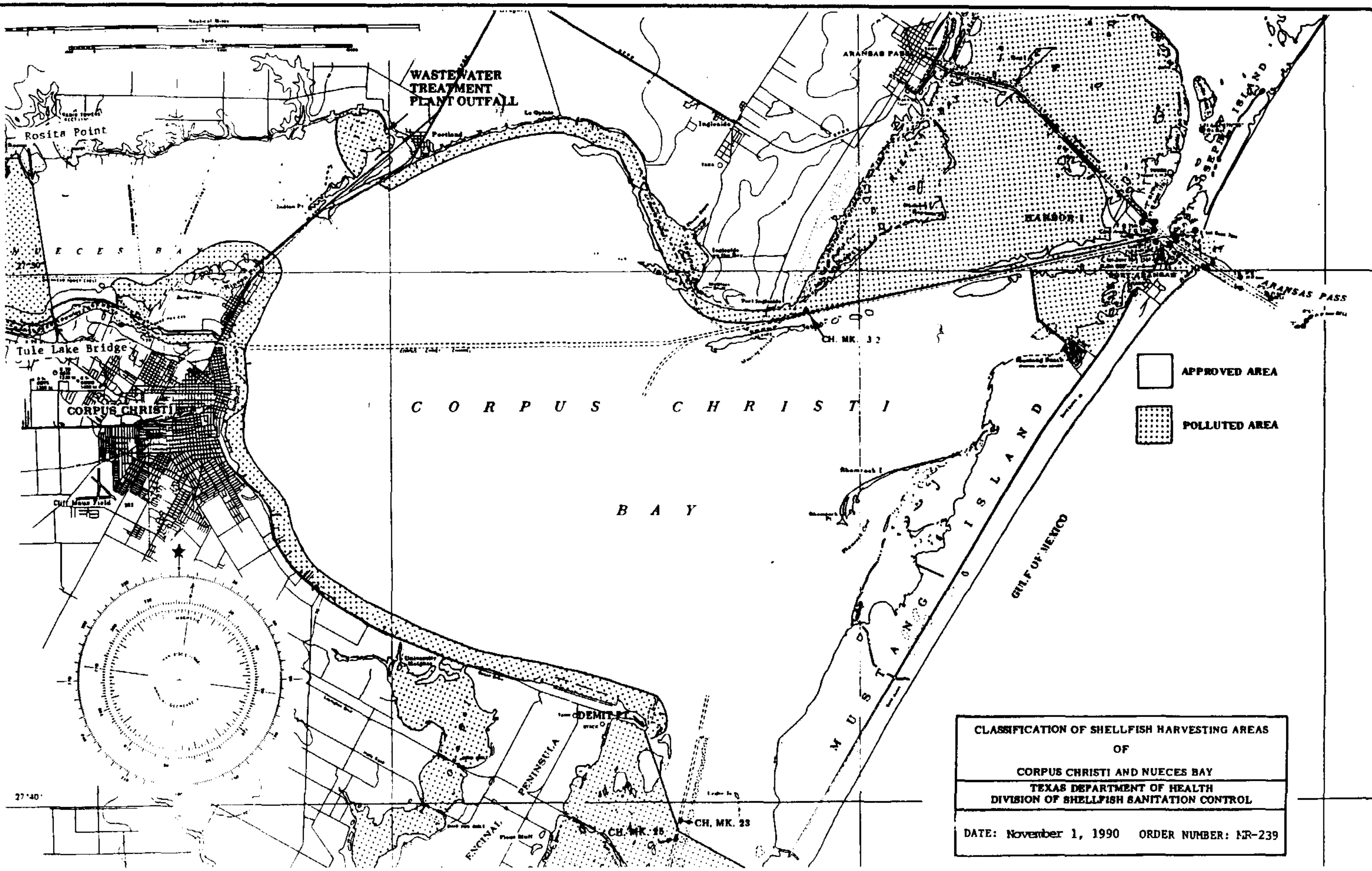
Table 2-4 summarizes the reported water quality of Corpus Christi Bay based on four years of water quality data. Information is shown for dissolved oxygen, temperature, pH, chloride, sulfate, total dissolved solids and fecal coliforms.

The Texas Department of Health (TDH) routinely monitors fecal coliform levels in the bay system. As presented in the 305(b), approximately 53,000 acres of Corpus Christi Bay (including parts of Oso Bay and Nueces Bay) are closed to shellfish (oyster) harvesting, due to elevated fecal coliform bacteria concentrations. Figure 2-1 shows areas of the bay system currently closed to shellfish harvesting as reported in the Comprehensive Sanitary Survey of the Producing Waters of Corpus Christi and Nueces Bays (TDH). In the NPS 319 report, the contributing problem status is listed as "potential nonpoint source contributions" (see Section 2.1). Possible point and nonpoint sources of contamination are reported as collection system leaks, bypassing, confined animal facilities, urban stormwater runoff, septic tanks and rangeland.

Rare elevations in concentrations of inorganic nitrogen, orthophosphorus and chlorophyll a have also been reported (less than 10% of reported value exceeded designated criteria).

2.3.2 NUECES BAY

Similar to Corpus Christi Bay, Nueces Bay also experiences occasional elevations of fecal coliforms. Portions of Nueces Bay are closed to shellfish harvesting due to these exceedances (see Figure 2-1). Nueces Bay appears in both the 305(b) and 319 reports as a subarea of Corpus Christi Bay which exhibits potential impacts of nonpoint source pollution. Orthophosphorus concentrations are also occasionally elevated (11 to 25% exceedance rate) with total phosphorus concentrations rarely elevated. Table 2-5 lists reported water quality conditions within the Bay.



SOURCE: TEXAS DEPARTMENT OF HEALTH

CDM
environmental engineers, scientists, planners, & management consultants

CLASSIFICATION OF SHELLFISH HARVESTING AREAS

FIGURE NO. 2-1

TABLE 2-5

REPORTED WATER QUALITY [1]
NUECES BAY

Parameter	Criteria	Number Samples	Minimum	Maximum	Mean	Number of Values Outside Criteria	Mean Values Outside Criteria
Dissolved Oxygen (mg/L)	5.0	51	5.3	10.1	7.2	0	0
Temperature (F)	95.0	52	57.2	89.6	74.8	0	0
pH	6.5-9.0	52	7.5	8.4	8.0	0	0
Chloride (mg/L)	n/a	51	5,857	23,200	16,972	0	0
Sulfate (mg/L)	n/a	47	505	3,130	2,225	0	0
Total Dissolved Solids (mg/L) [2]	n/a	52	6,845	28,900	21,673	0	0
Fecal Coliforms (#/100 mL)	14	16	2	35	4	3	25

1) Table illustrates the four years of water quality information for Segment 2482.

2) Total dissolved solids were estimated by multiplying specific conductance by 0.50.

SOURCE: Texas Water Commission

2.3.3 OSO BAY

As reported by the TWC in the 305(b) inventory, fecal coliform bacteria is a known water quality problem. As shown in Figure 2-1, the bay is closed to shellfish harvesting. Bay samples also show supersaturated dissolved oxygen levels. Phosphorus concentrations are periodically elevated (26 to 44% criteria exceedance rate). This is due, in part, to orthophosphorus concentrations exceeding established water quality criteria for 45 to 55% of the samples tested. Inorganic nitrogen and chlorophyll a are rarely elevated. It should be noted that although the 305(b) inventory report includes Oso Bay with Corpus Christi Bay and Nueces Bay as having fecal coliform bacteria related restrictions on shellfish harvesting, Oso Bay is not included in the Section 319 reported state-wide list of nonpoint source affected waters. Table 2-6 lists water quality conditions for Oso Bay.

2.3.4 UPPER LAGUNA MADRE

Laguna Madre proper encompasses approximately 350 square miles, extending along the coast from Corpus Christi to the southern tip of Texas near Brownsville. As shown in Figure 1 of Task 2.I.A, approximately 24 square miles of Laguna Madre are located within the study area. Table 2-7 details water quality conditions representative of the entire Laguna Madre, based on data taken from seven monitoring stations. Of the seven monitoring stations, none are located in Nueces County.

The monitoring station nearest the study area is located in Kleberg County south of the intersection of the Intracoastal Waterway and Padre Island Causeway. The Statewide Monitoring Network database was scanned for water quality data collected at this station (No. 2491.0050) from January 1989 to date. All data, shown in Table 2-8, was below designated criteria except for dissolved oxygen. One DO sample reading was above the 9.3 maximum criteria.

TABLE 2-6

REPORTED WATER QUALITY [1]
OSO BAY

Parameter	Criteria	Number Samples	Minimum	Maximum	Mean	Number of Values Outside Criteria	Mean Values Outside Criteria
Dissolved Oxygen (mg/L)	5.0	30	5.2	11.7	7.8	0	0
Temperature (F)	95.0	30	43.2	87.8	74.0	0	0
pH	6.5-9.0	30	7.8	9.0	8.3	0	0
Chloride (mg/L)	n/a	30	13,858	28,609	19,591	0	0
Sulfate (mg/L)	n/a	28	1,210	4,208	2,620	0	0
Total Dissolved Solids (mg/L) [2]	n/a	30	12,750	37,000	25,480	0	0
Fecal Coliforms (#/100 mL)	14	16	2	70	6	3	53

1) Table illustrates the four years of water quality information for Segment 2485.

2) Total dissolved solids were estimated by multiplying specific conductance by 0.50.

SOURCE: Texas Water Commission

TABLE 2-7

REPORTED WATER QUALITY [1]
LAGUNA MADRE

Parameter	Criteria	Number Samples	Minimum	Maximum	Mean	Number of Values Outside Criteria	Mean Values Outside Criteria
Dissolved Oxygen (mg/L)	5.0	99	3.8	9.3	6.5	13	4.5
Temperature (F)	95.0	99	45.2	88.1	74.7	0	0
pH	6.5-9.0	90	7.3	8.8	8.1	0	0
Chloride (mg/L)	n/a	97	5,476	31,100	19,993	0	0
Sulfate (mg/L)	n/a	94	56	3,864	2,614	0	0
Total Dissolved Solids (mg/L) [2]	n/a	99	14,850	34,924	26,502	0	0
Fecal Coliforms (#/100 mL)	14	61	2	10	6	0	0

1) Table illustrates the four years of water quality information for Segment 2491.

2) Total dissolved solids were estimated by multiplying specific conductance by 0.50.

SOURCE: Texas Water Commission

TABLE 2-8

WATER QUALITY DATA
UPPER LAGUNA MADRE

Parameter	Number of Samples	Minimum	Maximum	Mean
Dissolved Oxygen (mg/L)	5	8.0	9.6	8.8
pH	5	7.9	8.5	8.1
Chloride (mg/L)	2	19,232	24,000	21,616
Sulfate (mg/L)	2	2,700	2,713	2,706
Fecal Coliforms (#/100 mL)	1	3	3	3

SOURCE: Statewide Monitoring Network, January 1989 - July 1991.

2.3.5 NUECES RIVER

The Nueces River Basin drains approximately 16,950 square miles of south central Texas and empties into Nueces Bay in the study area. In the upper reaches, a large portion of river flow enters the Edwards Aquifer Balcones Fault zone, a highly fragmented limestone formation located well upstream of the study area. Therefore, the majority of river flow below the recharge zone is composed primarily of stormwater runoff. TWC reports increased levels of chloride, sulfate and total dissolved solids during low flow conditions at downstream portions of the river.

Although supersaturated dissolved oxygen levels occur periodically, TWC states that depressed oxygen levels are a known water quality problem for the tidally influenced portion of the Nueces River located below Calallen Dam. Phosphorus levels were reported as exceeding an elevated concentration of 0.2 mg/L for all samples taken. This may explain the occurrences of algal blooms within the tidal portion of the river and the upper reaches of Nueces Bay. As shown in Table 2-9, the tidal portion of the Nueces River is listed as exhibiting the highest severity of hypoxia associated with algal blooms in the 1990 state water quality inventory. Hypoxia is characterized by high dissolved oxygen levels (D.O. > 12.0 mg/L), and high chlorophyll a concentrations (maximum chlorophyll a >50 ug/L and mean chlorophyll a >20 ug/L). Table 2-10 summarizes water quality criteria and data in the tidal portion of the Nueces River.

2.3.6 CORPUS CHRISTI INNER HARBOR

The Corpus Christi Inner Harbor provides navigable access to the industrial district north of Corpus Christi. The inner harbor area is composed of approximately 0.7 square miles of channel and turning basins which open to Corpus Christi Bay. TWC lists designated uses of the inner harbor as noncontact recreation and intermediate quality aquatic habitat.

Table 2-11 shows reported water quality conditions for the inner harbor. In the statewide inventory, TWC reports orthophosphorus concentration levels as periodically

TABLE 2-9

ESTUARIES EXHIBITING HYPOXIA ASSOCIATED WITH ALGAL BLOOM [1)]

As stated in State Water Quality Inventory

Segment Number	Description
2101	Nueces River Tidal
1113	Armand Bayou Tidal
2201	Arroyo Colorado Tidal
2301	Rio Grande Tidal
2425	Clear Lake
2429	Scott Bay
2436	Barbours Cut
2428	Black Duck Bay
2430	Burnett Bay
2426	Tabbs Bay
2427	San Jacinto Bay
1101	Clear Creek Tidal
1103	Dickinson Bayou Tidal

1) Listed in order of decreasing severity. Parameters evaluated: Maximum DO (>12.0 mg/L), maximum chlorophyll a (>50 µg/L) an mean chlorophyll a (>20 µg/L).

SOURCE: Texas Water Commission

TABLE 2-10

REPORTED WATER QUALITY [1]
NUECES RIVER TIDAL

Parameter	Criteria	Number Samples	Minimum	Maximum	Mean	Number of Values Outside Criteria	Mean Values Outside Criteria
Dissolved Oxygen (mg/L)	5.0	40	1.2	19.4	9.2	4	3.5
Temperature (F)	95.0	40	53.2	89.6	75.1	0	0
pH	6.5-9.0	39	7.6	8.9	8.4	0	0
Chloride (mg/L)	n/a	38	133	17,800	6,897	0	0
Sulfate (mg/L)	n/a	38	36	2,637	944	0	0
Total Dissolved Solids (mg/L) [2]	n/a	40	452	24,850	10,356	0	0
Fecal Coliforms (#/100 mL)	200	10	2	525	90	4	403

1) Table illustrates the four years of water quality information for Segment 2101.

2) Total dissolved solids were estimated by multiplying specific conductance by 0.50.

SOURCE: Texas Water Commission

TABLE 2-11

REPORTED WATER QUALITY [1)]
CORPUS CHRISTI INNER HARBOR

Parameter	Criteria	Number Samples	Minimum	Maximum	Mean	Number of Values Outside Criteria	Mean Values Outside Criteria
Dissolved Oxygen (mg/L)	3.0	46	4.1	8.4	6.2	0	0
Temperature (F)	95.0	49	56.3	87.1	75.3	0	0
pH	6.5-9.0	46	7.8	8.6	8.1	0	0
Chloride (mg/L)	n/a	46	14,200	23,200	18,038	0	0
Sulfate (mg/L)	n/a	45	1,830	3,018	2,446	0	0
Total Dissolved Solids (mg/L) [2)]	n/a	49	17,750	28,540	24,258	0	0
Fecal Coliforms (#/100 mL)	200	15	2	405	7	1	404

1) Table illustrates the four years of water quality information for Segment 2484.

2) Total dissolved solids were estimated by multiplying specific conductance by 0.50.

SOURCE: Texas Water Commission

elevated and inorganic nitrogen levels as occasionally elevated. The Texas Department of Health reports the Inner Harbor as closed to shellfish harvesting due to elevated fecal coliform concentrations (see Figure 2-1).

TWC conducted an intensive water quality survey of the Inner Harbor area in June 1987. In December 1989, TWC published Results of Intensive Priority Pollutant Monitoring in Texas - Phase II, which included water quality data, observations and recommendations for the Inner Harbor. Varying concentrations of toxics were detected in ambient water quality samples, plant effluents to the Inner Harbor, sediment samples and tissue samples (see Table 2-12). Arsenic, cadmium, copper, mercury, selenium, and zinc levels exceeded screening criteria applied by TWC.

TWC attributes the presence of toxic chemicals in the Inner Harbor to past and present effluent discharges and stormwater runoff. In general, TWC found that the number of toxic chemicals and concentrations has declined since the last intensive survey was performed in 1981. TWC attributes this decline to increased effluent treatment requirements, the absence of an industrial effluent, and dredging in the Inner Harbor. TWC predicted a continued decrease in the scope of toxic chemical contamination due to the removal of dredged sediment in 1988, which served as a repository for residual contamination.

The Inner Harbor appears on a state-maintained list of waterbodies known to be impacted by any source of toxic or conventional pollutants. This comprehensive list (required by Section 304(L) of the Clean Water Act) is maintained as a planning tool for the implementation of future regulatory control programs.

2.3.7 OSO CREEK

Oso Creek (including West Oso Creek) serves a drainage area 180 square miles in size. Although not included in the statewide water quality inventory, TWC maintains several monitoring stations along Oso Creek. Station No. 2200.0150 is located at Oso Creek at FM 2444. Station No. 2200.0200 is located upstream at SH286. A third station is

TABLE 2-12
RESULTS OF INTENSIVE PRIORITY POLLUTANT
MONITORING IN THE INNER HARBOR

Sample Type	# Toxic Chemicals Analyzed	# Toxic Chemicals Detected	Toxic Chemicals Detected
Ambient	137	4	Methylene chloride, Copper, Ammonia, Zinc
Effluents	137	12	Phenolics, Methylene chloride, Antimony, Arsenic, Chromium, Copper, Nickel, Selenium, Zinc, Cyanide, Un-Ionized ammonia, Residual chlorine
Sediments	135	19	Methylene chloride, Anthracene/Phenanthene, Benzo-a-pyrene, Benzo(a)anthracene, 1,2-Benzanthracene, Benzo(b)fluoranthene/ Benzo(k)fluoranthene, Chrysene, Fluoranthene, Pyrene, Antimony, Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Zinc
Tissue	135	9	Methylene chloride, Arsenic, Cadmium, Copper, Selenium, Zinc, Mercury, p,p'dde, p,p'ddt

SOURCE: Texas Water Commission, LP 89-07.

located at FM 763 and Oso Creek. The SMN database was queried to obtain all water quality data available at these stations for the last two years. Data is shown in Table 2-13.

According to TWC staff, the water quality of Oso Creek is partially dominated by treatment plant effluent flow. Effluents discharged to Oso Creek increase the likelihood of high nutrients, fecal coliform, dissolved oxygen and chlorophyll a concentrations. This is confirmed by SMN data. As shown in Table 2-13, dissolved oxygen levels fluctuate greatly and fecal coliform levels are high. TWC data also indicates relatively high nitrogen, phosphorus and chlorophyll a concentrations. As shown in Figure 2-1, the Texas Department of Health has restricted shellfish harvesting in Oso Bay and the lower reaches of Oso Creek.

TABLE 2-13

WATER QUALITY DATA
OSO CREEK

Parameter	Number of Samples	Minimum	Maximum	Mean
Dissolved Oxygen (mg/L)	21	0.7	15.6	8.9
pH	22	6.9	9.8	8.1
Chloride (mg/L)	20	9	2,230	1,125
Sulfate (mg/L)	22	110	450	253
Fecal Coliforms (#/100 mL)	19	17	2,833	413

SOURCE: Statewide Monitoring Network, January 1989 - July 1991.

3.0 STORM SEWER SYSTEM DATA

3.1 DISCHARGE DATA

Although an extensive database of ambient water quality exists for local receiving waters, there is very little water quality data available for stormwater discharges from the storm sewer system. Such information would be used to characterize stormwater runoff amounts, stormwater pollution generation rates for typical land uses in the Corpus Christi area, and to quantify pollutant loads to local receiving waters. A single grab sample of stormwater runoff taken during a storm event will give general insight to the kinds and amounts of pollutants contained in runoff, for the analysis and modeling of total stormwater pollution loadings to local receiving waters, a series of grab samples taken during the course of a storm event is required. These grab samples must then be composited on a flow weighted basis, which dictates the need for continuous flow monitoring at the sampling site during the storm event. The flow weighted sample will exhibit "average" pollutant characteristics and total flow records will allow the calculation of total pollutant loads during a storm.

Based on a review of current data sources, including local, state and federal resources, the available stormwater discharge data is summarized below. As seen, no previous water quality data is reported for analysis performed on flow weighted samples. To obtain flow weighted water quality data, a storm event monitoring plan has been developed in Task 2.I.B.(2)(c) of this Master Plan.

3.2 ORIGINAL 208 STUDY

In the late 1970's, the Coastal Bend Council of Governments (COG) contracted with the U.S. Environmental Protection Agency (EPA) to conduct ongoing water quality management planning and studies per Section 208 of PL 95-217. The Corpus Christi Areawide Waste Treatment Management Program (the 208 Study) addressed the extent of impacts of both point and nonpoint influences to local bay waters. Although the 208

Study generated a considerable amount of valuable information based on ambient water quality data, no stormwater monitoring was conducted during the 208 Study.

3.3 208 STUDY UPDATE

In 1980, the Coastal Bend Council of Governments (COG) sponsored an updated 208 Study conducted by the University of Texas Marine Science Institute at Port Aransas. The significance of nonpoint source runoff on the environmental quality of the Corpus Christi Bay system was investigated based on sampling data collected during the course of the study. Water and sediment samples were taken for three periods:

- Dry Period - No rain for the weeks preceding sampling
- Trace Rainfall - 0.01 to 0.5 inch in 24 hours
- Heavy Rainfall - 2.5 inches per 24 hours or more

Samples were collected and transported to the City-County Health Laboratory in Corpus Christi for analysis of biological, chemical and physical parameters. Table 3-1 lists the 36 parameters addressed in this study. Twenty-one sampling locations were established throughout the Corpus Christi area to include impacts from agricultural, marsh, industrial, oil field and urban areas, as shown in Figure 3-1. Specific sampling locations are described in Table 3-2. Due to lack of full coverage of heavy rainfall within the study period, some stations were not sampled after heavy rainfall events. The actual sample schedule is shown in Table 3-3.

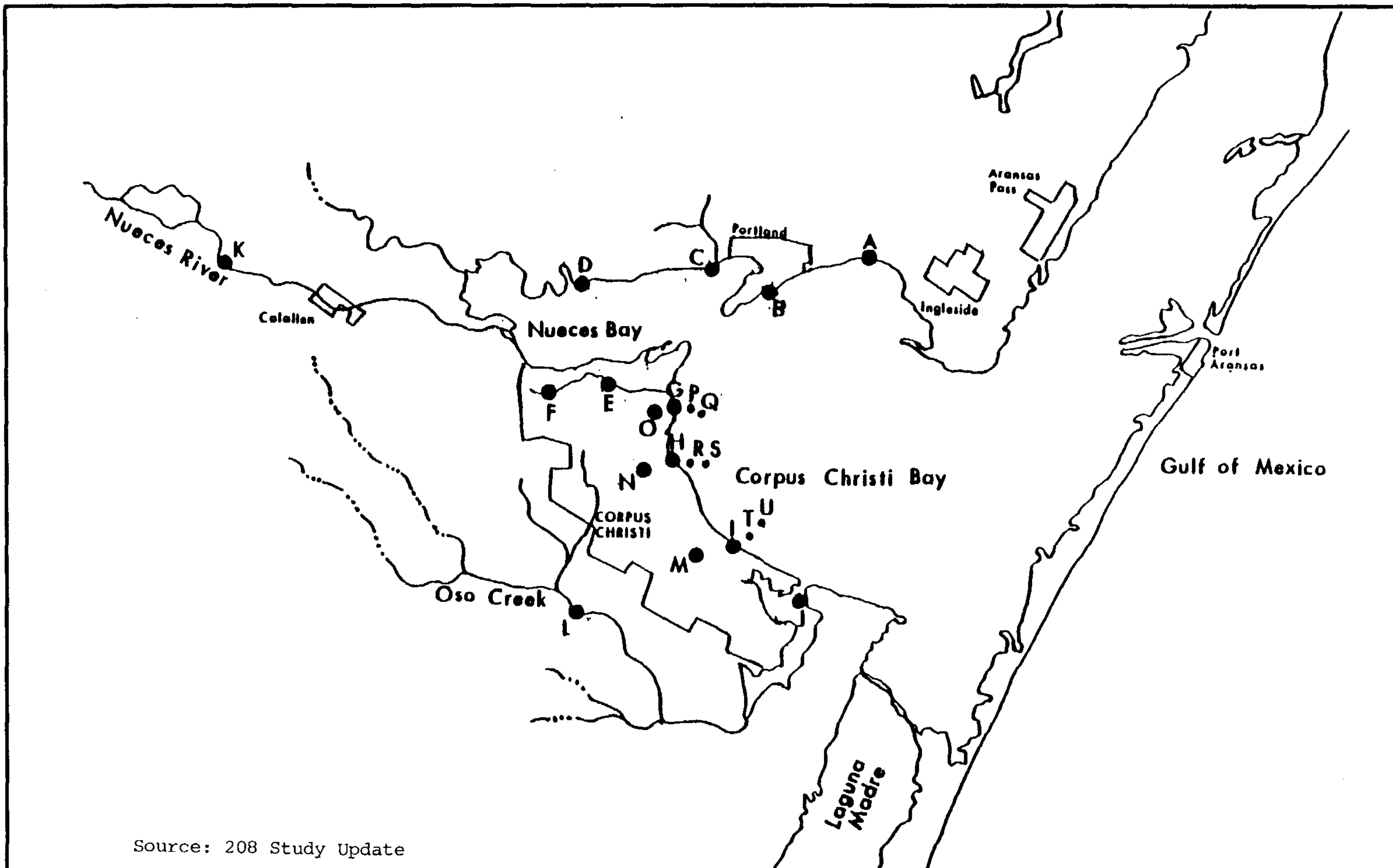
To determine the dilution/dispersion effects in the receiving waters, transects were located at three points along Corpus Christi Bay (sampling stations G-P-Q, H-R-S, and I-T-U). Stations were sampled after peak storm conditions. Transects were also sampled at 24 and 48 hours after the event to determine lingering pollutant concentrations.

TABLE 3-1

LIST OF STORMWATER POLLUTANT ANALYSES
FOR 208 UPDATE STUDY

Biological Oxygen Demand	Strontium
Chemical Oxygen Demand	Zinc (EPA 65)
Total Phosphorus (as P)	Total Organic Carbon
Nitrate	Total Solids
Ammonia	Chlorides
Nitrite	Oil and Grease
Total Coliforms	Phenols (EPA 52)
Fecal Coliforms	Sulfate
Fecal Streptococci	Diazinon
Salmonella	2-4 D (EPA 28)
Total Suspended Solids	Malathion
Arsenic (EPA 6)	Dieldrin/Aldrin (EPA 4)
Cadmium (EPA 11)	Antimony (EPA 5)
Chromium (EPA 21)	Chlordane (EPA 13)
Copper (EPA 22)	Chlorinated Phenols (EPA 18)
Lead (EPA 44)	PCBs (EPA 54)
Manganese	Selenium (EPA 56)
Mercury (EPA 45)	Vinyl Chloride (EPA 64)

SOURCE: Corpus Christi Bay System Nonpoint Source Evaluation, 1982 (208 Update Study)



Source: 208 Study Update

208 STUDY UPDATE - SAMPLING LOCATIONS

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FIGURE NO. 3-1

TABLE 3-2

SAMPLING LOCATIONS
208 STUDY UPDATE

Sampling Location	Description
A	Within the DuPont plant near Ingleside, off 361. Site is on the bay on the south property line at a small creek-like outfall on LaQuinta Channel.
B	A concrete outfall ditch on Shore Drive between Marie and Georgia Street in Portland.
C	West of Portland on Route 1074 past the water tower. On Moore Road turn toward the bay. The site is under a small bridge crossing a creek near the bay.
D	West of Portland on Route 1074 past the intersection with Route 893. Route 1074 turns north and at that point turns onto a dirt track towards the bay. At the end of the track it meets a creek, the sampling site.
E	East of Nueces Bay Blvd. to dead end at Inner Harbor. The outfall sampling site is to the left of a guard house at the end of the road.
F	Interstate to Navigation. East on Navigation to a driveway about 100 yards -- before the lift bridge at Inner Harbor. Go north on the drive to a creek-like outfall. Take the sample about 10 to 15 meters downstream from the small bridge over the creek.
G	Transect near the breakwater at the end of Power Street. Station G is approximately 50 feet from the breakwater. Station P is 500 feet to the east and Station Q is 1000 feet to the east. All stations are within the basin.
H	The outfall at the end of Louisiana Street near Cole Park. This is a transect. Station H is at the end of the outfall. Station R is 500 feet to the north east and Station S is 1000 feet to the northeast.

TABLE 3-2

SAMPLING LOCATIONS
208 STUDY UPDATE
(Continued)

Sampling Location	Description
I	Outfall near Airline Blvd.
J	Ocean Drive south past Corpus Christi State University. Site is at the south side of the bridge under the bridge.
K	Interstate 37 north to 77 south. North on Route 624, past intersection of 1889. The third street on the east is the turnoff. Turn east to the river. Walk to the site approximately 100 yards up the river to a small creek outfall.
L	West on Chapman Ranch Road, past Cabaniss Field to a bridge over Oso Creek. The site is under the bridge on the northwest side.
M	Storm water collecting box near Airline Blvd.
N	Collection sump near Louisiana Street Outfall.
O	Collection sump at the pumping station at Power and Water Streets.

SOURCE: Corpus Christi Bay System Nonpoint Source Evaluation, 1982 (208 Update Study).

TABLE 3-3

208 STUDY SAMPLING SCHEDULE

Sample Area	Station	Rain Event 1980				
		Control		Trace	Heavy	
		Water	Sediment	Water	Water	Sediment
		03/26 - 04/01		04/25	08/29	
Corpus Christi Bay						
La Quinta Channel	A	X		X	O	
Portland	B	X		X	X	
Transects, City	G P O	X	X	XG	X	X
	H R S	X	X	XH	X	X
	I T U	X	X	XI	X	X
Inner Harbor	E F	X		X	O	
Storm Sewers	N O M			X		
Oso Bay						
Center	J	X	X		O	
Creek	L	X			O	
Nueces River	K	X	X		O	
Nueces Bay	C D	X	X		O	

X = Samples taken.
O = Rainfall conditions inadequate for sampling during project period.

SOURCE: Corpus Christi Bay System Nonpoint Source Evaluation (208 Update Study)

The majority of the sampling locations provided for the analysis of bay waters shortly after stormwater discharges. Only five of the 21 sites sampled actual stormwater runoff before it entered a local receiving water. The sampling stations that provide data for stormwater runoff quality are sites E, F, M, N and O. Sites G, H and I may also be considered indicative of stormwater runoff, since these sites are located immediately adjacent to stormwater outfalls. It should be noted that samples taken at these stations (G, H and I) are diluted by bay water and will not be truly representative of stormwater runoff. Yet, these sites do provide some insight to pollutants potentially present in stormwater runoff. The nature and limited number of storm events sampled do not allow the calculation of storm event mean concentrations for modeling purposes. As stated previously, a series of samples taken over the course of the storm event is needed to produce a flow weighted sample indicative of cumulative storm effects.

Appendix A contains raw data collected during the 208 Study update and study conclusions. Table 3-4 contains all of the pertinent observations made in the study.

3.4 TWC DISTRICT 12 DATA

Periodically, TWD District 12 staff receives public reports of potential water quality problems. Some of these reports are associated with stormwater discharges to local receiving waters and are characterized by observations of oil sheens or turbid discharges. TWC staff responds through field investigations, taking a grab sample of the suspect effluent. Based on discussions with TWC staff, the majority of these discharges display high levels of fecal coliforms, oil and grease, solids and nutrients. Although these reports are useful to detail potential water quality concerns and sources, this data is not suitable for water quality modeling purposes. Similar to the 208 Study update, this data is based on grab sample results. For stormwater polution modeling, flow weighted composite samples are required to provide "average" pollutant concentration information.

TABLE 3-4

1982 ANNUAL UPDATE OBSERVATIONS [1]

Parameter	Observation
Dissolved Oxygen	Levels dropped in response to rainfall, but returned to baseline conditions.
BOD_5	General increase after rainfall.
TSS	General increase after rainfall.
Oil and Grease	No visual observations during collection. Station O >50 ppm - trace rainfall. Higher concentrations at Station G downtown area.
Fecal Coliforms [2]	Urban runoff generally one to two orders of magnitude above allowable standards.
Nutrients	Observed in street and agricultural runoff.
Polychlorinated Biphenyls (PCB) [2]	Observed in water and sediment samples at Stations G and P - downtown area.
Phenols [2]	Observed at Stations E (baseline) and F (trace rainfall) Inner Harbor and at Station L (Oso Creek).
Pesticides [2]	Diazinon, Malathion, Chlordane detected in trace amounts.
Metals [2]	For all metals tested, samples that exceeded suggested State or Federal guidelines were: Copper (E, F, O); Nickel (F); Zinc (E, F, O); Lead (O); and Chromium (F).

1) Source: Corpus Christi Areawide Waste Treatment Management, Corpus Christi Bay System Non-Point Source Evaluation - First Annual Update, July 1982.

2) Suggested for further study in 1982 Update.

4.0 WATERSHED MANAGEMENT MODEL

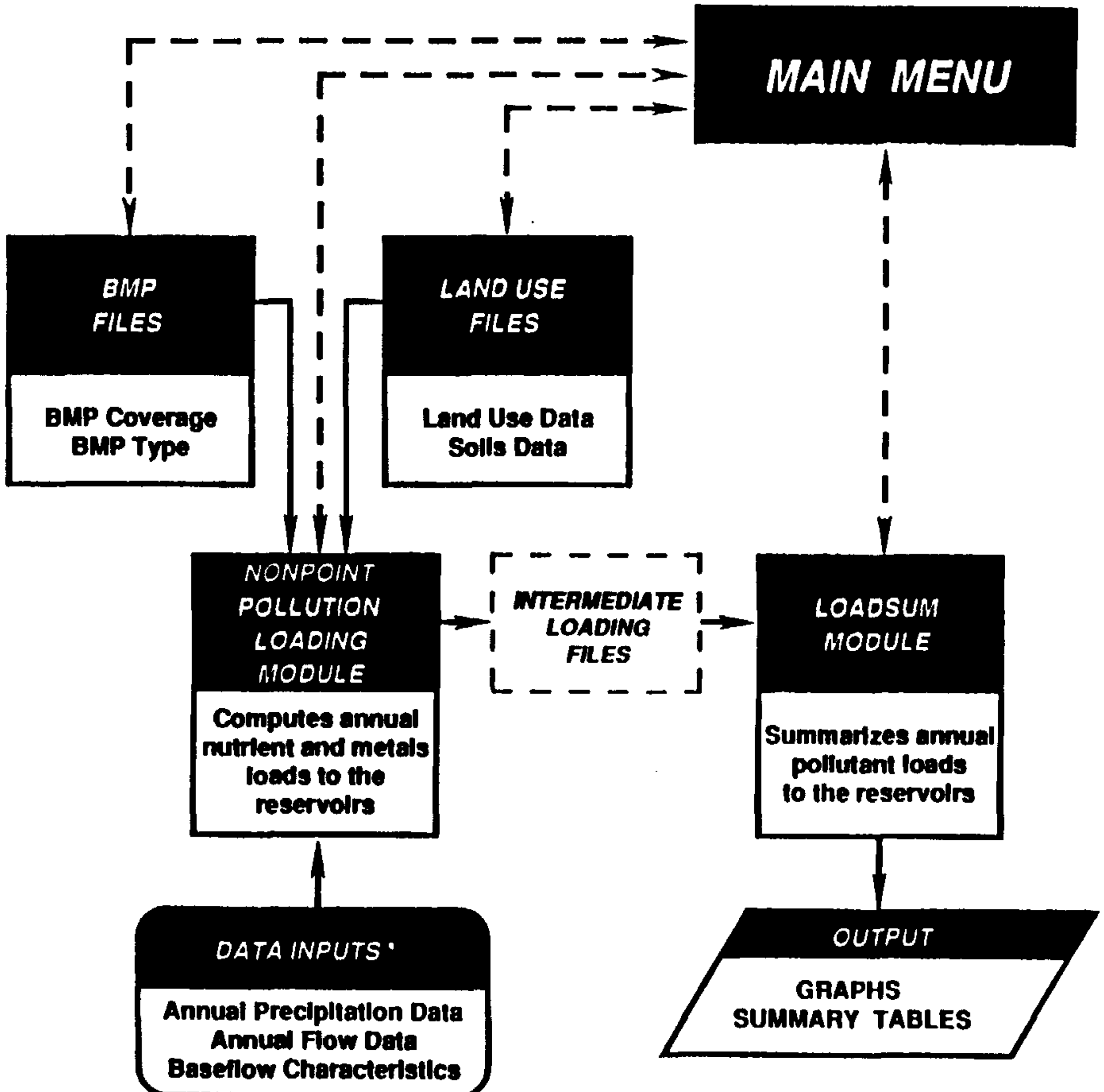
4.1 OVERVIEW

In Task 2.I.B.(1) of this Master Plan, techniques for the quantification of runoff and corresponding amounts of NPS pollution generated from areas tributary to storm sewer system outfall points were evaluated. Hydrologic models were reviewed and an NPS model selected for use. In this section, the Watershed Management Model (WMM) developed by Camp Dresser & McKee Inc. will be presented to demonstrate its application to stormwater quality management.

As described in Task 2.I.B.(1), the Watershed Management Model provides a basis for the evaluation of the water quality benefits and relative costs of alternate management strategies. Watershed protection strategies may be identified and evaluated for nonstructural controls, including land use controls and buffer zones, and for structural best management practices (BMPs), including onsite and regional detention basins. Combinations of nonstructural and structural controls can be evaluated to develop a watershed management plan. The alternative management strategies are evaluated using the WMM spreadsheet model, which projects nonpoint pollution loadings from the watershed delivered to local receiving waters such as Corpus Christi Bay.

4.2 INPUT REQUIREMENTS

The interaction between the various components of the WMM are completed via menus and spreadsheet macros using a spreadsheet program and an IBM-AT compatible computer. Figure 4-1 depicts the interaction between the main computational modules and supporting data programs. Figure 4-2 illustrates the main menu that is used to access the computational modules and supporting data programs. Within each module there are submenus that allow for data input in a "user friendly" environment. Data is input in two ways: (1) by responding to a data prompt from the program; and (2) by moving the cursor to the appropriate data location and filling in the cell.



* Entered Interactively During Program Execution

SCHEMATIC OF WATERSHED MANAGEMENT MODEL

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FIGURE NO. 4-1

REGIONAL STORMWATER MASTER PLAN
WATERSHED MANAGEMENT MODEL
VERSION 1.0

To create/edit watershed SETUP file:	Type ALT A
To create/edit LAND USE file:	Type ALT C
To create/edit BMP COVERAGE file:	Type ALT B
To run NPL module:	Type ALT N
To run LOADSUM module:	Type ALT L
To run LAKE module:	Type ALT R
To revise DCIAs:	Type ALT D
To revise EMCs:	Type ALT E
To exit to DOS:	Type ALT Q

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FEBRUARY 1991

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EXAMPLE TEST CASE - SCREEN MENU

FIGURE NO. 4-2

Data required to successfully use the model for this demonstration included existing land use projections, runoff coefficients, average annual precipitation, annual baseflow, average baseflow pollutant concentrations, percent watershed imperviousness, watershed area, number of subbasins, and potential evapotranspiration. For demonstration purposes, input data was based on reported information. Certain assumptions were made for the sake of illustration. Input data should be verified before the WMM model is actually applied to basins or subbasins in the study area.

4.3 NONPOINT POLLUTION LOADING (NPL) MODULE

The Nonpoint Pollution Loading module of the Watershed Management Model is based on nonpoint pollution loading factors which relate land use patterns and percent imperviousness in a watershed to "per acre" pollutant loadings. For the purposes of this demonstration, pollutant loading analyses have been limited to the parameters for which considerable loading data are reported in the literature: total phosphorus (total-P), total nitrogen (total-N), lead, and zinc. Total-P and total-N are required in order to evaluate potential eutrophication impacts to receiving waters. Lead and zinc are heavy metals which typically exhibit higher nonpoint pollutant loadings than other metals found in urban runoff. These heavy metals may be viewed as representative of a wide range of toxicants that have been identified in previous field monitoring studies of urban runoff pollution. Other parameters can be modeled once a sufficient monitoring result database is compiled and EMCs calculated as described in Tasks 2.I.B.(1) & (2)(c).

4.3.1 RAINFALL/RUNOFF RELATIONSHIPS

Nonpoint pollution loading factors (lbs/acre/year) for different land use categories are based upon annual runoff volumes and event mean concentrations (EMCs) for different pollutants. The EMC is defined as the average of individual measurements of storm loading divided by the storm runoff volume. One of the keys to effective transfer of literature values for non-point pollution loading factors to a particular study area is to make adjustments for actual runoff volumes in the watershed under study. In future nonpoint source monitoring efforts, adjusted runoff coefficients will be available as a result of Task 2.I.C. In order to calculate annual runoff volumes for a basin, the pervious and impervious fraction of each land use category was used as the basis for determining rainfall/runoff relationships. For rural-agricultural (non-urban) land uses, the pervious fraction represents the major source of runoff or streamflow, while impervious areas are the predominant contributor for most urban land uses.

Annual runoff volumes for the pervious/impervious areas in each land use category were calculated by multiplying the average rainfall volume by a runoff coefficient. The average annual rainfall for the Corpus Christi International Airport rain gage is approximately 30.8 inches. A runoff coefficient of 0.95 was assumed for impervious area (i.e. 95 percent of the rainfall was assumed to be converted to runoff from the impervious fraction of each land use). Therefore, the average annual runoff from impervious areas is about 29.3 inches/year. A pervious area runoff coefficient of 0.20 was assumed. The total average annual surface runoff is calculated by weighing the impervious and pervious area runoff factors for each land use category. Water surfaces were assumed to be 100 percent impervious. Evapotranspiration losses were subtracted from precipitation falling directly on water surfaces. An annual potential evapotranspiration rate of 60 inches/year was used based on reported information in past 208 studies.

4.3.2 ANNUAL NON-POINT POLLUTION LOADING FACTORS

Non-point pollution monitoring studies throughout the U.S. over the past 10 years have shown that annual "per acre" discharges of urban stormwater pollution (e.g., nutrients, metals, BOD, fecal coliforms) are positively related to the amount of imperviousness for a given land use (i.e. the more imperviousness the greater the non-point pollution load). Due to the lack of a sufficient database of storm event water quality data in the Corpus Christi area, available U.S. EPA Nationwide Urban Runoff Program values for non-point pollution loading factors will be used for the preliminary non-point pollution loading example. Future nonpoint source studies in the Corpus Christi area will benefit from EMC values generated during the implementation of the wet weather sampling plan (Task 2.I.B.(2)(c)). Wet weather monitoring data will provide insight to the specific nature of local stormwater runoff and resulting EMC values will assist in the adjustment of national data to regional conditions.

4.3.3 DELIVERY RATIO/TRAVEL TIME

The nonpoint pollution loading factors represent measurements of loadings which have been discharged into a storm sewer, swale, or stream channel. For urban and agricultural land uses, sediment deposition during overland flow is already accounted for. Therefore, these loading factors represent discharges into the storm sewers or stream channels within a watershed. In large watersheds, where maximum instream travel times are one day or greater, the storm event loadings discharges to the drainage system are likely to be reduced (e.g., sediment deposition) enroute to the basin mouth. Since large infrequent flood events can scour out stream beds and storm sewers and transport deposited pollutant loads downstream, some studies make the assumption that 100 percent of the nonpoint pollution loadings discharged into the drainage system will ultimately be delivered to the receiving water. The Watershed Management Model incorporates a pollutant delivery ratio into annual nonpoint pollution loading evaluations. For this demonstration, a delivery ratio of 100 percent was assumed for the test basin.

4.3.4 FAILING SEPTIC TANK IMPACTS

Residential developments not serviced by a central wastewater collection system usually rely on household septic tanks and soil absorption fields for wastewater treatment and disposal. Septic tank systems typically have a limited useful life expectancy and failures commonly cause localized water quality impacts. The WMM has the ability to incorporate septic loadings into the total estimate of nonpoint source pollutants. For this demonstration, no septic loadings were assumed to exist in the test area.

4.3.5 BEST MANAGEMENT PRACTICES

Various water quality treatment practices are utilized to reduce the amount of stormwater pollutants discharged to receiving waters. Often called "best management practices" (BMPs), these practices may consist of erosion control measures, nonstructural controls (land use/density restrictions) and structural controls.

Erosion control practices are used to prevent the transport of eroded material and soils by stormwater runoff particularly from construction sites and other disturbed land areas. Examples of erosion control measures include silt fences, storm drain inlet protection and temporary sediment traps. The practices are accounted for in the WMM model by adjusting the delivery ratio parameter (see Section 4.3.3).

Nonstructural controls aim to improve runoff quality by reducing the generation and accumulation of potential pollutants at or near their source. Nonstructural controls typically include fertilizer and pesticide application controls through public education, street cleaning and land use/density restrictions. The WMM model can reflect the reduction of pollutant accumulation by adjusting EMC parameters. Land use controls are directly modeled through land use data input to the model.

Structural controls for nonpoint source water quality include man-made structures designed to detain or retain runoff long enough for a reduction in pollutant loads to occur. Using detention facilities, stormwater is temporarily detained for a period of time and then released. Depending upon the type of control measures utilized, treatment occurs in the form of settling, biological uptake and/or infiltration. In the case of retention facilities, a portion of the runoff is permanently removed from the flow of stormwater and treated.

The efficiency of pollutant removal can be set in the WMM model to reflect the type of system under evaluation. Figure 4-3 shows a typical menu for BMP efficiency input. Default settings in the model are typical of wet detention systems. These systems are particularly attractive for coastal areas where high seasonal ground water precludes the use of dry systems or systems which rely on infiltration. These detention systems mimic many of the characteristics of natural wetlands in that a permanent pool is maintained and pollutant removal occurs as a result of both particulate settling and biological uptake within the water column and by emergent vegetation.

```
REGIONAL STORMWATER MASTER PLAN
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VERSION 1.0

Enter first BMP Type
 TP Removal Efficiency   [      50%]
 TN Removal Efficiency   [      30%]
 Pb Removal Efficiency   [      80%]
 Zn Removal Efficiency   [      60%]

Enter second BMP Type
 TP Removal Efficiency   [      30%]
 TN Removal Efficiency   [      20%]
 Pb Removal Efficiency   [      70%]
 Zn Removal Efficiency   [      40%]

 PRESS    ALT P    For Prompted Data Entry
 PRESS    ALT S    To Save Changes
 PRESS    ALT M    For Main Menu
```

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EXAMPLE TEST CASE - BMP EFFICIENCIES SCREEN

FIGURE NO. 4-3

In addition to setting the removal efficiency for BMPs, provisions have been incorporated into the WMM model to establish the percentage of each land use served by the assumed BMP. In this manner, the user can distinguish between older developments which probably do not have stormwater quality BMPs and newer developments which have included such facilities.

4.4 SENSITIVITY ANALYSIS

Because the nonpoint pollution loading factors used in the Watershed Management Model were derived from a combination of sources, the model incorporates a sensitivity analysis with a range of literature values for each land use category. The EMCs (mg/L) calculated from the loading factors (lbs/acre/year) based on the average annual runoff estimates are assumed to be representative of a "medium" or "most probable" estimate of the nonpoint pollution loading factor for each specific land use. The purpose of the sensitivity analysis is to develop estimates of the extremes, high and low values of pollutant loadings.

A statistical approach is used to estimate the "high" and "low" loading factors for each pollutant. Based on a review of monitoring study data, a coefficient of variation (COV) is assumed for EMCs specific to each pollutant and each land use. The COV is calculated as the standard deviation divided by the mean and provides an indication of the relative degree of uncertainty associated with the EMC estimates.

The underlying probability distribution of the nonpoint pollution EMC data was tested during the NURP study. With only isolated exceptions, the EMCs were characterized by lognormal distributions. Therefore, it is assumed that all EMCs are lognormally distributed.

"High" and "low" EMC estimates are generated for the 95th percentile and the 5th percentile. The annual loadings discharged from a watershed are automatically computed in the Nonpoint Pollution Loading Module for the average EMC estimates and for both the high and low EMC estimates for each land use scenario.

4.5 SIMULATION SETUP

The WMM was conceptually applied to the Flour Bluff ADP test area for demonstration purposes. This demonstration illustrates pollutant loads resulting from two scenarios: 1) existing land use conditions; and 2) the effects of implementing BMPs. The test area was analyzed as a whole, thus only a single basin was modeled. During actual model application, a particular watershed should be subdivided into several basins for analysis. The WMM model will analyze and provide results for each subbasin separately and for the watershed as a whole.

4.6 SCENARIOS

4.6.1 EXISTING LAND USE

The Flour Bluff ADP was chosen for use as a demonstration area due to its diverse mixture of existing land use. Based on information provided by the City of Corpus Christi Planning and Urban Development Department, existing land use for the Flour Bluff area is generally as follows:

Land Use	Acres
Residential	2,151
Commercial	208
Industrial	59
Agricultural	39
Undeveloped	5,146
TOTAL	7,603 acres

To better illustrate the capabilities of the WMM, the land uses above were assumed to be a composite of more specific land uses as shown in Figure 4-4. For instance, residential land use was assumed to be a combination of low, medium and high density single-family homes and multi-family buildings (apartments and duplexes). Undeveloped

REGIONAL STORMWATER MASTER PLAN
WATERSHED MANAGEMENT MODEL
LAND USE SCENARIO DATABASE
WATERSHED: Flour Bluff

LAND USE FILE NAME: EXIST
SCENARIO: Existing Land Use

Subbasin Range Name: SB1

LAND USE SCENARIO: EXISTING
SUBBASIN ID: Flour Bluff
JURISDICTION: Corpus Christi

Land Use	Acres
Cropland	39
Forested Uplands	0
Rangeland/Woodlands	2,446
Pasture	2,100
Confined Feedlot	0
Open/Recreation	200
Ornamentals	0
Wetlands	0
Marsh	400
Citrus	0
LDSF Residential	200
MDSF Residential	1,800
HDSF Residential	151
Multifamily Bldg	0
Mobile Home	0
Commercial/Services	208
Extractive	0
Institutional	0
Industrial	59
Transportation	0
Water	0
STP & Power Plants	0
Total	7,603

EXAMPLE TEST CASE - LAND USE

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FIGURE NO. 4-4

land was subdivided into open lands, pasture, wooded areas and marshes. During actual model application, aerial photography inspection and field verification are recommended for land use determinations.

A review of the Soil Survey of Nueces County, Texas indicates that soils in the Flour Bluff area are composed primarily of Galveston and Mustang fine sands. These soils are listed as belonging to the Hydrologic Groups A and A/D, respectively.

For the sake of illustration, an assumption was made that no BMPs existed for this scenario. Thus, a comparison can be made to reflect the effects of BMP implementation in model results. The WMM model can also be used to compare several different BMP scenarios to maximize future water quality management strategies using future land use projections. The model can also estimate percent pollutant load reductions provided by existing BMPs.

4.6.2 EXISTING LAND USE WITH BMPS

For comparison, a second scenario was modeled which assumed a certain level of BMP controls applied to the study area.

In this example, two different BMP controls were simulated. Wet and Dry Detention BMP controls were assumed to provide combined coverage to twenty percent of the watershed. The user can access the BMP efficiency file and input specific BMP removal efficiencies. Additionally, the BMP coverages file may be accessed from the BMP file menu. The BMP coverages file allows the user to define the percentage of each land use category associated with each BMP type. Although removal efficiencies can be transferred effectively from literature, it is recommended that actual BMP coverages for the Corpus Christi area be determined through field observation and testing prior to future modeling efforts.

4.6.3 OUTPUT SUMMARY

Output is generated in a summary table format. The output categories include: Drainage Basin, Area, Percent Impervious, Septic Impact (not used in this example), Loading Factors, Constituent, and units of measurement. Additionally, the surface (nonpoint source) loads and baseflow results are shown for: 1) no BMP controls; and 2) with BMPs. A percent reduction of surface NPS loads resulting from implementing the modeled BMP scenario is automatically calculated.

The results of each scenario are presented on Figure 4-5. As seen, the modeled BMP scenario provided for 5%, 8%, 10% and 15% reductions of pollutant loadings for nitrogen, phosphorus, zinc and lead, respectively.

The WMM model can provide percent reduction estimates for a number of scenarios based on existing land uses and BMPs. As discussed in Section 4.3.5, the WMM model is capable of providing analysis of structural <u>and</u> nonstructural BMP control strategies, allowing stormwater managers to maximize future control strategies.

REGIONAL STORMWATER MASTER PLAN
WATERSHED MANAGEMENT MODEL
NONPOINT SOURCE LOADING SUMMARY (1)

LAND USE: Existing

Basin	Drainage Area (ac)	% Imperv	Septic Impact	Loading Factors (2)	Constituent	(units)	No BMP Controls <---- Average Annual ----> Surface	Baseflow	Total	With BMPs <---- Average Annual ----> Surface	Baseflow	Total	% Reduction Surface NPS Loads
Flour Bluff	7,603	11.7%	0.0%	Medium	Runoff	(in/yr)	8.86	4.00	12.86	8.86	4.00	12.86	
Flour Bluff	7,603	11.7%	0.0%	Medium	Total-P	(lbs/yr)	3,240	830	4,070	2,980	830	3,810	-8.0%
Flour Bluff	7,603	11.7%	0.0%	Medium	Total-N	(lbs/yr)	17,910	6,200	24,110	17,010	6,200	23,210	-5.0%
Flour Bluff	7,603	11.7%	0.0%	Medium	Lead	(lbs/yr)	481	0	481	409	0	409	-15.0%
Flour Bluff	7,603	11.7%	0.0%	Medium	Zinc	(lbs/yr)	356	0	356	321	0	321	-10.0%
Flour Bluff	7,603	11.7%	0.0%	High	Total-P	(lbs/yr)	7,630	830	8,460	7,020	830	7,850	-8.0%
Flour Bluff	7,603	11.7%	0.0%	High	Total-N	(lbs/yr)	35,610	6,200	41,810	33,830	6,200	40,030	-5.0%
Flour Bluff	7,603	11.7%	0.0%	High	Lead	(lbs/yr)	1,156	0	1,156	982	0	982	-15.0%
Flour Bluff	7,603	11.7%	0.0%	High	Zinc	(lbs/yr)	920	0	920	828	0	828	-10.0%
Flour Bluff	7,603	11.7%	0.0%	Low	Total-P	(lbs/yr)	920	830	1,750	840	830	1,670	-8.0%
Flour Bluff	7,603	11.7%	0.0%	Low	Total-N	(lbs/yr)	7,190	6,200	13,390	6,830	6,200	13,030	-5.0%
Flour Bluff	7,603	11.7%	0.0%	Low	Lead	(lbs/yr)	128	0	128	109	0	109	-15.0%
Flour Bluff	7,603	11.7%	0.0%	Low	Zinc	(lbs/yr)	80	0	80	72	0	72	-10.0%

(1) Input data and results have not been verified. Presented for WMM model demonstration purposes only.

(2) Loading factors are representative of statistical significance with respect to the estimate of nonpoint pollution loadings for specific land use.

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EXAMPLE TEST CASE - NONPOINT SOURCE LOADING SUMMARY

FIGURE NO. 4-5

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APPENDIX A

WATER QUALITY DATA COLLECTED DURING 208 STUDY UPDATE WITH STUDY CONCLUSIONS

Table 12 PHYSICAL DATA

Station	SAMPLE DEPTH - FT. (To be used with following physical data)					TEMP °C					OXYGEN ppm				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
C	1					24.5					9.7				
D	1					23.5					9.7				
G	0		0	0	0	25		29.2	29.2	29.2	7.7		5.9	7.0	7.8
	6		6.5	8.0	5.0	25		29.6	29.5	29.5	7.52		5.6	6.8	7.1
H	0		0	0	0	25		27.5	29.5	28.8	7.2		5.2	6.0	7.1
	4					25					6.8				
I	0		0	0	0	25		25.7	29.3	29.1	6.9		6.3	3.4	2.6
	8		8	8.0	8.0	25		29.2	29.4	29.5	5.3		3.2	1.4	6.0
P	0		0	0	0	25		29.0	29.4	29.4	6.4		5.7	7.5	7.3
	8		6.5	8.0	6.0	25		29.5	29.5	29.5	6.5		5.3	6.9	6.8
Q	0		0	0	0	25.1		29.2	29.3	29.5	6.7		5.9	7.1	7.5
	4		6.5	7.0	8.0	25.1		29.3	29.5	29.6	6.8		5.3	6.8	7.2
R	0		0	0	0	25.3		29.0	30.0	29.4	8.4		4.9	5.3	6.4
	5		5.5	5.0	9.0	25.3		29.5	30.1	29.3	8.6		4.1	5.2	6.3
S	0		0	0	0	25.1		28.8	29.2	29.5	7.52		5.3	5.6	6.2
	8		8	13.0	9.0	25.2		29.7	29.5	29.5	7.52		3.2	4.1	6.1
T	0		0	0	0	26.0		29.0	29.5	29.8	7.2		5.5	4.9	6.3
	5		10	4.5	4.5	25.6		29.5	29.5	29.5	7.34		3.4	4.9	5.9
U	0		0	0	0	25.1		28.8	29.3	29.5	7.52		5.3	5.2	6.2
	4		5	10.0	10.0	25.2		29.6	29.2	29.4	7.52		3.4	5.0	6.2

PHYSICAL DATA

Station	SALINITY 0/00					pH					DEPTH OF WATER FT.				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
C	22.64					8.1					1.5				
D	22.64					8.3					1.0				
G	18.68		23.7	22.5	18.0	8.2		8.2	8.3	8.3	6				
	18.68		25.6	23.5	18.0	8.2		8.2	8.3	8.32	6				
H	20.04		12.0	21.4	7.6	8.2		8.05	8.1	8.2	4				
	20.04					8.2					4				
I	20.04		0.4	18.7	10.4	8.2		7.5	8.0	7.9	8				
	20.04		21.1	21.4	18.1	8.0		8.1	7.99	8.2	8				
P	18.68		22.8	21.6	18.3	8.1		8.2	8.2	8.35	8				
	18.68		27.4	23.5	18.3	8.1		8.2	8.3	8.35	8				
Q	19.36		22.8	22.1	18.3	8.1		8.2	8.3	8.35	4				
	19.36		22.8	22.5	18.3	8.1		8.2	8.3	8.4	4				
R	20.04		22.1	21.8	17.3	8.3		8.15	8.0	8.2	5				
	20.04		22.1	22.1	17.3	8.3		8.10	8.1	8.2	5				
S	20.04		20.0	22.1	17.7	8.2		8.2	8.1	8.24	8				
	20.04		23.5	22.8	17.7	8.2		8.1	7.1	8.2	8				
T	20.04		20.4	22.5	15.3	8.2		8.2	8.05	8.15	5				
	20.04		22.8	22.8	16.0	8.2		8.15	8.12	8.2	5				
U	20.04		17.7	22.5	16.7	8.2		8.1	8.1	8.12	4				
	20.04		22.1	22.8	17.3	8.2		8.1	8.12	8.2	4				

PHYSICAL DATA

Station	DISTANCE TO SHORE FT.					TURBIDITY J.T.U.									
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
C	50														
D	100														
G	0					22.1		8	14	16					
	0														
H	0					37.8		26.5	300	180					
	0														
I	0					46.5		43.5	26	72					
	0														
P	500					24.9		8.5	10	18					
	500														
Q	1,000					23.0		8.0	11	27					
	1,000														
R	500					27.3		10	70	42.5					
	500														
S	1,000					16.8		8.5	24	21.5					
	1,000														
T	500					29.8		10	72	41.5					
	500														
U	1,000					12.2		10	22	39.5					
	1,000														

WATER ANALYSES - BACTERIOLOGY

Station	TOTAL COLIFORM # ORG/100 ml.					FECAL COLIFORM # ORG/100 ml.					FECAL STREPTOCOCCI # ORG/100 ml.				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	100	Lost				<10	Lost				<10	Lost			
B	20	Lost				<10	Lost				<10	Lost			
C	OG					300					<10				
D	<10					<10					<10				
E	600	14,000				300	8,500				<10	870			
F	220	8,000				100	24,000				10	680			
G	Lost	12,000	1,000	180	200	Lost	3,200	11,000	<10	40	Lost	660	<10	<10	<10
H	Lost	OG	OG	560	OG	Lost	800	2,000	350	7,000	Lost	410	<10	<10	<10
I	<10	7,000	OG	OG	OG	<100	4,600	460	15,000	5,000	<10	500	<10	<10	<10
J	<10					<10					<10				
K	190					110					<10				
L	OG					≥100,000					<10				
M															
N		6,000					4,700					730			
O		2,000					200					1,130			
P	40		550	270	60	<100		120	40	30	<10		<10	<10	<10
Q	<100		400	280	180	<10		180	<10	60	<10		<10	<10	<10
R	Lost		TNTC	OG	OG	Lost		3,000	380	<10	Lost		<10	<10	<10
S	Lost		OG	120	Lost	Lost		3,000	100	Lost	Lost		<10	<10	Lost
T	Lost		OG	260	90	Lost		15,000	100	<10	Lost		<10	<10	<10
U	Lost		OG	80	70	Lost		6,500	<10	<10	Lost		<10	<10	<10

OG - overgrown
TNTC = too numerous to count

WATER ANALYSES - BACTERIOLOGY

Station	SALMONELLA # ORG/100 ml. Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	<1	Lost													
B	<1	Lost													
C	<1														
D	<1														
E	<1	<1													
F	<1	<1													
G	Lost	<1	<1	<1	<1										
H	Lost	<1	<1	<1	<1										
I	<1	<1	<1	<1	<1										
J	<1														
K	<1														
L	<1														
M															
N		<1													
O		<1													
P	<1		<1	<1	<1										
Q	<1		<1	<1	<1										
R	Lost		<1	<1	<1										
S	Lost		<1	<1	Lost										
T	Lost		<1	<1	<1										
U	Lost		<1	<1	<1										

WATER ANALYSES

Station	BOD mg/l 4 day, *6 day					COD mg/l					T-SOLIDS mg/l				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	1	11				7.8	29				44,000	13,000			
B	1	12				12	>50/56				31,000	13,000			
C	<1					21					32,000				
D	3					34.8					36,000				
E	14	19				88	>50/100				3,200	6,200			
F	5	52				16.9	>50/152				33,000	1,500			
G	3	5	7	6	8	16	17	18	<15	<15	32,000	33,000	37,600	25,600	26,300
H	2	41	8	7	8	20	43	46	78	<15	33,000	24,000	7,820	24,500	26,100
I	8	13	9	8	8	20	>50/53	82	<15	110	32,000	21,000	10,200	10,700	24,900
J	3					23					34,000				
K	2					18					803				
L	26					>50/54.7					34,000				
M															
N		15					>50/73					1,200			
O		29					499					499			
P	*6		6	6	7	22		46	78	19	32,000		29,800	25,700	26,400
Q	*3		7	7	8	23		<15	389	375	32,000		28,300	25,500	26,400
R	2		6	6	6	16		107	87	<15	33,000		25,100	25,400	25,400
S	2		6	25	6	15		19	19	<15	32,000		22,200	25,300	25,400
T	3		7	7	6	19		<15	<15	19	33,000		22,200	26,600	25,700
U	3		6	7	6	17		121	<15	19	34,000		12,000	26,100	25,000

WATER ANALYSES

Station	TSS mg/1					AMMONIA AS N mg/1					NITRITE AS N mg/1				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	41	68				0.36	9.3				<0.03	0.06			
B	39	100				0.23	0.07				<0.03	0.03			
C	158					0.10					<0.03				
D	275					0.36					0.04				
E	32	102				<0.05	0.13				0.14	0.07			
F	24	86				0.17	8.3				0.03	0.81			
G	34	76	29	29	43	<0.05	0.12	0.09	<0.05	<0.05	<0.03	<0.03	<0.03	0.03	<0.03
H	166	202	106	582	492	<0.05	<0.05	0.26	0.11	<0.05	<0.03	<0.03	0.07	0.15	<0.03
I	35	218	310	54	174	0.08	0.06	0.28	0.53	0.10	<0.03	<0.03	0.04	0.71	<0.03
J	90					<0.05					<0.03				
K	41					<0.05					<0.03				
L	31					20					<0.03				
M															
N		30					<0.05					0.03			
O		670					0.13					0.05			
P	32		23	25	47	<0.05		0.07	<0.05	<0.05	<0.03		<0.03	<0.03	<0.03
Q	44		27	42	54	<0.05		0.06	<0.05	<0.05	<0.03		<0.03	<0.03	<0.03
R	56		24	151	99	<0.05		0.11	0.10	<0.05	<0.03		<0.03	0.05	<0.03
S	42		29	49	49	<0.05		0.08	0.06	<0.05	<0.03		<0.03	<0.03	<0.03
T	87		31	116	121	<0.05		0.10	0.08	<0.05	<0.03		<0.03	<0.03	<0.03
U	62		30	56	106	0.05		0.20	0.07	<0.05	<0.03		<0.03	<0.03	<0.03

WATER ANALYSES

Station	NITRATE AS N mg/l					KJELDAHL AS N mg/l					T-PHOSPHORUS mg/l				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	0.07	0.08				0.36	0.8				0.11	3.7			
B	0.08	0.59				<0.3	0.9				0.05	0.23			
C	0.18					<0.3					0.16				
D	0.38					0.36					0.24				
E	17	0.87				<0.3	<0.3				0.98	0.68			
F	0.18	3.7				0.3	2.2				0.13	0.98			
G	0.10	0.24	0.03	0.05	<0.03	<0.3	<0.3	0.58	0.39	0.58	0.06	0.15	0.05	0.03	0.07
H	0.09	0.18	0.60	0.29	0.24	<0.3	2.8	1.1	0.67	1.1	0.19	0.25	0.67	0.29	0.25
I	0.06	0.39	0.37	0.42	0.39	<0.3	2.4	1.2	1.4	0.77	0.08	0.40	0.77	0.68	0.19
J	0.06					<0.3					0.16				
K	0.07					0.6					0.14				
L	0.10					1.3					3.2				
M															
N		0.90					2.0					0.24			
O		0.81					2.4					0.28			
P	0.06		0.03	0.03	<0.03	<0.3		0.49	0.72	0.48	0.06		0.07	0.04	0.08
Q	0.06		0.03	<0.03	<0.03	<0.3		0.47	0.66	0.47	0.07		0.06	0.06	0.07
R	0.09		0.10	0.04	<0.03	0.4		0.43	0.81	0.64	0.07		0.10	0.12	0.07
S	0.09		0.10	0.03	<0.03	1.0		0.36	0.69	<0.25	0.05		0.10	0.08	0.05
T	0.09		0.07	0.04	<0.03	<0.3		0.40	0.60	<0.25	0.10		0.09	0.09	0.11
U	0.09		0.18	0.03	<0.03	<0.3		0.33	0.57	<0.25	0.06		0.14	0.13	0.07

WATER ANALYSES

Station	O-PHOSPHORUS AS P mg/l Base	Trace	Heavy	H-24	H-48	TOC mg/l Base	Trace	Heavy	H-24	H-48	CHLORIDE mg/l Base	Trace	Heavy	H-24	H-48
A	0.04	3.6				11	14				15,900	10,000			
B	0.01	0.11				4.4	16				13,000	6,510			
C	0.06					5.4					16,500				
D	0.09					4.8					17,100				
E	0.68	0.41				25	35				1,090	2,160			
F	0.07	0.78				2.5	42				16,600	532			
G	<0.01	0.05	0.03	0.02	0.02	3.8	8	6	4	4	17,800	16,800	11,300	12,300	12,300
H	0.01	0.09	0.48	0.04	0.06	6.6	19	5	9	11	16,900	16,500	3,530	12,400	12,100
I	0.03	0.18	0.21	0.61	0.12	4.3	20	5	5	7	16,500	8,000	4,410	4,770	11,900
J	0.06					7.0					18,500				
K	0.06					5.0					289				
L	1.9					16					1,530				
M															
N		0.15					17					510			
O		0.29					430					180			
P	<.01		0.03	0.03	0.07	4.8		5	8	4	15,700		11,900	12,000	12,400
Q	<.01		0.03	0.03	0.05	13		4	18	4	15,700		11,700	11,900	12,000
R	.01		0.05	0.05	0.04	5.2		11	6	4	16,800		9,730	11,700	12,000
S	.01		0.05	0.03	0.04	4.8		7	5	9	13,200		10,200	12,200	12,000
T	.01		0.04	0.03	0.04	4.3		4	5	7	19,800		10,000	11,900	12,200
U	.01		0.08	0.03	0.04	14		4	5	5	17,400		5,830	12,400	12,300

WATER ANALYSES

Station	SULFATE mg/1 Base	Trace	Heavy	H-24	H-48	PHENOLICS mg/1 Base	Trace	Heavy	H-24	H-48	OIL & GREASE mg/1 Base	Trace	Heavy	H-24	H-48
A	2,000	1,200				<5	<5				<10	<10			
B	1,800	800				<5	<5				<10	<10			
C	2,200					<5					<10				
D	2,200					<5					<10				
E	520	380				170	<5				<10	16			
F	2,000	220				<5	58				<10	19			
G	2,000	2,000	1,800	1,900	1,900	No Sample	<5	<5	<5	<5	L.A.	<10	<5	<5	<5
H	2,300	1,400	520	1,800	1,900	<5	<5	<5	<5	<5	QNS	<10	6.6	<5	Interference
I	2,100	1,200	690	820	1,800	<5	<5	<5	<5	<5	<10	<10	9.8	<5	<5
J	2,400					<5					<10				
K	64					<5					<10				
L	310					14					<10				
M															
N		94					5					19			
O		49					Interference					82			
P	2,000		1,900	1,800	1,900	<5		<5	<5	<5	<10		<5	<5	Interference
Q	2,100		1,800	1,900	1,900	<5		<5	<5	<5	<10		<5	<5	<5
R	2,300		1,600	1,900	2,100	<5		<5	<5	<5	<10		<5	<5	<5
S	2,100		1,600	1,900	1,900	<5		<5	<5	<5	<10		<5	<5	<5
T	2,100		1,700	1,800	2,100	<5		<5	<5	<5	<10		<5	<5	<5
U	2,100		1,300	2,000	2,000	<5		<5	<5	<5	<10		<5	<5	<5

WATER ANALYSES - PESTICIDES

Station	DIAZINON ug/l					2-4D ug/l					MALATHION ug/l				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	<0.5	<0.5				<20	<20				<1.0	<1.0			
B	1.7	<0.5				<20	<20				<1.0	<1.0			
C	0.84					<20					<1.0				
D	1.3					<20					<1.0				
E	0.75	<0.5				<20	<20				<1.0	2.5			
F	8.8	0.68				<20	<20				<1.0	2.5			
G	<0.5	<0.5	<0.5	<0.5	<0.5	<20	<20	<20	<20	<20	<1.0	<1.0	<1.0	<1.0	<1.0
H	<0.5	<0.5	1.1	<0.5	<0.5	<20	<20	<20	<20	<20	<1.0	2.6	<1.0	<1.0	<1.0
I	<0.5	<0.5	0.5	<0.5	<0.5	<20	<20	<20	<20	<20	<1.0	1.7	<1.0	<1.0	<1.0
J	10					<20					<1.0				
K	11					<20					<1.0				
L	5.2					<20					<1.0				
M															
N		<0.5					<20					<1.0			
O		<0.5					<20					<1.0			
P	<0.5		<0.5	<0.5	<0.5	<20		<20	<20	<20	<1.0		<1.0	<1.0	<1.0
Q	<0.5		<0.5	<0.5	<0.5	<20		<20	<20	<20	<1.0		<1.0	<1.0	<1.0
R	<0.5		<0.5	<0.5	<0.5	<20		<20	<20	<20	<1.0		<1.0	<1.0	<1.0
S	<0.5		<0.5	<0.5	<0.5	<20		<20	<20	<20	<1.0		<1.0	<1.0	<1.0
T	<0.5		<0.5	<0.5	<0.5	<20		<20	<20	<20	<1.0		<1.0	<1.0	<1.0
U	<0.5		0.6	<0.5	<0.5	<20		<20	<20	<20	<1.0		<1.0	<1.0	<1.0

WATER ANALYSES - PESTICIDES

Station	DIELDRIN ug/1					CHLORDANE ug/1					CHLORINATED PHENOLS ug/1				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	<0.1	<0.1				<1.0	<1.0				<100	<100			
B	<0.1	<0.1				<1.0	<1.0				<100	<100			
C	<0.1					<1.0					<100				
D	<0.1					<1.0					<100				
E	<0.1	<0.1				<1.0	<1.0				<100	<100			
F	<0.1	<0.1				2.6	<1.0				<100	<100			
G	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<100	<100	<100	<100	<100
H	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<100	<100	<100	<100	<100
I	<0.1	<0.1	<0.1	<0.1	<0.1	<1.0	<1.0	<1.0	<1.0	<1.0	<100	<100	<100	<100	<100
J	<0.1					<1.0					<100				
K	<0.1					1.9					<100				
L	<0.1					1.1					<100				
M															
N		<0.1					<1.0					<100			
O		<0.1					<1.0					<100			
P	<0.1		<0.1	<0.1	<0.1	<1.0		<1.0	<1.0	<1.0	<100		<100	<100	<100
Q	<0.1		<0.1	<0.1	<0.1	<1.0		<1.0	<1.0	<1.0	<100		<100	<100	<100
R	<0.1		<0.1	<0.1	<0.1	<1.0		<1.0	<1.0	<1.0	<100		<100	<100	<100
S	<0.1		<0.1	<0.1	<0.1	<1.0		<1.0	<1.0	<1.0	<100		<100	<100	<100
T	<0.1		<0.1	<0.1	<0.1	<1.0		<1.0	<1.0	<1.0	<100		<100	<100	<100
U	<0.1		<0.1	<0.1	<0.1	<1.0		<1.0	<1.0	<1.0	<100		<100	<100	<100

WATER ANALYSES - PESTICIDES

	PCB's ug/l					ALDRIN ug/l									
Station	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	<1.0	<1.0				<0.05	<0.05								
B	<1.0	<1.0				<0.05	<0.05								
C	<1.0					<0.05									
D	1.4					<0.05									
E	<1.0	<1.0				<0.05	<0.05								
F	2.7	<1.0				<0.05	<0.05								
G	1.5	<1.0	<1.0	1.4	<1.0	<0.05	<0.05	<0.05	<0.05	<0.05					
H	1.1	<1.0	<1.0	<1.0	<1.0	<0.05	<0.05	<0.05	<0.05	<0.05					
I	<1.0	<1.0	<1.0	1.0	<1.0	<0.05	<0.05	<0.05	<0.05	<0.05					
J	2.0					<0.05									
K	<1.0					<0.05									
L	<1.0					<0.05									
M															
N		<1.0					<0.05								
O		<1.0					<0.05								
P	<1.0		<1.0	<1.0	<1.0	<0.05		<0.05	<0.05	<0.05					
Q	1.0		<1.0	1.1	<1.0	<0.05		<0.05	<0.05	<0.05					
R	1.1		<1.0	<1.0	<1.0	<0.05		<0.05	<0.05	<0.05					
S	2.0		<1.0	<1.0	<1.0	<0.05		<0.05	<0.05	<0.05					
T	<1.0		<1.0	<1.0	<1.0	<0.05		<0.05	<0.05	<0.05					
U	<1.0		<1.0	<1.0	<1.0	<0.05		<0.05	<0.05	<0.05					

WATER ANALYSES METALS

Station	As ug/1 Base	Trace	Heavy	H-24	H-48	Cd ug/1 Base	Trace	Heavy	H-24	H-48	Cr ug/1 Base	Trace	Heavy	H-24	H-48
A	<2	4.4				<5	<5				<20	<20			
B	<2	4.2				<5	<5				<20	<20			
C	<2					<5					23				
D	<2					<5					<20				
E	13	8.0				<5	<5				250	39			
F	2.0	9.0				<5	<5				160	560			
G	<2	<2	<2	<2	<2	<5	9	<5	<5	<5	<20	<20	<20	<20	<20
H	<2	2.4	<2	<2	<2	<5	7	<5	<5	<5	<20	<20	<20	<20	<20
I	<2	4.2	<2	<2	<2	<5	6	<5	<5	<5	<20	<20	<20	46	<20
J	<2					<5					<20				
K	8					<5					200				
L	8					<5					<20				
M															
N		2.8					<5					<20			
O		8.2					<5					150			
P	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
Q	<2		<2	<2	<2	7		<5	<5	<5	<20		<20	<20	<20
R	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
S	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
T	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
U	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20

WATER ANALYSES - METALS

Station	As ug/1					Cd ug/1					Cr ug/1				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A	<2	4.4				<5	<5				<20	<20			
B	<2	4.2				<5	<5				<20	<20			
C	<2					<5					23				
D	<2					<5					<20				
E	13	8.0				<5	<5				250	39			
F	2.0	9.0				<5	<5				160	560			
G	<2	<2	<2	<2	<2	<5	9	<5	<5	<5	<20	<20	<20	<20	<20
H	<2	2.4	<2	<2	<2	<5	7	<5	<5	<5	<20	<20	<20	<20	<20
I	<2	4.2	<2	<2	<2	<5	6	<5	<5	<5	<20	<20	<20	46	<20
J	<2					<5					<20				
K	8					<5					200				
L	8					<5					<20				
M															
N		2.8					<5					<20			
O		8.2					<5					150			
P	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
Q	<2		<2	<2	<2	7		<5	<5	<5	<20		<20	<20	<20
R	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
S	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
T	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20
U	<2		<2	<2	<2	<5		<5	<5	<5	<20		<20	<20	<20

WATER ANALYSES - METALS

Station	Cu ug/l Base	Cu ug/l Trace	Cu ug/l Heavy	Cu ug/l H-24	Cu ug/l H-48	Hg ug/l Base	Hg ug/l Trace	Hg ug/l Heavy	Hg ug/l H-24	Hg ug/l H-48	Mn ug/l Base	Mn ug/l Trace	Mn ug/l Heavy	Mn ug/l H-24	Mn ug/l H-48
A	<10	<10				<1	<1				45	277			
B	12	<10				<1	<1				180	110			
C	<10					1.4					100				
D	13					<1					110				
E	<10	24				<1	<1				39	76			
F	12	24				<1	<1				71	85			
G	18	18	<10	<10	<10	<1	<1	<1	<1	<1	25	37	22	27	28
H	15	23	<10	<10	<10	<1	<1	<1	<1	<1	70	72	56	310	370
I	<10	30	<10	<10	<10	<1	<1	<1	<1	<1	45	112	80	78	158
J	<10					<1					72				
K	<10					<1					54				
L	<10					<1					240				
M															
N		<20					<1					<10			
O		160					<1					110			
P	11		<10	<10	<10	<1		<1	<1	<1	33		20	20	41
Q	11		<10	<10	<10	<1		<1	<1	<1	32		16	21	47
R	14		<10	<10	<10	<1		<1	<1	<1	34		23	120	55
S	11		<10	<10	<10	<1		<1	<1	<1	27		20	43	41
T	15		<10	<10	<10	<1		<1	<1	<1	53		19	150	110
U	<10		<10	<10	<10	<1		<1	1	<1	47		27	52	76

WATER ANALYSES - METALS

Station	Ni ug/l Base	Trace	Heavy	H-24	H-48	Pb ug/l Base	Trace	Heavy	H-24	H-48	Zn ug/l Base	Trace	Heavy	H-24	H-48
A	<20	60				70	<40				13	13			
B	30	50				<40	<40				9	48			
C	<20					<40					25				
D	<20					60					44				
E	<20	40				<40	230				290	170			
F	220	30				60	60				52	355			
G	50	100	<20	<20	<20	<40	<40	<50	<50	<50	18	20	21	32	24
H	50	80	<20	<20	<20	<40	120	<50	65	60	15	79	49	80	55
I	<20	80	<20	<20	<20	60	230	73	<50	<50	17	100	49	45	36
J	<20					<40					19				
K	120					<40					38				
L	<20					<40					17				
M															
N		<30					<40					3			
O		<30					660					610			
P	<20		<20	50	<20	<40		<50	<50	<50	23		10	15	24
Q	<20		<20	<20	<20	<40		<50	<50	<50	23		15	30	28
R	80		<20	<20	<20	<40		<50	<50	<50	13		12	30	18
S	70		<20	<20	<20	<40		<50	<50	<50	30		12	13	19
T	80		<20	<20	<20	<40		<50	<50	<50	9		12	48	27
U	60		<20	<20	<20	50		<50	<50	<50	12		22	17	22

SEDIMENT ANALYSES

Station	COD mg/kg					T-PHOS. mg/kg					KJELDAHL AS N mg/kg				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A															
B															
C	2,500					740					170				
D	21,000					1,900					810				
E															
F															
G	19,100				11,000	1,300				140	340				380
H	81,400				33,000	6,300				270	5,500				1,100
I	33,400				13,000	4,200				180	4,200				410
J	18,000					440					210				
K	12,000					1,500					490				
L															
M															
N															
O															
P	16,000				9,400	2,000				150	610				370
Q	6,400				10,000	1,200				190	430				460
R	2,670				7,200	680				120	<100				390
S	3,930				15,000	660				180	180				690
T	4,720				3,800	1,000				50	240				120
U	2,640				12,000	660				150	260				650

SEDIMENT ANALYSES

Station	OIL & GREASE mg/kg					ALDRIN ug/kg					CHLORDANE ug/kg				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A															
B															
C	420					<1.0					<20				
D	480					<1.0					<20				
E															
F															
G	6,800				4,300	<1.0				<1.0	<20				<20
H	10,000				1,500	<1.0				<1.0	<20				<20
I	1,200				1,200	<1.0				<1.0	<20				40
J	1,300					<1.0					<20				
K	480					<1.0					<20				
L															
M															
N															
O															
P	1,100				250	<1.0				<1.0	<20				6.8
Q	280				160	<1.0				<1.0	<20				<20
R	400				150	<1.0				<1.0	<20				<20
S	240				160	<1.0				<1.0	<20				<20
T	580				140	<1.0				<1.0	32				<20
U	330				370	<1.0				<1.0	<20				<20

SEDIMENT ANALYSES

Station	CHLORINATED PHENOLS ug/kg Base	Trace	Heavy	H-24	H-48	DIAZINON ug/kg Base	Trace	Heavy	H-24	H-48	DIELDRIN ug/kg Base	Trace	Heavy	H-24	H-48
A															
B															
C	<2,000					<5					<3				
D	<2,000					<5					<3				
E															
F															
G	<2,000				<2,000	<5				<5	<3				<3
H	<2,000				<2,000	<5				<5	<3				<3
I	<2,000				<2,000	<5				<5	<3				<3
J	<2,000					<5					<3				
K	<2,000					<5					<3				
L															
M															
N															
O															
P	<2,000				<2,000	<5				<5	<3				<3
Q	<2,000				<2,000	<5				<5	<3				<3
R	<2,000				<2,000	<5				<5	<3				<3
S	<2,000				<2,000	<5				<5	<3				<3
T	<2,000				<2,000	<5				<5	<3				<3
U	<2,000				<2,000	<5				<5	<3				<3

SEDIMENT ANALYSES

Station	2-4D ug/kg					MALATHION ug/kg					PCB's ug/kg				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A															
B															
C	<400					<10					<20				
D	<400					<10					<20				
E															
F															
G	<400				<400	<10				<10	8,600				130
H	<400				<400	<10				<10	<20				<20
I	<400				<400	<10				<10	<20				<20
J	<400					<10					<20				
K	<400					<10					29				
L															
M															
N															
O															
P	<400				<400	<10				<10	970				210
Q	<400				<400	<10				<10	<20				<20
R	<400				<400	<10				<10	<20				<20
S	<400				<400	<10				<10	<20				<20
T	<400				<400	<10				<10	<20				<20
U	<400				<400	<10				<10	<20				<20

SEDIMENT ANALYSES

Station	As mg/kg Base	Trace	Heavy	H-24	H-48	Cd mg/kg Base	Trace	Heavy	H-24	H-48	Cr mg/kg Base	Trace	Heavy	H-24	H-48
A															
B															
C	0.75					<0.1					0.75				
D	3.4					1.1					4.3				
E															
F															
G	<0.1				0.12	0.44				<0.1	<0.50				<0.5
H	2.7				0.98	0.62				1.1	5.0				8.9
I	6.5				2.1	<0.1				0.57	8.5				5.9
J	<0.1					0.18					<0.5				
K	1.9					<0.1					1.2				
L															
M															
N															
O															
P	1.8				2.4	1.6				1.3	21				7.7
Q	1.1				2.9	0.63				1.2	3.3				13
R	0.69				0.22	<0.1				0.48	0.67				0.16
S	1.1				1.4	<0.1				1.2	0.9				3.8
T	0.99				0.66	<0.1				0.32	2.8				1.2
U	0.85				0.40	<0.1				0.42	1.3				0.63

SEDIMENT ANALYSES

Station	Cu mg/kg					Hg mg/kg					Mn mg/kg				
	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48	Base	Trace	Heavy	H-24	H-48
A															
B															
C	1.3					<0.05					31				
D	6.5					0.06					150				
E															
F															
G	<0.50				<0.5	0.18				<0.05	37				6.9
H	11				11	<0.05				<0.05	93				290
I	6.4				6.2	<0.05				<0.05	130				160
J	0.83					<0.05					5.3				
K	2.6					<0.05					120				
L															
M															
N															
O															
P	11				7.2	0.05				0.06	85				100
Q	3.4				6.5	<0.05				0.05	57				160
R	2.4				0.83	<0.05				<0.05	25				90
S	1.3				4.2	<0.05				<0.05	30				130
T	1.7				3.2	<0.05				<0.05	38				25
U	1.1				0.79	<0.05				<0.05	33				110

SEDIMENT ANALYSES

Station	Ni mg/kg Base	Trace	Heavy	H-24	H-48	Pb mg/kg Base	Trace	Heavy	H-24	H-48	Zn mg/kg Base	Trace	Heavy	H-24	H-48
A															
B															
C	1.1					2.9					7.5				
D	6.5					8.4					58				
E															
F															
G	1.3				<0.5	16				2.8	24				0.28
H	1.1				9.0	77				100	63				100
I	5.1				5.4	27				41	41				47
J	0.66					3.7					2.0				
K	3.4					5.6					12				
L															
M															
N															
O															
P	4.0				3.3	160				39	160				120
Q	2.2				10	13				22	67				100
R	0.6				4.2	55				7.5	12				32
S	1.3				0.65	8.6				15	15				57
T	1.0				2.4	91				14	17				17
U	0.67				1.3	13				9.1	11				26

Conclusions

Hydrological and physical data of runoff conditions, other than oxygen, were within generally accepted values reported as environmental fluctuations of Corpus Christi Bay System. Oxygen levels were depressed below normal after heavy rainfall, but rapidly returned normal baseline conditions. Intestinal organisms increased above acceptable levels during rain events. No salmonella were present and fecal streptococci indicated animal contamination. Bacteria levels rapidly decreased with time in the transects indicating absorption by natural processes in the bay water. PCB was found in trace amounts in the water at base conditions and were relatively high in sediments in the downtown boat basin. Oil and grease were below acceptable levels and Phenolics had one significant level at station E. Nutrients were increased during rain events, but were rapidly reduced to base conditions. No evidence of long lasting oxygen depletion due to nutrients was evident. Short term oxygen depletion rapidly returned to base conditions. Commonly used pesticides were detected in base and trace rainfall primarily in agricultural runoff. All values were below suggested criteria. In a few samples, some heavy metals were above EPA and USGS suggested criteria; Nickel and Copper. Sediment values were all below criteria.

In general, concentrations of some pollutants reached significant levels immediately after rain events, but were rapidly reduced to background concentrations. Occasional pollutants reached significant levels and further studies are suggested to relate pollutant concentrations to natural watershed background levels or degradative processes.

Suggested Future Studies:

Coliforms and fecal streptococci counts were above acceptible levels at transects G, H and I after rain events. Although the numbers decreased to background with time, the effluent site was high for 48 hours. This indicates potential hygiene effects for bacteria and viruses. Continuing studies on the environmental effects of bacteria and viruses of health significance should be made along with attempts to differentiate between human and animal coliforms and streptococci.

The levels of PCB in the sediments at stations G and P suggest further studies to determine the specific compounds, their origin, and in situ degradation rates.

The phenol concentration of 170 ppm at station E needs further study to determine any significance to the aquatic system.

Malithion levels in water at station E and Chlordane in the sediment at station T were above EPA criteria. Studies to determine degradation of such pesticides would be of value in interpreting existing data.

Several heavy metals were above suggested criteria. Further studies on the distribution and origin and significance of Chromium (F), Lead (O), Copper (E, F, O) and Nickel (F) where water or sediments reached levels above criteria. This new information can be compared to existing data.

TABLE OF CONTENTS

1.0 INTRODUCTION

As a part of the Regional Stormwater Master Plan, the Dry Weather Sampling Plan has been developed to guide field and management personnel in the collection and analysis of dry weather field samples which will characterize the quality of any existing illicit discharges or illegal dumping to the storm sewer system. This will be a key element in the management and maintenance of the City stormwater sewer system in a manner which will eliminate non-stormwater discharges to the storm sewer system.

Stormwater is defined by the Environmental Protection Agency (EPA) to be stormwater runoff, surface runoff, and drainage.

Illicit discharge is defined by the EPA to be any discharge not composed entirely of stormwater except discharges pursuant to an National Pollutant Discharge Elimination System (NPDES) permit. Examples of illicit discharges would include chlorinated swimming pool drainage, fire hydrant flushing, landscape irrigation, foundation drains, air conditioning condensation drainage, roof drains, individual car washing, and infiltration of ground water. Water from industrial processing such as industrial brine or sewage is also defined by EPA as non-stormwater discharge.

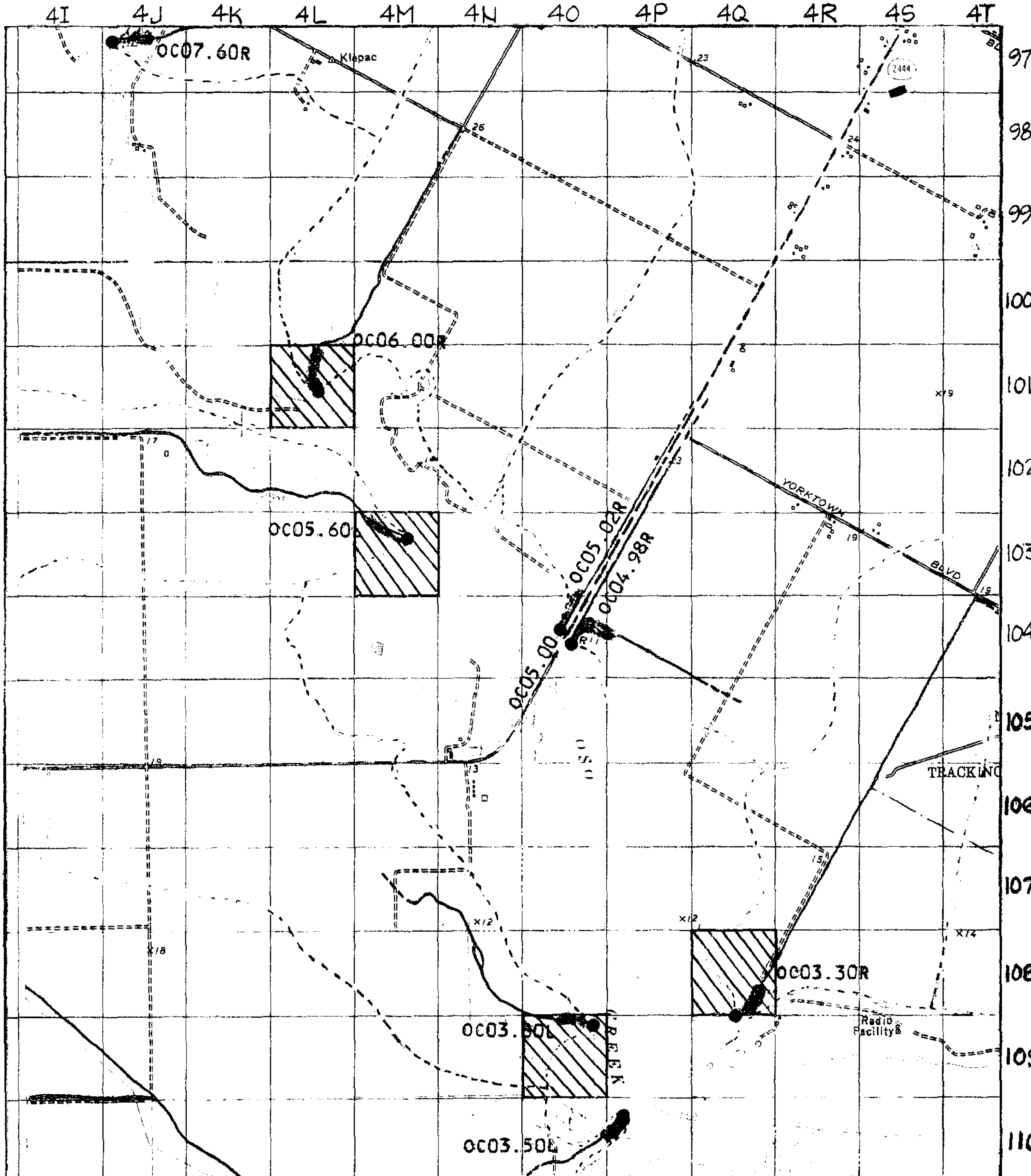
The following plan for dry weather sampling will guide field and management personnel in collection and analysis of field samples. Task 2.I.C.(3) presents a control plan describing methods of detecting and locating illicit connections to the storm sewer system.

2.0 DRY WEATHER SAMPLING PLAN REQUIREMENTS

The Dry Weather Sampling Plan will follow federal NPDES regulatory guidelines as listed in 40 CFR 122.26. The EPA defines two alternatives for sampling site selection. The first alternative allows all major outfalls to be sampled or "screened". A major outfall is defined by EPA as a municipal separate storm sewer outfall that discharges from a single pipe with an inside diameter of 36 inches or more or its equivalent (discharge from a single conveyance other than circular pipe which is associated with a drainage area of 50 acres or more), or for municipal separate storm sewers that receive stormwater from lands zoned for industrial activity, an outfall that discharges from a single pipe with an inside diameter of 12 inches or more, or its equivalent (discharge from other than a circular pipe associated with a drainage area of two acres or more).

The second alternative requires that a one-fourth mile grid be placed over the municipal storm sewer system map, creating one-fourth mile square cells. The grid is to be oriented with grid lines running north to south and east to west. According to NPDES suggested guidelines, cells which contain segments of the stormwater system are chosen for field screening based on land use, age of structures in the area, hydrological conditions, population density, and traffic density. Sites found to exhibit flow are then sampled using EPA sampling procedures. In the City of Corpus Christi, the EPA is requiring that a maximum of 250 sites be chosen for screening. This is due to the fact that Corpus Christi is classified as a medium municipality, which is defined by EPA as a city with a population between 100,000 and 250,000. The 1980 census indicated that the City's population was 231,999. The current 1990 census count for Corpus Christi is 257,453, but the number is still subject to revision until all information is received and resolved, which is expected by mid-July 1991.

For the purpose of screening point location in Corpus Christi, cells are labeled using a numerical/alphabetical scale for east/west orientation, and a numerical scale for north/south orientation. For example: Figure 2-1 shows the proposed system for cell



MAPPING DATA DETAIL:

DISCHARGE POINT: DRAINAGE AREA DIVIDE: --- RECEIVING WATERS: ~~

FIGURE 2-1

identification of a typical area. In this case, cell 4L/101 contains an outfall known as OC06.OOR. This outfall is located on Oso Creek (OC), six miles (06.00) from the Oso Creek reference point, on the right hand side (R) when facing upstream. In this manner, cells are identified which contain screening points.

2.1 DRY WEATHER SAMPLING STRATEGY

The City of Corpus Christi currently plans to field screen all major outfalls. By screening all major outfalls which discharge into significant receiving waters, as well as supplemental sites chosen from the EPA recommended grid system, if necessary, a more representative analysis for illicit connections can be performed. This may best be accomplished by using a two-phase approach to meet EPA requirements for dry weather field screening.

The first phase of this approach will be performed in Task 2.I.A (Mapping Data Collection). The field survey crews currently performing mapping data collection will locate and map all major outfalls, as well as record presence of flow. This activity will serve two tasks at once. First, it will locate and map outfalls for the Mapping Data Collection Plan. Secondly, it will screen outfalls for dry weather flow.

In the second phase, sampling crews will return to all outfalls which were screened and found to be flowing during mapping data collection and perform sampling activities (Task 2.I.D) per EPA standards, which are discussed in Section 2.2 and 2.3. Existing sites which exhibit flow will be located on base maps, which will be used for guidance by the sampling crews (Figure 2-1).

If the total number of screening points found by the mapping data collection crew is less than 250, supplemental sites may be selected. Supplemental sites will be chosen from cells in the storm sewer grid map using the following priority:

Priority for Supplemental Screening Site Selection:

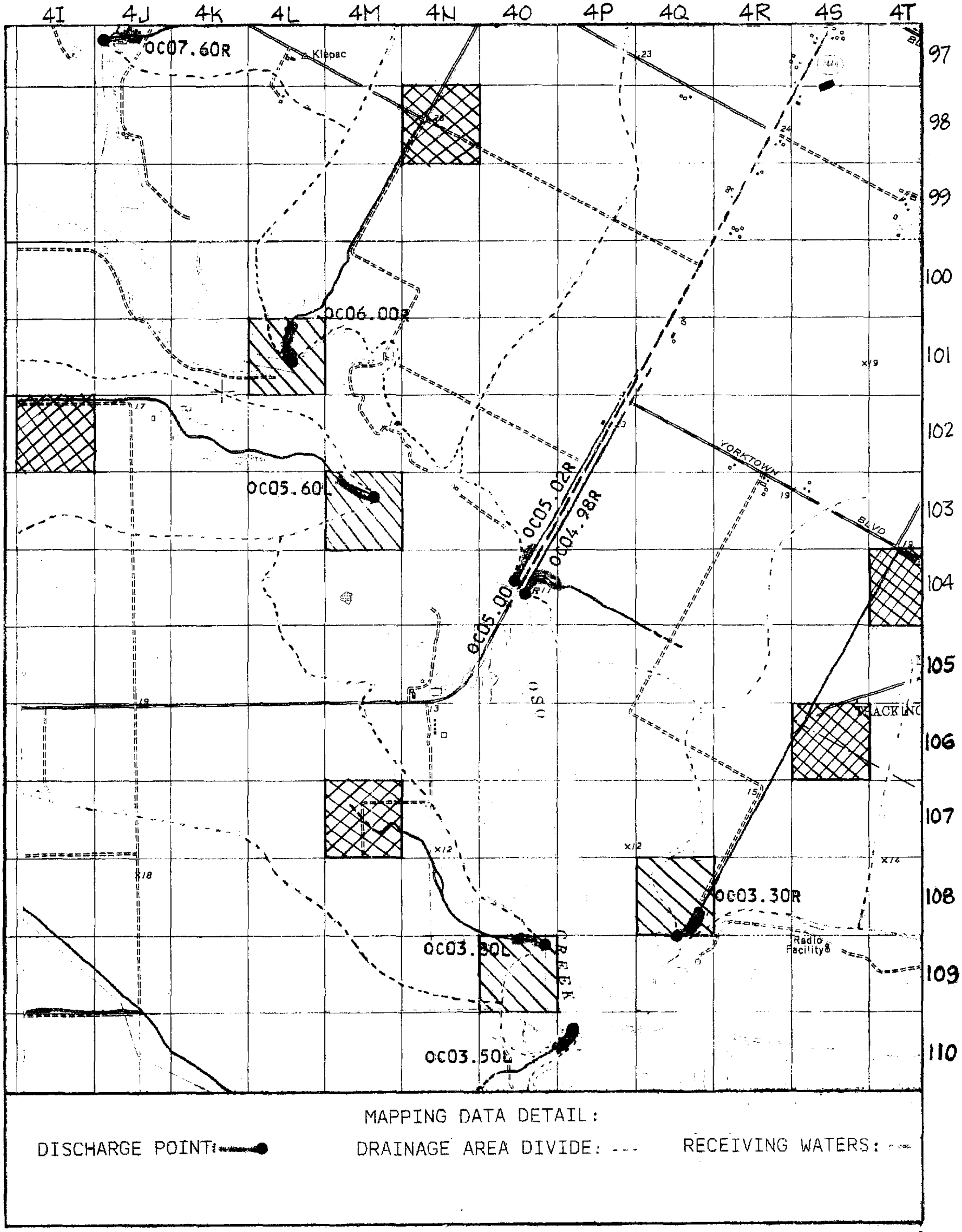
1. Upstream From Submerged Outfall
2. Upstream From Flowing Outfall
3. Industrial Areas, including transportation facilities
4. Institutional, especially medical facilities
5. Commercial
6. Residential
7. Open Space

This priority is based on activities and land usages which have a greater potential for illicit connection or discharge into the City storm sewer system. The "upstream from submerged outfall" priority will enable crews to screen submerged outfalls for flow, since flow was unable to be detected at the outfall during mapping data collection. The potential for nonpoint source pollutant generation is also considered.

This methodology will facilitate the future location of points of illicit discharge or illegal dumping to the storm sewer. For example: Cell 4Q/108 contains outfall OC03.30R, which exhibited flow during mapping data collection (Figure 2-2). If additional screening sites were determined to be necessary, they would be chosen upstream of the outfall at critical points such as intersecting drainageways which contribute to the main drainageway. For example: Cell 4S/106 contains a segment of an open ditch which enters the main ditch. This cell would be chosen for screening. Another site such as Cell 4T/104 could be chosen to give a comparison of samples taken above and below the area which contributes runoff to these drainageways. In Task 2.1.C.3, this selection methodology should prove useful for tracing sources of illicit connection to the City storm sewer system.

2.2 DRY WEATHER SAMPLING AND TESTING PROCEDURE

The procedure for dry weather sampling of major outfalls exhibiting flow will be performed according to procedures required by the Environmental Protection Agency.


4I
4J
4K
4L
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4N
4O
4P
4Q
4R
4S
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97
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102
103
104
105
106
107
108
109
110
OC07.60R
Klepac
OC06.00R
OC05.60L
OC05.02R
OC04.98R
OC05.00
YORKTOWN
BLVD
TRACKING
OC03.30R
Radio Facility
OC03.80L
CREEK
OC03.50L
MAPPING DATA DETAIL:
DISCHARGE POINT:
DRAINAGE AREA DIVIDE: ---
RECEIVING WATERS:

FIGURE 2-2

The following steps will be taken during dry weather sampling with results recorded on a Dry Weather Sampling Data Sheet (Figure 2-3):

1. Record date and time of arrival.

2. Identify site using the I.D. stake placed by the mapping data collection survey crew. Note that the stake was located by circling (YES) in stake found block on data sheet. If the stake is not found, note by circling (NO) in stake found block and record the following in the comments section of Dry Weather Sampling Data Sheet:

    a. I.D. numbers of sites before and after unidentified site.
    b. Size of structure (e.g., pipe diameter, channel width).
    c. Type of construction material and any identifying characteristics.

3. Inspect for flow.

    a. If flow is present, record on data sheet and obtain a grab sample. The grab sample will be taken from within the body of the flow, not from a ponded area, to avoid possible dilution.

        i. Note if sample is first or second sample (detailed in Section 2.5).

        ii. Visually inspect the sample for the following parameters: a) color; b) odor; c) turbidity; d) oil sheen; e) algae; f) surface scum

        iii. Using the testing system selected by the City, with EPA approval, follow the procedures per test system instructions to determine presence and concentration of the following: a) total copper; b) total phenol; c) total chlorine; d) pH; e) detergents.

DRY WEATHER SAMPLING DATA SHEET

Task 2.I.B(2)(c)

FILL IN BLANKS/CIRCLE APPROPRIATE ITEMS
PROVIDE DESCRIPTION OF ITEMS CIRCLED AS APPLICABLE

INVESTIGATOR:______________________________

DATE:________________	TIME:________________
SITE I.D. #________________	FLOW: YES NO

V I S U A L C H E C K R E S U L T S

STAKE FOUND: YES NO	SAMPLE: 1 2
COLOR: YES NO	ODOR: YES NO
TURBIDITY: YES NO	SCUM: YES NO
OIL SHEEN: YES NO	ALGAE: YES NO

T E S T K I T R E S U L T S

TOTAL COPPER:__________(ppm)	TOTAL CHLORINE:__________(ppm)
TOTAL PHENOL:__________(ppm)	pH:__________
AMMONIA: __________(ppm)	DETERGENTS:__________(ppm)
FLOW DEPTH: __________	VELOCITY:
OUTFALL DIMENSIONS: __________	_____(FT)/_____(SEC.) = _____(FT./SEC)
	METHOD: 1) FLOW STICK 2) STAKE TO STAKE

COMMENTS: ______________________________

FIGURE 2-3

iv. Determine the velocity of flow using the method best suited for the magnitude of flow. For small, slow-moving flows such as conduits or streams which can be easily stradled, the flow stick method is recommended. For large, fast-moving flows, the stake-to-stake method is recommended.

The flow stick method uses a four-foot pole with a nail driven in the end of the pole. A small center-drilled cork is placed over the nail. A three-foot string attaches the cork to the nail. Velocity of flow is determined by inserting the stick into the mouth of an outfall, or upstream in case of small stream. The cork is allowed to slip off of the nail and float downstream. A stop watch will be used to record time required for the cork to float downstream and pull the string taut. This will indicate velocity in 3 feet/N seconds. For example: If two seconds were required for the string to become taut, the velocity would be 3 ft./2 sec. = 1.5 ft./sec.

The stake-to-stake test uses two stakes which are placed 20 feet apart along the bank of large flows. A floating object such as a "Cheetos" cheese ball is tossed into the water upstream of the first stake. When the float reaches the first stake, the stop watch is started. As the float reaches the second stake, the stop watch is stopped at that point. This will indicate velocity in 20 ft./N seconds. For example: if 5 seconds were recorded for the float to travel from stake-to-stake, the velocity would be 20 ft./5 seconds, or 4 feet/second.

The float used in either the flow stick method or stake-to-stake method should be placed in the center of the surface of the flow being measured. Results of the velocity test and the method used should be recorded on a data sheet for calculation of flow rate.

v. Photograph outfall and flow

4. If flow is not present, record on data sheet and continue to next site.

2.3 DRY WEATHER SAMPLING AND TESTING PROCEDURE FOR SUPPLEMENTAL SITES

If supplemental sites are required to be utilized, their screening and sampling (if flow is found) will require additional steps. The steps needed to screen a supplemental site will consist of a combination of procedures used in the mapping data collection and dry weather sampling procedures. This is necessary due to the fact that the supplemental sites will be sites selected from the City stormwater sewer system grid. These sites will not have been inspected at this point so they will have to be located, tagged with an I.D.stake, checked for flow, and sampled if flow is present.

Sampling Crews will be provided with a grid map which will have selected supplemental sites marked (Figure 2-2). The crews will then locate the cell in the field and perform the following steps while recording results on a Mapping Data/Dry Weather Sampling Data Sheet for Supplemental Sites (Figure 2-4).

1. Locate a point of access to the segment of the City storm sewer system contained in the cell area.

2. Identify the access point with an I.D. stake which has the cell number affixed.

3. Note time and date.

4. Measure conduit or channel dimensions, noting if pipe, box culvert or open channel.

5. Note construction material, (e.g., earth, metal, concrete).

MAPPING DATA/DRY WEATHER SAMPLING DATA SHEET FOR SUPPLEMENTAL SITE

FILL IN BLANKS/CIRCLE APPROPRIATE ITEMS
PROVIDE DESCRIPTION OF ITEMS CIRCLED AS APPLICABLE

INVESTIGATOR:____

DATE:____________________	TIME:____________________
SITE I.D. #____________________	DEBRIS: YES NO

SITE MATERIAL: CONCRETE METAL EARTH OTHER

SITE STRUCTURAL CONDITION: GOOD FAIR POOR

SITE SILTATION DEPTH: NONE 1/4 FULL 1/2 FULL 3/4 FULL PLUGGED

CONDUIT OR CHANNEL DIMENSIONS:________________________________

WEED GROWTH: YES NO	FLOW: YES NO
COLOR: YES NO	ODOR: YES NO
TURBIDITY: YES NO	SCUM: YES NO
OIL SHEEN: YES NO	ALGAE: YES NO

LAND USE: UNDEV. AGRI. IND. RES. COMM.

FLOW DEPTH:____________	VELOCITY: ____(FT)/____(SEC.) = ______(FT/SEC)

METHOD: 1) FLOW STICK 2) STAKE TO STAKE

TOTAL COPPER:____________(ppm)	TOTAL CHLORINE:____________(ppm)
TOTAL PHENOL:____________(ppm)	PH:____________
AMMONIA: ____________(ppm)	DETERGENTS:____________(ppm)

COMMENTS: ____

FIGURE 2-4

6. Note structural condition of site.

7. Note siltation depth in conduit or channel.

8) Record presence of: a) debris; b) weed growth.

9. Inspect for flow.

   a. If flow is present, record on data sheet and obtain a grab sample. The grab sample will be taken from within the body of the flow, not from a ponded area. This will avoid possible dilution.

      i. Visually inspect the sample for the following parameters:
      a) color; b) odor; c) turbidity; d) oil sheen; e) algae;
      f) surface scum

      ii. Using the testing system selected by the City of Corpus Christi with E.P.A. approval, follow the procedures per test system instructions to determine presence and concentration of the following: a) total copper; b) total phenol; c) total chlorine; d) pH; e) detergents.

      iii. Determine the velocity of flow using the method best suited for the magnitude of flow (as discussed in Section 2.2.3.iv).

      iv. Photograph outfall and flow

10. Note ease of accessibility of the site in comments section of Data Sheet for future access.

11. Photograph site.

12. If flow is not present, record on data sheet and continue to next site.

2.4 SPECIAL CONDITIONS

In some cases, supplemental sites will be within sections of the city storm sewer system which may be accessible only by manholes. This will require planning with the City to enable city personnel to open manholes so that the sampling crew can obtain grab samples of flows within buried conduits. Methods for remotely obtaining samples without entering manholes will be developed to avoid having to send sampling crews into manholes. In some cases, cooperation will have to be planned with city personnel as well as police or traffic personnel. This will be necessary in cases where the only site for access to the storm sewer lies within a street. Special conditions which require unusual planning will be handled as they arise in a manner which will meet sampling requirements as well as ensure the safety of the sampling crew.

2.5 SAMPLING TIME CONSTRAINTS

One requirement of the EPA is that all sites exhibiting flow will be sampled twice with no less than four hours between samplings and no more than 24 hours between samplings. The following process should allow the time constraint to be met:

1. Establish list of sampling sites to be accessed for the day.

2. Perform initial sampling until approximately 12:00 noon.

3. A rest period for lunch may be taken if so desired by the crew.

4. Return to the first flowing sampling site which was sampled at the start of the day and resample flowing sites in the same order as initial sampling. It is not required to return to sampling sites if no flow was present.

This sampling procedure should allow crews to meet time constraints.

3.0 SAMPLE TESTING OPTIONS

There are three options for testing water samples which are available at this time. These options are as follows:

1. Use of a prefabricated kit which contains testing procedures for all parameters which EPA has required to be identified in dry weather flow samples.

2. Use a combination of kits which have the capability of analyzing samples for the presence and concentration of all parameters as required by EPA.

3. Use of local laboratories to perform sampling for presence and concentration of all parameters as required by EPA.

It is estimated that there will be a minimum of 100 sampling sets to be performed. This estimation is based on the fact that a maximum of 250 sites will be screened and approximately 20% of outfalls have been observed to have flow during mapping data collection. Thus, 20% (250) = 50 flowing sites which will be sampled twice; therefore, 100 (minimum) sample sets. Additional outfalls may be discovered flowing which will require sampling sets. Also, the City will probably be utilizing the kits in follow-up to this specific task. Therefore, the following analysis is based upon 200 sample sets which is the maximum to be expected. A sampling set is defined as one set of tests for all five EPA required parameters for field screening. Testing options will be evaluated using the following:

1. Economics - Cost/Sample Set Based On: $\dfrac{\text{Total Cost of Option (Kit, Materials)}}{200}$
2. Availability
3. Dependability and Accuracy
4. Ease of Use
5. Compatability with EPA Regulations

3.1 PREFABRICATED TEST KIT OPTION

Two companies have been located at the time of this report, which produce a kit specifically designed for NPDES permitting: 1) the Lamotte Company and 2) the Chemetrics Company.

The Lamotte Storm Pollution Detection Kit (#7443) was specifically designed and manufactured to meet EPA requirements for field test procedures outlined in the November 16, 1990 Federal Register. The Lamotte Storm Drain Kit was designed to test for the five field screening parameters: 1) total phenol; 2) total copper; 3) total chlorine; 4) pH; 5) detergents.

The Lamotte Storm Drain Pollution Detection Kit (#7443) sells for $385.00 and will perform 50 samples before reagents must be replaced. Reagent refills are available for $92.50, and will provide enough reagent for 50 tests. The cost per sample set of the Lamotte Storm Drain Pollution Detection Kit is $3.31.

This sampling system uses liquid and powdered reagents which are added to samples per kit instructions. One difficulty with this type of system will occur during very windy conditions. Droplets or powders may be blown away while being added to samples, and cause inaccurate results. Due to the predominantly windy conditions in Corpus Christi, this could become a problem. After reagents are added for a particular test, a color change will occur if the parameter being tested for is present. This color is then compared to a chart which indicates concentration by color. The only parameter not based on color comparison is pH. The pH is determined using a digital pH meter. The Lamotte Storm Drain Pollution Detection Kit requires simple procedures and is readily available.

Another available test kit is manufactured by Chemetrics. The Chemetrics kit was also designed to meet EPA requirements for field-testing the five referenced parameters. The cost of the Chemetrics Stormwater Kit is $250.00. Thirty sample sets may be performed before the kit's regeants will be exhausted. Regeant refills cost $117.00 and will prepare the kit for an additional 30 sets of tests. The cost per sample set of this kit is $4.76.

The Chemetrics kit operates by an ampoule system primarily. Glass ampoules containing premixed reagents for the parameter being tested for are inverted into a container of the water sample. The ampoule tip is snapped off while under the water sample surface so that the vacuum within the ampoule can draw the specific volume of the water sample needed into the ampoule. If the parameter being tested for is present in the water sample, a color change will occur due to the reaction of reagents and the sample which was drawn into the ampoule.

A reading is made using factory-prepared ampoules for color comparison. The test ampoule is compared to a range of colors until a match is made. The concentration can then be read from the chart which holds the color comparison ampoules. The parameters which do not use the ampoule process are pH and detergents. The pH is read using a digital pH indicator. Detergents are tested for by adding three liquid reagents. After the reagents are added, if detergents are present, a color change will occur. A reading is obtained by comparing sample/reagent color to a color comparison chart.

The Chemetrics Kit appears to be easy to use and has a higher potential for accurate results. This is due to the fact that for all tests other than detergents, reagents are premixed in ampoules which draw the exact amount of sample required. The detergents test uses three simple additions of liquid reagents to a measured volume of sample.

One problem which could occur would be the drawing of air into the ampoule, should it not be submerged properly. Another possibility would be stoppage of the ampoule tip by trash in the event that a water sample is very dirty.

3.2 COMBINATION OF INDIVIDUAL KITS OPTION

Another available option for field sampling is selecting individual parameter test kits capable of performing all the required tests. Hach, Lamotte, and Chemetrics are all manufacturers of test kits which will be used as resources of individual parameter test kits, their prices and specifications. The parameters for which test kits need to be selected are: 1) total copper; 2) total chlorine; 3) total phenol; 4) detergents; 5) pH.

Hach manufacturers a test kit called the DR/1A colorimeter, which is a single beam, filter photometer. The DR/1A uses one-inch sample cells to hold a water sample mixed with a reagent for photometric color analysis. The meter of the DR/1A uses an interchangeable scale to indicate concentrations. Each parameter has its own scale which is placed under the indicating meter pointing needle, as that parameter is tested.

The sample cell, which looks like a small glass tube, is filled with a specified volume of water sample. A reagent pillow, which is a small pouch of dry reagent, is added to the sample. The reagent will then cause a color change to occur if the parameter being tested for is present. The sample cell is placed into a socket in the DR/1A and the indicator scale of the parameter being tested for, is placed under the indicating meter. The proper wave length is dialed in (as stated on indicator meter scale) and a concentration is obtained for the parameter.

The DR/1A photometer is EPA approved for total phenol, total copper, and total chlorine testing. The remaining parameters to be tested for are: 1) detergents, and 2) pH.

Detergents can be sampled for with the Hach Detergent Test Kit (#1432-03). This kit uses a reagent which is added to a specific volume of water sample. A color change occurs, and a reading is taken by comparing the samples color to a color chart. The color that best matches the color of the sample is chosen and the corresponding reading is the concentration of detergents in the sample.

Values for pH can be obtained using the Lamotte #1707/DHA-2 digital pH indicator. This device is immersed per instructions to obtain a pH level, as indicated by the digital read-out on the instrument.

This example is one of many options which can be put together using individual parameter kits of the different manufacturers. The cost per sample set of this particular example is $8.26. This option appears easy to use because of the pre-measured regeant "pillows". The only problem which would be associated with it is the possibility of delay due to pieces of equipment and regeants being ordered from different places. This option will also require more separate pieces of equipment to be carried around in the field. The pieces of equipment in this option are readily available for use at this time.

3.3 LABORATORY OPTION

Another option which can be used for the purpose of dry weather sample analysis is local water testing laboratories. The procedure for using this alternative would be to collect samples from flowing field sites using approved collection procedures and containers. Basic preservation methods would need to be used to stop sample deterioration. The difficulty due to the special glassware required, the preservation requirements of samples, and the cost of laboratory work make this option much less feasible than field sampling. Estimates of charges for testing of water samples for EPA required parameters ranged from $70.00-$90.00 for each sample set. This price quote included prices of testing for all EPA required parameters.

Turn-around on sample analysis ranges from two weeks to six weeks, depending on the amount of work being done by the lab at this time. This option is available at the present time and meets all EPA requirements.

3.4 SAMPLE TESTING RECOMMENDATIONS

A comparison of options indicating the tests a kit will perform, cost per sample set, testing methods, and manual field mixing of reagents in samples is shown in Table 3-1. The options previously discussed will all perform the task of analyzing water samples. However, it is evident that some options are more economical, others are easier to use, and still others are more accurate. The most accurate results would be received from the laboratory option. However, the difficulties associated with collection of samples in the field, while using approved glassware and proper sample preservation techniques, make this option time consuming and cost-prohibitive. Also, testing results for field screening purposes do not require the level of accuracy provided by an in-laboratory analysis.

The option of creating a combination kit with kits designed for individual parameter testing would prove an acceptable option. However, the difficulty associated with communication with more than one manufacturer, replenishing reagents for each specific kit, different operation procedures of manufacturers and bulk of several different kits make the combination kit option less acceptable than the compact prefabricated kit.

By far, the option appearing to meet the Dry Weather Sampling Plan requirements with the least difficulty, most economical expense, and highest level of organization and prethought, is the prefabricated test kits. Procedures for operation and kit specifications for both the Lamotte and Chemetrics storm drain tests kits are discussed in Section 4.0, Test Kit Selection.

TABLE 1

OPTION COMPARISONS

Tests Performed By System:	PREFAB TEST KITS Lamotte	PREFAB TEST KITS Chemetrics	LABORATORY Local/Private	COMBINATION KITS Lamotte, Chemetrics, Hach
1) Total Phenol	YES	YES	YES	YES
2) Total Copper	YES	YES	YES	YES
3) Total Chlorine	YES	YES	YES	YES
4) Ph	YES	YES	YES	YES
5) Detergents	YES	YES	YES	YES
Cost/Sample Set	$3.31	$4.76	$70.00 - $90.00	$8.26

Method Used For Colorimetry	Lamotte	Chemetrics	Local/Private	Lamotte, Chemetrics, Hach
1) Total Phenol	Chart Comparison	Premix Ampoule Comparison	-	Colorimeter
2) Total Copper	Chart Comparison	Premix Ampoule Comparison	-	Colorimeter
3) Total Chlorine	Chart Comparison	Premix Ampoule Comparison	-	Colorimeter
4) Ph	Digital pH Indicator	pH Pocket Pen	-	Digital pH Indicator
5) Detergents	Chart Comparison	Premix Ampoule Comparison	-	Colorimeter

Parameters Requiring Manual Measurement or Mixing Of Reagent and Sample	Lamotte	Chemetrics	Local/Private	Lamotte, Chemetrics, Hach
1) Total Phenol	YES (Liquid/Powdet)	NO	NO	YES (Reagent Pillow)
2) Total Copper	YES (Liquid/Powder)	NO	NO	YES (Reagent Pillow)
3) Total Chlorine	YES (Liquid/Powder)	NO	NO	YES (Reagent Pillow)
4) Ph	NO	NO	NO	NO
5) Detergents	YES (Liquid/Powder)	NO	NO	YES (Reagent Pillow)

4.0 TEST KIT SELECTION

4.1 LAMOTTE SPECIFICATIONS

The tests performed using the Lamotte Test Kit and their ranges are as follows:

1) pH:
   Range: 0 - 14 pH
   Sensitivity: ± .2 pH

2) Total Phenols:
   Range: 0.1 ppm - 1.0 ppm
   Sensitivity: From 0.1 to 0.6 ppm sensitivity is 0.1 ppm
   From 0.6 to 1.0 ppm sensitivity is 0.2 ppm

3) Total Copper:
   Range: 0.05 to 0.50 ppm
   Sensitivity: 0.05 ppm

4) Total Chlorine:
   Range: 0.1 ppm - 1.0 ppm
   Sensitivity: From 0.1 ppm to 0.6 ppm sensitivity is 0.1 ppm
   From 0.6 ppm to 1.0 ppm sensitivity is 0.2 ppm

5) Detergents:
   Range: 0.1 to 2.0 ppm
   Sensitivity: 0.1 ppm

4.2 LAMOTTE SAMPLING PROCEDURES

A simplified description of the Lamotte Storm Drain Test Kit Procedure for each parameter is described in the following: (Detailed instructions accompany each kit purchased.)

1. pH: The Lamotte Digital pH Meter is immersed into a beaker filled with the sample being tested. The meter will then give a pH reading as indicated by a digital read-out.

2. Total Copper: A reagent is added to a test tube containing the water sample. The tube is then placed in an axial reader. The axial reader compares the color of the sample and reagent to a color chart which indicates concentration in parts per million (ppm).

3. Total Phenols: Reagents are added to a test tube containing the sample being tested. A color change will occur if phenols are present. the sample is then placed in an optic comparitor which compares the color of the sample and reagents to obtain a reading in ppm.

4. Total Chlorine: A reagent is added to a test tube containing a sample of the water being tested. The test tube is then placed in an optic comparitor to compare the color of the sample to a chart and obtain a reading in ppm.

5. Detergents: A special titration flask is filled with the sample being tested and reagents are added until color change occurs. The number of drops of reagent added indicates concentration in ppm. Each drop indicates 0.1 ppm.

Appendix A contains a photo of the Lamotte Kit and additional information.

4.3 CHEMETRICS SPECIFICATIONS

The tests performed using the Chemetrics test kit and their ranges are as follows:

1) pH:

Range: 0 - 14 pH
Sensitivity: $\pm$ .2 pH

2) Total Phenols:

Range:	0 - 1.0 and 1.0 - 12.0 ppm
Sensitivity:	From 0 to 0.6 ppm sensitivity is 0.1 ppm
	From 0.6 to 1.0 ppm sensitivity is 0.2 ppm
	From 1.0 to 12.0 ppm sensitivity is 0.5 ppm

3) Total Copper:

Range:	0 - 1.0 and 1 - 10.0 ppm
Sensitivity:	From 0 to 1.0 ppm sensitivity is 0.1 ppm
	From 0.6 to 1.0 ppm sensitivity is 0.2 ppm
	From 1.0 to 10.0 ppm sensitivity is 0.5 ppm

4) Total Chlorine:

Range:	0 - 1.0 and 1 - 5.0 ppm
Sensitivity:	From 0 to 1.0 ppm sensitivity is 0.1 ppm
	From 0.6 to 1.0 ppm sensitivity is 0.2 ppm
	From 1.0 to 5.0 ppm sensitivity is 0.5 ppm

5) Detergents:

Range:	0.25 - 5.0 ppm
Sensitivity:	(5 increments of concentration are used which are: 0.25, 0.5, 1.0, 2.0, 5.0 ppm

4.4 CHEMETRICS SAMPLING PROCEDURES

A simplified description of the Chemetrics Stormwater Discharge Test Kit Procedure for each parameter is described in the following: Detailed instructions accompany each kit purchased.

1. pH: The Chemetrics pH pocket pen is immersed into a beaker filled with the water to be tested. The pocket pen will indicate pH level with a digital read-out.

2. Total Copper: A copper ampoule is submerged into the water sample. The ampoule tip is then snapped off, allowing a portion of the sample to be drawn into the ampoule. The ampoule is mixed by inverting several times. The ampoule is then compared to a color chart and a reading is taken.

3. Total Phenols: Same as above.

4. Total Chlorine: Same as above.

5. Detergents: Five mL of sample are placed in a square sample cell. Ten drops of TA-1 reagent, four drops of TA-2 reagent, and two mL of TA-4 reagent are added. The cell is capped, shaken, and then allowed to sit for two minutes. The sample/reagents will settle into two layers. The top layer is drawn off using a syringe. Five mL of distilled water and four drops of TA-3 reagent are added to the lower layer of sample/reagent which remains. The mixture is shaken and allowed to sit for two minutes. The color of the sample/reagent mixture is then compared to a color chart to obtain a reading.

Appendix B contains a photo of the Chemetrics Kit and additional information.

4.5 TEST KIT SELECTION

At the present time, two kits (Lamotte Storm Drain Kit and Chemetrics Stormwater Discharge Kit) are available for use. It is recommended that the Chemetrics Kit be utilized for dry weather sampling. The basis for selection of the Chemetrics Kit over the Lamotte Kit is its ease of use and potential for accurate results. The Chemetrics Kit uses vacuum-sealed, premeasured reagent ampolues which, when submerged and unsealed, draw the exact volume of water sample into the ampoule, mixing it with the reagent. This will prove much easier than addition of liquid or powdered reagents by hand in windy field conditions as required by the Lamotte Test Kit.

The greater range of the Chemetrics Kit is another important factor. A comparison of ranges for Lamotte and Chemetrics kits is shown in Table 2.

TABLE 2

RANGE COMPARISON

TEST	RANGE LAMOTTE	RANGE CHEMETRICS
Phenols	0.1 - 1.0	0 - 12.0
Copper	0.05 - 0.50	0 - 10.0
Chlorine	0.1 - 1.0	0 - 5.0
Detergents	0.1 - 2.0	0.25 - 5.0

The costs of the Lamotte and Chemetrics kits are both acceptable as well. The Chemetrics Kit is slightly more expensive, but the ease of use as well as built-in accuracy will make it worth the additional expense.

Due to the fact that final selection of a kit with EPA approval will be made by the City of Corpus Christi at the start of dry weather sampling, both kits will need to be considered as options. Familiarity with kit procedures and ranges will prove useful for later application in the field.

5.0 DRY WEATHER SAMPLING SCHEDULE

A two-person crew should be able to locate and sample 6-10 sites each day (including travel and mobilization time). One day per week will be spent in the office finalizing data forms, cataloging photographs, and entering data into the computerized database. At this rate, it is expected to take 6-7 weeks to complete the dry weather sampling task.

Major outfall sites will be sampled using the following schedule:

Scheduled Sampling Area	Tentative Schedule
1) Corpus Christi Bay Area	Week 1
2) Oso Bay Area	Week 1
3) Oso Creek Area	Week 1
4) West Oso Creek Area	Week 2
5) Nueces River Area	Week 2
6) Inner Harbor Area	Week 2
7) Upper Laguna Madre Area	Week 2

Supplemental screening sites will be screened (and sampled if flowing) using the following schedule:

Screening/Sampling Area	Tentative Schedule
1) Corpus Christi Bay Area	Week 3
2) Oso Bay Area	Week 3
3) Oso Creek Area	Week 4
4) West Oso Creek Area	Week 5
5) Nueces River Area	Week 6
6) Inner Harbor Area	Week 6
7) Upper Laguna Madre Area	Week 7

Crews should meet briefly each morning to prepare a work plan for the day. This will allow the crews to minimize travel time, avoid duplication of effort, and provide information on their approximate location, should the need to contact them arise. Access to sites may best be achieved by City drainage rights-of-way and easements, through private property, and sometimes by boat.

In some cases, coordination of arrangements for access will need to be made by the City. The City will establish a contact person to handle the necessary arrangements. At the time of field training, required lead time for obtaining access will be discussed. The weekly preplanning of areas to be surveyed will allow time to make these arrangements and keep crews fully employed.

The time spent in the office will be utilized to meet with the City and its consultants to discuss problems and to pass on collected data so that the analysis of this data can begin. Field data sheets will be given to the City at this time. Crews should also preplan activities for the future week and make the necessary arrangements for accessing the sites.

Required equipment to be utilized in dry weather sampling is as follows:

Base Maps	Flashlights
Clipboard, Pencil, Pen	Data Forms
Two-Way Radio	Camera
Rubber Gloves	Stormwater Test System
4 - Glass Sample Bottles	Backpack or Beltpack
Stakes	"Cheetos" Cheese Balls
Rinse Water Collection Container	Wash Basin

Distilled Water for Rinsing Sampling Equipment
Safety Equipment (First Aid\Snake Bit Kit)

6.0 DRY WEATHER SAMPLING CREW SAFETY PLAN

Field investigations conducted at remote locations require that sampling personnel be acquainted with and follow a safety plan. Crews should be formed of two persons minimum. Protective clothing should be worn as required by the area being sampled and the season. Comfortable walking shoes or hiking boots, long pants, hats and sunglasses would be appropriate. Insect repellent will be needed to repel ground insects and mosquitoes. Mace repellent is necessary for protection from aggressive dogs. Two-way radios should be carried allowing contact with the City's contact person. This will allow the crews current location to be monitored as well as enable the City to provide assistance, should it become necessary. Coordination should be conducted with the City Stormwater Department to obtain access to easements and drainage rights-of-way and avoid the possibility of entering private property without permission.

Emergency procedures will need to be established according to the terrain being currently surveyed. In the event that the sampling crews need assistance, this will ensure that the City has the appropriate equipment available to reach them.

7.0 FIELD TRAINING

It is expected that the City will negotiate a contract for field sampling. Before commencing field sampling, the contracted field crews will be provided with a field training session. This training will acquaint the crews with the topics necessary to successfully complete the project.

Required Data List	Standard Methods for Obtaining Data
Data Collection Sheets	Site Numbering System
Mapping Organization	Priority of Watersheds
Required Equipment	Safety Procedures

Follow-up to the training will occur at the end of the first week when the sampling crews spend a day in the office organizing their data. At this time, the consultant will again meet with the sampling personnel to review data for completeness and revise procedures, if necessary. Instruction will also be provided in database utilization and input procedures.

8.0 REFERENCES

Chemetrics, Inc., Advanced Systems for Water Analysis, Calverton, Virginia, 1991.

Lamotte Chemical Company, Water Testing Products, Chestertown, Maryland, 1991.

Hach Company, Products for Analysis, Loveland, Colorado, January 1990.

Environmental Protection Agency, Rhoda Harris, Conversation Concerning Flow Measurement, April 1991.

Fort Worth Health Department, Procedures for Field Screening Storm Drain Outfalls, Fort Worth, Texas, April 1991.

Environmental Protection Agency, National Pollutant Discharge Elimination System Permit Application Regulations for Stormwater Discharges, 40 CFR, Parts 122, 123 and 124, Washington, D.C., 1989.

APPENDIX A
LAMOTTE CHEMICAL PRODUCTS COMPANY

LaMOTTE CHEMICAL PRODUCTS COMPANY

MANUFACTURERS OF CHEMICAL TEST KITS
ANALYTICAL REAGENTS
PORTABLE INSTRUMENTS FOR THE ANALYSIS OF WATER • SOIL • AIR

Dear Analyst,

Thank you for inquiring about LaMotte Chemical testing equipment. We hope the accompanying literature covers your particular needs.

To request additional information or to place an order, you may use the form enclosed for your convenience. Or call us at 800-344-3100. Our experienced order service personnel are eager to help you, and a LaMotte technical service representative is standing by to answer your questions.

For more than 60 years, LaMotte Chemical has been a leading manufacturer of test kits, analytical reagents, apparatus, and instrumentation for water analysis, soil nutrient analysis, and air pollution detection. We specialize in the development of practical, simplified test methods for on-site use - without sacrificing professional accuracy.

Our test kits and instruments are designed to give years of dependable performance. When your supply of stable, accurate LaMotte reagents runs low, refill reagents can be ordered quickly, easily, and economically. And prompt, friendly service is a component of every product we offer.

We hope these comments will help you to choose LaMotte products with confidence. We want to make our test equipment a productive part of your analytical activities. Please call us at 800-344-3100.

Sincerely yours,

LaMOTTE CHEMICAL PRODUCTS COMPANY

Richard LaMotte

Richard LaMotte
Director of Communications

RL:fsl
Enclosures

ADDRESS: P.O. BOX 329 CHESTERTOWN, MARYLAND 21620
CABLE ADDRESS: LAMOCHEM CHESTERTOWN, MARYLAND
TELEX: (WUI) 6849068 LAMOCHEM

PHONE: 301-778-3100 (IN MD)
TOLL FREE: 1-800-344-3100

LaMOTTE

NEW STORM DRAIN POLLUTION DETECTION KIT

The Model SDPC Detection Kit was specifically designed and manufactured to meet US EPA requirements for field test procedures approved in the November 16, 1990 Federal Register to monitor illicit storm drain connections. Each unit includes test for pH, Total Chlorine, Total Copper, Phenols, and Detergent surfactants.

The Model SDPC is packaged in a rugged portable carrying case for on-site use. Reagents provided for 50 tests of each parameter.

SPECIFICATIONS

pH PockeTester	0-14 pH ±0.2 pH 0-14 pH test strips For range finding.
Phenols	0.1-1.0 ppm
Copper	0.05 - 0.50 ppm
Detergents	Titration method, 0.1 ppm sensitivity
Chlorine	0.1 - 1.0 ppm
Accessories	Sampling and dilution, glassware included, laminated instructions

MODEL SDPC **CODE 7443**
Price $385.00

Reagent Refill **Code R-7443**
Price $92.50

800 344 3100

LaMOTTE COMPANY
PO BOX 329
CHESTERTOWN, MD
21620

301 778 3100
FAX 301 778 6394

LaMOTTE

NEW STORM DRAIN POLLUTION DETECTION KIT

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21620

301 778 3100
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APPENDIX B
CHEMETRICS, INC.

CHEMlines Update
from CHEMetrics
the innovative leader in water analysis

Vol. 5
Issue 1
Winter 1991

CHEMetrics Announces New Multiparameter Test Kit

Monitor Five Analytes for EPA Storm Water Regs

CHEMetrics' first multiparameter test kit, for quantifying five analytes in storm water discharges, is now available. The new kit is designed for use by an estimated 125,000 municipalities and private industrial facilities now required to test storm water discharges to obtain an EPA permit.

In a single compact case, the Storm Water Discharges Test Kit (cat. no. M-1000) contains packs of 30 CHEMets® ampoules for the detection of Total Chlorine, Total Phenol, and Total Copper. The kit also includes a pH pocket pen and a Detergents (Surfactants) method for 50 tests, as well as a syringe and filters, sample collection beakers, a refuse container, and complete instructions. Refills and replacement accessories are readily available.

CHEMetrics' new multiparameter test kit makes storm water field-screening easy and economical.

Manufacturers Must Test Discharges

The EPA regulation published November 16, 1990 requires *all* U.S. manufacturers who discharge storm waters directly into a municipal storm sewer system, or ultimately into U.S. waters, to apply for a permit. CHEMetrics' multiparameter kit meets EPA requirements for field-screening water quality at the industrial connections to municipal systems. For more information on the regulations, contact the USEPA in Washington, D.C. at **(202) 475-9541**, or contact your local water control board.

A New Multiparameter Product Line

The Storm Water Discharges Test Kit is the first in a new line of multiparameter products planned by CHEMetrics. The new products will be packaged in compact hard plastic cases which will contain everything needed to run 30 tests of 3 or more different analytes.

Designed to User Demand

CHEMetrics' new multiparameter kits will be packaged to meet user needs— whether in a specific industry such as petroleum refining, or in a special application like environmental monitoring. If you have a need for a multiparameter test kit, COMPLETE AND RETURN THE REPLY CARD on the reverse side of this page, or contact Marketing at **1-800-356-3072.**

New Catalog Simplifies FAX Orders

Your 1991/2 CHEMetrics product catalog is on its way to you! The new edition now contains a convenient FAX ORDER FORM. Simply photocopy the page, list products and quantities, and fax! The catalog also features a new index format for faster, easier product references. If you need additional copies, please COMPLETE AND RETURN THE REPLY CARD or contact Marketing at **1-800-356-3072.**

EPA Lead Rule Delayed

EPA's long-awaited final rule on lead in drinking water, scheduled for release December 14, 1990, has been delayed indefinitely. The level that the EPA is expected to designate for remedial action is expected to be between 15 to 20 parts per billion. CHEMetrics' Lead Test Kit (cat. no. K-6350) enables analysts to detect lead in the 0-50 ppb range at virtually any tap in just 5 minutes.

CHEMetrics' Spectrophotometer Goes Digital

The versatile System 1000™ spectrophotometer now provides a digital display, making result determination even easier for the analyst. The digital instrument (cat. no. A-1051), which can read more than 20 analytes using CHEMetrics' Vacu-vials® ampoules, replaces the analog version (cat. no. A-1050), but is available at the same price ($395.00).

The new digital instrument can be purchased as part of a complete photometric outfit called the Digital System 1000™, or as an individual unit. In addition to the instrument, the Digital System 1000 product contains 30 Vacu-vials ampoules, a filter, a calibration chart, complete instructions, and all accessories needed for fast and dependable analysis with parts-per-million sensitivity.

Digital System 1000

Analyte	Range	Cat. No.	Price
Ammonia	0-7 ppm	T-1503	$495.00
Chlorine	0-3ppm	T-2503	$495.00
Chromate	0-4 ppm	T-2803	$495.00
Copper	0-6 ppm	T-3503	$495.00
Cyanide	0-0.4 ppm	T-3803	$495.00
Formaldehyde	0-7 ppm	T-4203	$495.00
Glycol	0-40 ppm	T-4403	$495.00
Hydrazine	0-0.7 ppm	T-5003	$495.00
Hydrogen peroxide	0-1.5 ppm	T-5503	$495.00
Hydrogen peroxide	0-4 ppm	T-5543	$495.00
Iron (tot. sol.)	0-5 ppm	T-6003	$495.00
Iron (tot.)	0-2.5 ppm	T-6023	$495.00
Nitrate	0-2 ppm	T-6903	$495.00
Nitrite	0-0.7 ppm	T-7003	$495.00
Oxygen (dissolved)	0-2 ppm	T-7503	$495.00
Oxygen (dissolved)	0-450 ppb	T-7553	$495.00
Ozone	0-2 ppm	T-7403	$495.00
Phenol	0-9 ppm	T-8003	$495.00
Phosphate	0-4 ppm	T-8513	$495.00
Phosphate	0-40 ppm	T-8503	$495.00
Silica	0-10 ppm	T-9003	$495.00
Sulfide	0-1.6 ppm	T-9503	$495.00
Zinc	0-3 ppm	T-9903	$495.00

Are You Technically Perplexed?

If you have a question about water analysis, chances are that CHEMetrics' Customer Service department can help. With more than 25 years of technical experience, CHEMetrics' Customer Service group can help you with everything from choosing the right kit for your application, to designing a custom kit to your specifications. Customer Service also can help with all of your private labeling needs.

For prompt, courteous, and accurate technical information, contact CHEMetrics Customer Service department at **1-800-356-3072.**

Contact Teresa Neale with your technical inquiries.

Trademark Acknowledgments

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System 1000, Digital System 1000, and CHEMlines are trademarks of CHEMetrics, Inc.

CHEMetrics, Inc.

For more information about CHEMetrics' products in this CHEMlines Update, complete the enclosed ready reply card or contact us by phone at (800) 356-3072; by fax at (703) 788-4856; or write to us at Route 28, Calverton, VA 22016.

Detach, place in envelope, and mail to CHEMetrics

☐ **YES! I would like to receive/continue receiving CHEMlines™ Update**
☐ **I am already on CHEMetrics' mailing list**
☐ Please send **1991/2 Catalog**
☐ Please send information on the **Storm Water Discharges** Test Kit
☐ I am interested in a **multiparameter test kit** from CHEMetrics:

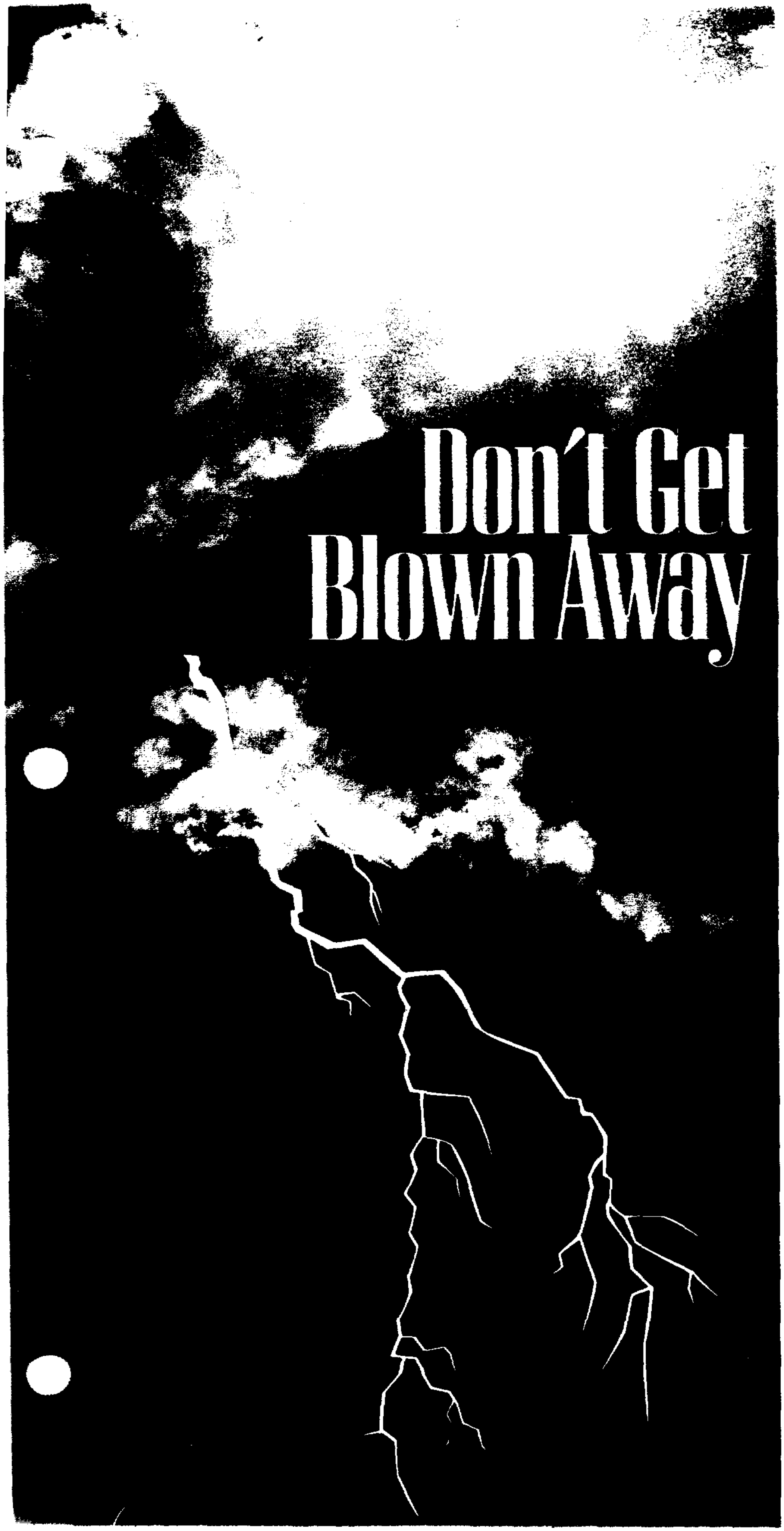
Analyte	Range
______	______
______	______
______	______
______	______
______	______

My application is: (Check all applicable.)
☐ Process Water
☐ Waste Water
☐ Power Generation
☐ Drinking Water
☐ Boiler Water
☐ Cooling Water
☐ Food & Beverage
☐ Petroleum
☐ Other ______

☐ Please send information on the **Digital System 1000:** Analyte(s) ______

Please send information on these innovative products
☐ Dissolved Oxygen (0-100 ppb)
☐ Ammonia
☐ Phenols
☐ Chlorine
☐ Iron
☐ Sulfide
☐ Phosphate
☐ Lead
☐ Ozone
☐ Other ______ Range ______

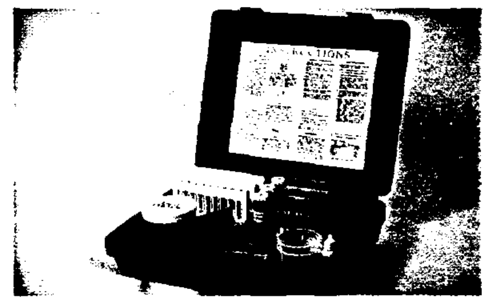
NAME ______ COMPANY ______
ADDRESS ______ PHONE ( ) ______
CITY ______ STATE ______ ZIP ______



By EPA's Storm Water Regulations...

With CHEMetrics' test kits for storm water discharges monitoring, you can have accurate, reliable, *EPA-acceptable* results in 2 minutes or less.

THE SIMPLE, ELEGANT SOLUTION. CHEMetrics' test kits provide the fastest, easiest field method for quantitative storm water discharges analysis—self-filling CHEMets® ampoules. Simply immerse the ampoule in the sample, snap the tip, and compare the resulting color with standards.



Multiparameter Storm Water Discharges Kit *contains 30 tests for each of the 5 EPA-mandated parameters: Total Chlorine, Total Phenol, Total Copper, pH, and Detergents (surfactants). The kit includes everything needed in a compact, portable case. Refills are readily available.*

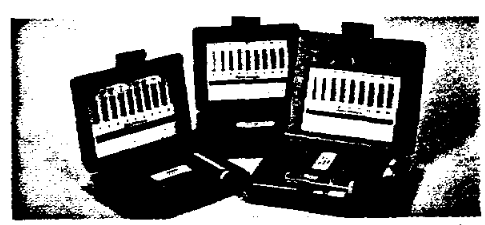
NO CUMBERSOME PREPARATIONS. CHEMetrics' storm water discharges test kits require no sample dilutions or pH buffering, and no disposal procedures. Analysts can complete testing quickly and move on to the next outfall.

FEWER TESTING ERRORS. The simplicity of CHEMets ampoules reduces operator error and helps keep you on schedule. And, faulty results due to contamination or stale reagents are eliminated—because each ampoule remains vacuum-sealed until the test is run.

THE RIGHT SENSITIVITY. With CHEMetrics' products, you can count on dependable results at sensitivity levels needed for EPA compliance.

THE RIGHT PRICE. CHEMetrics' test kits are the true low-cost, high-value solution for storm water discharges analysis.

START TESTING TODAY. Get a head start with CHEMetrics' storm water discharges test kits available now!



Single Parameter Kits *for Total Chlorine, Total Phenol, and Total Copper enable you to run CHEMetrics' tests with other methods. Each kit contains everything needed to run 30 tests. Refills are readily available.*

MULTIPARAMETER STORM WATER DISCHARGES TEST KIT
List Price: $250.00

TEST	CHEMISTRY	RANGE	NOTES
Tot. Chlorine	DDPD	0-1 & 1-5 ppm	30 tests, 2-min. proc.
Tot. Phenol	4-aminoantipyrine	0-1 & 1-12 ppm	30 tests, 2-min. proc.
Tot. Copper	Bathocuproine	0-1 & 1-10 ppm	30 tests, 2-min. proc.
pH	pH pocket pen	± .2 pH units	15-second procedure
Detergents (Surfactants)	3 reagents	0.25-5.0 ppm	30 tests, 5-min. extraction

Other Component Data

Complete Instructions
Turbidity Syringe and 7 filters (.45 microns)
2 Sample Collection Beakers
Refuse Container for used filters and/or up to 90 used ampoules
Case Specifications: 15½ × 13⁵⁄₁₆ × 4¾ inches

SINGLE ANALYTE STORM WATER DISCHARGES TEST KITS

TEST	CHEMISTRY	CAT. NO.	RANGE	LIST PRICE
Tot. Chlorine	DDPD	K-2505	0-1 & 1-5 ppm	$44.50
		R-2505	0-1 & 1-5 ppm	19.00
Tot. Phenol	4-aminoantipyrine	K-8012	0-1 & 1-12 ppm	44.50
		R-8012	0-1 & 1-12 ppm	19.00
Tot. Copper	Bathocuproine	K-3510	0-1 & 1-10 ppm	44.50
		R-3510	0-1 & 1-10 ppm	19.00

BENEFITS

- ▶ Satisfies EPA field-testing criteria
- ▶ Delivers fast, accurate results at specified sensitivity levels
- ▶ Tolerates interferences and turbidity
- ▶ Reduces testing errors with simplified procedures
- ▶ Avoids complicated preparations
- ▶ Saves time and money over competitive methods
- ▶ Long shelf-life

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Call 1-800-356-3072 between 8-4:30 ET
Fax 1-703-788-4856 24 hours a day

CHEMetrics

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Calverton, VA 22016

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TABLE OF CONTENTS

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(Continued)

1.0 INTRODUCTION

1.1 PURPOSE

This Wet Weather Sampling Plan (Task 2.I.B.(2)(c) of the Regional Stormwater Master Plan) has been developed as a guide for the collection and analysis of stormwater samples to characterize land use impacts on the quality of stormwater runoff in the Corpus Christi/Nueces County area. The stormwater monitoring results will be used to determine representative event mean concentrations (EMCs) of pollutants in stormwater runoff. EMCs are used in combination with discharge records or flow estimates to determine total stormwater pollutant discharge loadings to receiving waterways/bodies.

The Master Plan gives special emphasis to the control of stormwater pollution. Stormwater pollution is defined as pollutants and contaminants contained in runoff. Stormwater contains a wide range of pollutants, including nutrients, metals, organics, oils, greases, bacteria and solids. Ultimately, Master Plan recommendations will be made on how best to reduce or minimize the amount of stormwater pollutants entering local drainage conveyances. Recommendations will also consider the protection of local receiving waters such as Corpus Christi and Oso Bays, where pollutants accumulate and pose a greater threat to the local ecology. Recommendations will be based, in part, on the modeling of stormwater runoff quantities and associated stormwater pollution loadings. Stormwater pollution loadings based on potential future land uses, projected population increases and stormwater management alternatives will also be modeled to develop and optimize short-term and long-term pollution control strategies. The data developed as part of the wet weather sampling program will be utilized to refine EMC and runoff values used in stormwater modeling estimates and control strategy development. In the future, water quality monitoring may be required to assess the pollutant removal effectiveness of stormwater pollution control strategies, to ensure water quality objectives are met and to meet regulatory permitting requirements.

Significant factors considered in the design of this sampling plan are as follows:

- Site selection and sampling locations - e.g., watershed size, hydraulic characteristics, land use (mixed urban versus single land use), sampling site locations (equipment siting above floodplain, access, security, AC power).

- Sampling station security - instrument shelters, location in fenced secure area, availability of AC power supply (most run on DC with solar recharge), security of sampling probes and conduits, public safety and vandalism considerations.

- Water quality parameters - e.g., nutrients, toxic metals (total and dissolved), suspended solids, oils and grease, total organic carbon, microbial contamination indicators.

- Flow monitoring strategy - availability of existing gaged basins, monitoring instrumentation, primary flow control device (weirs, flumes) versus open channel rating measurements, rain gauge network, tidal influence.

- Sampling strategy - number of storms for runoff sampling; precipitation duration, volume, intensity; sampling instrumentation, automatic samplers versus manual grab sampling; method, discrete versus flow composite; sampling frequency; sample and preparation for transport to lab, collection chain of custody protocols.

- Laboratory analytical procedures - sample volumes required, preservation techniques and holding times, analytical procedures, laboratory QA/QC.

- Data management and analysis - design of a water quality/quantity database for microcomputer applications.

1.2 FORMAT

This plan is divided into six sections, including the Introduction as Section 1.0. Section 2.0 provides an overview of technical and procedural monitoring considerations for stormwater flow monitoring and sampling. Section 3.0 presents a recommended strategy for wet weather sampling. Section 4.0 describes available monitoring and sampling equipment applicable to this program. Section 5.0 provides a Quality Assurance/Quality Control plan to maintain the accuracy of sampling results. Finally, Section 6.0 lists references used for the development of this document.

2.0 CONSIDERATIONS

2.1 MONITORING SITES

As stated previously, the intent of the proposed wet weather monitoring program is to collect stormwater quality data representative of typical land uses in the Corpus Christi area. Stormwater EMCs for each land use can then be incorporated into analytical procedures and/or computer models to develop watershedwide pollutant loading projections. Major outfalls of the local municipal separate storm sewer system (MS4) were located and mapped per Task 2.I.A of the Master Plan. Various criteria were applied to each of these major outfalls for consideration as a candidate monitoring site.

The contributing drainage area and associated land uses for each major outfall were determined in Task 2.I.C.(1) & (2). Since event mean concentrations must be established for several individual land uses, outfalls which drain areas with relatively homogeneous land uses were selected. Proposed monitoring sites were recommended to characterize stormwater runoff from predominantly agricultural, commercial, industrial and low density and high density (apartments/condos) residential land uses. Other selection criteria included:

1. Dry weather flow <u>not</u> observed and no evidence of illegal dumping to minimize the possibility of influences not directly related to land use, and to ensure that the sample is representative of <u>stormwater</u> pollution.

2. Ability to develop an accurate stage-discharge rating for the conveyance.

3. Watershed size (watershed size of 50 to 200 acres for agricultural, commercial and residential land use; 2 acre minimum for industrial land use sites).

4. No tidal influences or surcharging.

5. Proximity to NPDES permitted discharges, which may influence discharge quality.

6. Site suitability:

   a. Legal access
   b. Public safety and security of equipment
   c. Availability of electrical power
   d. Ability to install equipment

In Task 2.I.C.(4), monitoring sites were recommended for monitoring based on the above criteria. The contributing drainage area for each selected monitoring site exhibits a predominant land use as shown (agricultural, commercial, industrial, or residential).

2.2 ANALYSES

Various pollutants may be found in stormwater runoff. Historically, stormwater runoff from agricultural and residential areas tend to exhibit concentrations of nutrients, pesticides and herbicides. Results also show mean concentrations of heavy metals and organics tend to be higher in commercial and industrial areas.

In consideration of implementing a long-term monitoring program in the Corpus Christi area, the selection of pollutants to be monitored is an important factor in determining the value of the resulting database.

Current EPA standards for wet weather sampling programs require that composite stormwater samples be analyzed for:

- All toxic organic pollutants listed in Table 2-1 (same as Table II of Appendix D of 40 CFR Part 122).

- All toxic pollutants listed in Table 2-2 (same as Table III of Appendix D of 40 CFR Part 122).

- Additional pollutants:

  - Total Suspended Solids (TSS)
  - COD
  - Oil and Grease*
  - Fecal Coliform*
  - Total Nitrogen
  - Total Ammonia plus Organic Nitrogen
  - Total Dissolved Solids
  - BOD5
  - pH*
  - Fecal Streptococcus*
  - Dissolved Phosphorus
  - Total Phosphorus

  * From grab sample

Depending upon available funding and ultimate monitoring goals, the number of parameters requiring analysis may be reduced to reflect only those pollutants expected to be present. The use of indicator species analyses may also be considered to reduce the cost of laboratory analysis (see Section 3.7). A narrative description including date, duration and volume of rainfall, and duration between the storm event sampled and the end of the previous measurable storm event (greater than 0.1 in rainfall) will be included with each sample collected from the representative outfalls. Section 2.4 describes desirable storm event characteristics for monitoring purposes.

TABLE 2-1

Organic Toxic Pollutants
Listed in Table II of Appendix D
of 40 CFR Part 122

VOLATILES	PESTICIDES
Acrolein	Aldrin
Acrylonitrile	Alpha-BHC
Benzene	Beta-BHC
Bromoform	Gamma-BHC
Carbon Tetrachloride	Delta-BHC
Chlorobenzene	Chlordane
Chlorobromomethane	4,4'-DDT
Chloroethane	4,4'-DDE
2-Chloroethylvinyl Ether	4,4'-DDD
Chloroform	Dieldrin
Dichlorobromomethane	Alpha-Endosulfan
1,1-Dichloroethane	Beta-Endosulfan
1,2-Dichloroethane	Endosulfan Sulfate
1,1-Dichloroethylene	Endrin
1,2-Dichloropropane	Endrin Aldehyde
1,3-Dichloropropylene	Heptachlor
Ethylbenzene	Heptachlor Epoxide
Methyl Bromide	PCB-1242
Methyl Chloride	PCB-1254
Methylene Chloride	PCB-1221
1,1,2,2-Tetrachloroethane	PCB-1232
Tetrachloroethylene	PCB-1248
Toluene	PCB-1260
1,2-Trans-Dichloroethylene	PCB-1016
1,1,1-Trichloroethane	Toxaphene
1,1,2-Trichloroethane	
Trichloroethylene	
Vinyl Chloride	

TABLE 2-1

Organic Toxic Pollutants
Listed in Table II of Appendix D
of 40 CFR Part 122
(Continued)

ACID COMPOUNDS
2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,6-Dinitro-O-Cresol
2-Nitrophenol
4-Nitrophenol
P-Chloro-M-Cresol
Pentachlorophenol
Phenol
2,4,6-Trichlorophenol

TABLE 2-1

Organic Toxic Pollutants
Listed in Table II of Appendix D
of 40 CFR Part 122
(Continued)

BASE/NEUTRAL

Acenaphthene
Acenaphthylene
Anthracene
Benzidine
Benzo(a)anthracene
Benzo(a)pyrene
3,4-Benzocluornthene
Benzo(ghi)perylene
Benzo(k)fluoranthene
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl)ether
Bis(2-chloroisopropyl)ether
Bis(2-ethylhexyl)phthalate
4-Bromophenyl phenyl ether
Butylbenzyl phthalate
2-chloronaphthalene
4-chlorophenyl phenyl ether
Chrysene
Dibenzo(a,h)anthracene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3-Dichlorobenzidine
Diethyl phthalate
Dimethyl phthalate
Di-n-butyl phthalate
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octyl phthalate
1,2-Diphenylhydrazine (as azabenzene)
Fluroranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
Napthalene
Nitrobenzene
N-nitrosodimethylamine
N-nitrosodi-n-propylamine
N-nitrosodiphenylamine
Phenanthrene
Pyrene
1,2,4-Trichlorobenzene

TABLE 2-2

Pollutants Listed in Table III
(Toxic Metals, Cyanide, and Total Phenol)
of Appendix D of CFR Part 122

Antimony, total	Mercury, total
Arsenic, total	Nickel, total
Beryllium, total	Phenols, total [1)]
Cadmium, total	Selenium, total
Chromium, total	Silver, total
Copper, total	Thallium, total
Cyanide, total [1)]	Zinc, total
Lead, total	

[1)] EPA requires analyses of grab sample for this pollutant.

2.3 PUBLICLY OWNED INDUSTRIAL SITES

Should wet weather monitoring be considered for certain municipal facilities associated with industrial activity (landfills, treatment facilities, vehicle maintenance facilities), it is recommended that the following wet weather monitoring be performed at each outfall.

1. A sample should be collected during the first 30 minutes of discharge or as soon thereafter as practicable.

2. A flow-weighted composite sample from an average storm event should be obtained:

   - Either automatic or manual sampling can be used.
   - Either the entire hydrograph or the first four hours must be sampled.
   - The storm event must be greater than 0.1 inch and must have occurred at least 72 hours from the previous (greater than 0.1 inch) storm event.
   - The following constituents should be sampled:
     - Any pollutant limited in a process effluent guideline for the facility.
     - Any pollutant listed in the facility NPDES permit for its process wastewater and:

Oil and Grease	TSS
pH	Total Kjeldahl Nitrogen
BOD5	Total Phosphorus
COD	Total Plus Nitrite Nitrogen

     - Any of these pollutants, if they are expected to be present:

13 Toxic Metals	113 Toxic Organic Pollutants
Cyanide	23 Conventional and Non-Conventional Pollutants
Total Phenols	

If two or more outfalls are considered to be similar in that they serve drainage areas with similar characteristics, only one should be monitored.

2.4 SAMPLING FREQUENCY

To acquire "representative" water quality data, it is desirable to collect stormwater samples from discharge produced by an average storm event. Samples should be taken from storm events greater than 0.1 inch and at least 72 hours from the previously measurable (greater than 0.1 inch rainfall) storm event. Total rainfall amount and duration should not have a variance of more than 50 percent from the average or median rainfall event. Information obtained from the USGS rainfall database (1948-1989) was evaluated. The results for average storm event data based on a SYNOP analysis is shown in Table 2-3.

Located along the coastal plain of Texas, the study area experiences annual average rainfall amounts ranging from 26 to 31 inches. Annually, there are two distinctive wet periods. The months of May and June typically provide twenty percent of the annual average rainfall amount. The second wet period, August through October, coincides with hurricane season, when tropical disturbances are likely. Statistically skewed by infrequent severe tropical storms, the total rainfall amount for these three months averages 12 inches. During the course of the year, at least one sample should be taken during each wet period (as described above) and each intervening dry period. Of course, the feasibility of obtaining a representative sample during each of these periods will be dictated by weather conditions.

In order to perform preliminary water quality statistics for EMC derivation, six to eight storm events should be sampled. It is anticipated that water quality data from storm events which meet the above criteria can be collected within one year of program start-up. To develop a statistically significant water quality database, a minimum of 15 to 20 storm events should be sampled.

TABLE 2-3
SYNOP RAINFALL ANALYSIS

STATION: CORPUS CHRISTI WSO AP, TEXAS
PERIOD: 1948-1989

INTER-EVENT TIME:	AVERAGE STORM EVENT STATISTICS (a)									AVERAGE MONTHLY PRECIPITATION	
	8 HOURS			12 HOURS			46 HOURS (b)				
	DUR	VOL	NO.	DUR	VOL	NO.	DUR	VOL	NO.	TOTAL	SNOW
MONTH	(HRS)	(IN)	EVENTS	(HRS)	(IN)	EVENTS	(HRS)	(IN)	EVENTS	(IN)	(IN)
JAN	15.6	0.60	2.5	18.1	0.63	2.5	43.6	0.83	2.2	1.66	0.03
FEB	14.5	0.70	2.5	16.9	0.71	2.5	46.7	0.84	2.0	1.87	0.04
MAR	8.6	0.52	1.6	10.7	0.55	1.5	24.8	0.72	1.5	0.94	0.00
APR	8.3	0.82	2.2	10.2	0.80	2.2	25.8	0.91	1.7	1.90	0.00
MAY	6.2	0.75	3.9	8.6	0.83	3.6	27.3	1.12	2.7	3.00	0.00
JUN	8.0	0.86	3.5	10.9	0.94	3.1	44.4	1.53	2.1	3.03	0.00
JUL	6.8	0.77	2.5	9.0	0.83	2.4	37.3	1.16	1.7	2.10	0.00
AUG	7.3	0.96	3.3	8.8	1.00	3.2	34.2	1.33	2.0	3.25	0.00
SEP	8.7	1.01	5.3	11.8	1.10	4.8	44.6	1.75	3.2	5.50	0.00
OCT	8.9	0.85	3.6	11.3	0.93	3.5	39.7	1.48	2.4	3.31	0.00
NOV	11.8	0.66	2.3	14.0	0.69	2.2	30.0	0.76	2.0	1.53	0.00
DEC	12.4	0.54	2.3	16.2	0.58	2.1	44.2	0.68	1.7	1.35	0.00
ALL EVENTS	9.4	0.79	35.5	12.0	0.84	33.6	37.4	1.14	25.2	29.44	0.07

(a) Minimum SYNOP event volume = 0.10 inches
(b) "Optimum" inter-event time computed by SYNOP

3.0 MONITORING AND SAMPLING STRATEGY

3.1 SAMPLING METHODS

Sampling methods for stormwater analyses vary based on the intended use of the data. There are three basic sampling methods as follows:

1. Manual Grab Sampling - Field personnel are present during storm events to manually collect samples.

2. Sequential Sampling - Uses an automatic sampler which deposits discrete samples into **separate** containers during the course of a storm event.

3. Composite Sampling - Uses an automatic sampler which combines all samples into a **single** large container.

When storm events occur, especially in small urban basins with short times of concentrations (e.g., the time for stormwater to travel from the hydraulically most distant point in the basin to the outfall point), the peak loadings of pollutants in stormwater may occur before personnel are able to arrive at a site and begin manual sampling. For this reason, it is desirable to use automatic flow monitoring and water quality sampling instruments. Manual sampling has the advantages of lower capital costs, simplicity and flexibility. However, these advantages are outweighed by the potential for failure to obtain data when storm events occur and the likelihood that crews will mobilize for events which do not meet the "representative" storm event criteria as described in Section 2.4. Past experience with stormwater pollution monitoring has shown that a sampling program incorporating automatic monitoring equipment is most effective.

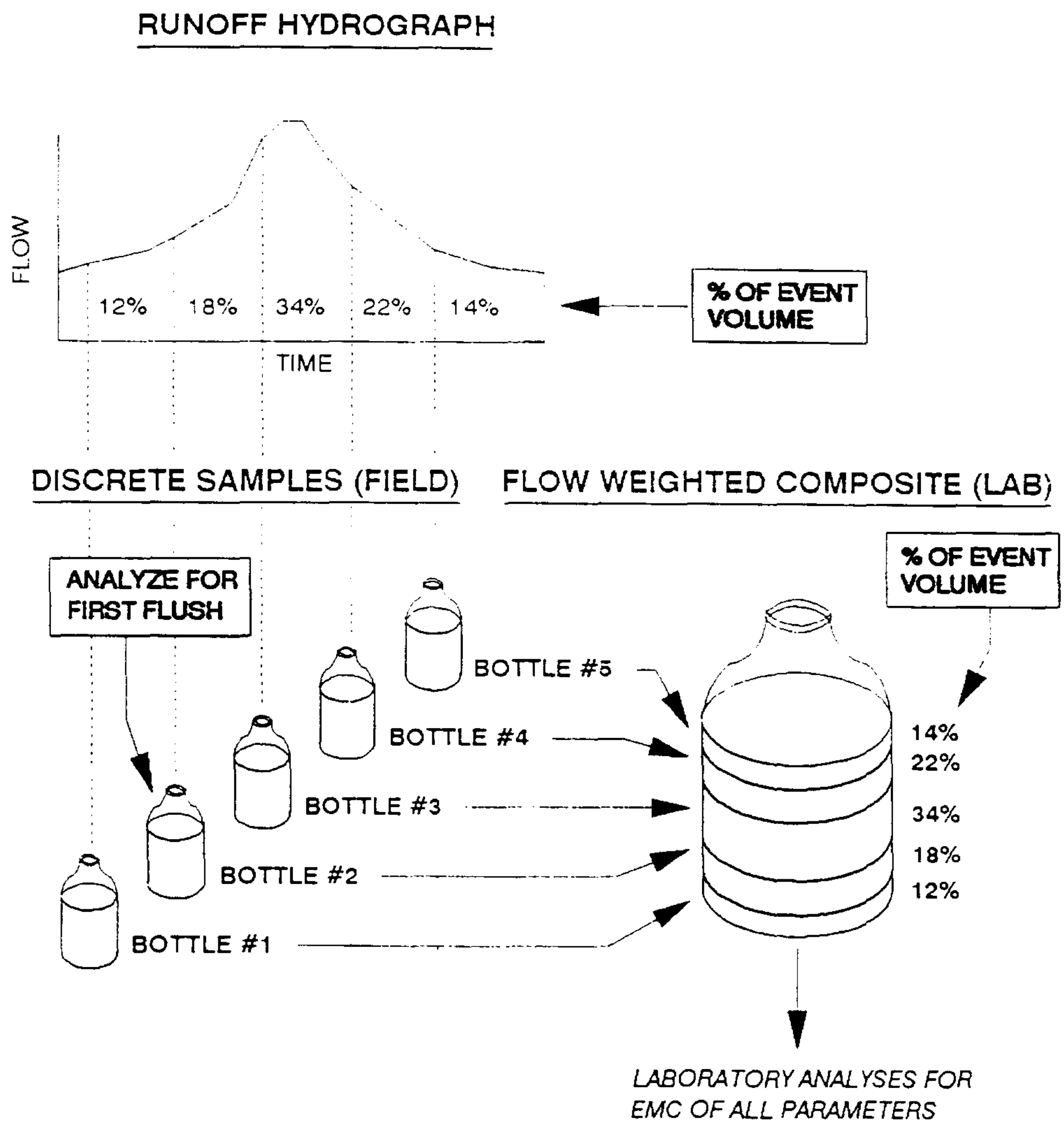
Automatic samplers can typically be configured to collect either sequential discrete or composite samples. Sequential sampling refers to the use of an automatic sampler which deposits discrete stormwater samples into separate containers during a storm event. Samplers can be programmed to sample after a predetermined time increment or, if interfaced with a flowmeter, after a selected flow increment (e.g., after every 5,000 gallons of runoff). A discrete grab sample will be used for analysis of pH, cyanide, total phenols, oil and grease, fecal coliform, and fecal streptococcus, as referenced in Section 2.2.

To develop event mean concentration data from discrete samples, a flow weighted (composite) sample must be obtained. To produce a single flow composite sample from several samples taken during a storm event, the storm event hydrograph (derived from automatic flow meter records) must be analyzed. If the sampler is operated on a time-incremental basis, the flow hydrograph can be analyzed to determine the proportion of total storm event flow each sample bottle represents. A flow composite sample can be produced by proportionally combining individual samples. If the sampler is operated in a flow-proportional mode, each sample will represent an equivalent flow volume and selected samples can be composited using equal volumes from each sample bottle to produce a flow-proportional storm event composite sample.

Figure 3-1 shows the basic procedures for determining event mean pollutant concentrations from field monitoring samples and data. The procedure shown is based on the compositing of time-incremental samples to obtain a flow-weighted sample. The resulting laboratory analyses would provide EMCs of each parameter tested.

A major problem with flow composite sampling using a single sample container (e.g., carboy) is that it is very difficult to determine beforehand what constitutes the beginning and end of a storm event. If the sampler continues to sample unattended after a storm event, the resulting composite sample may be diluted with non-storm event flows and analysis data will not provide representative storm event EMCs.

A hybrid of the sequential and composite sampling modes is recommended whereby sequential discrete samples are collected in the field, which may then be manually composited in the laboratory. This sampling mode would require that the sampler be interfaced with a flowmeter. The flowmeter would be configured to place an event



MONITORING PROCEDURES FOR DETERMINING EVENT MEAN POLLUTANT CONCENTRATIONS

CDM
environmental engineers, scientists, planners, & management consultants

FIGURE 3-1

mark on the flow strip chart each time a sample is collected. After a storm event, the flow strip chart can be analyzed to select those samples that best represent the storm hydrograph. Selected samples would be manually composited after the storm to produce a single flow-composite sample.

Automatic samplers are recommended which use peristaltic pumps (e.g., high lift, accurate volume delivery, no contamination of sample, and high sample line velocity 3-5 fps). These samplers can be configured to collect flow proportional discrete samples into separate sample bottles. The flow increment for sample collection would depend on actual site conditions at each station. Initially, time increment sequential sampling (i.e. collect samples at 15-minute intervals) may be necessary if flow rates are not known. Sample collection sequencing is then refined based on the results obtained during actual storm events.

The automatic sampler may be initiated by a liquid level actuator. This device switches on the sampler only after a preselected rise in stream stage. Once sampling is initiated, the sampler will collect flow incremental samples during the entire runoff hydrograph and terminate only when stream stage drops below the actuator. This will ensure that the "first flush" is sampled, as well as the recession limb of the hydrograph.

The sampler is typically configured with a carousel of 24 one-liter sample bottles. The sampler is interfaced with a flowmeter and programmed to collect an aliquot (typically 250 ml) of sample after a specified flow volume (for example, 5,000 cubic feet of flow). This sampling mode could specify that up to four aliquots be composited in the same sample bottle to increase the sample coverage of a storm event.

3.2 POLLUTOGRAPH VS. EMC

The sampling methods must produce water quality data representative of actual runoff conditions. The required level of detail should also be considered. For example, if water quality models will only predict total storm event pollutant loads to a receiving water, then it is probably not necessary to collect and analyze individual samples over a storm event hydrograph (i.e. develop a pollutograph) because the storm event mean concentration (EMC) (e.g., total storm load divided by the total runoff volume) during the storm will be sufficient data to develop an estimate of pollutant loadings. If first flush effects or peak pollutant concentration were of interest, then it would be necessary to collect a series of discrete samples so that a pollutograph (e.g., instantaneous pollutant concentration versus time) may be developed.

Monitoring to Develop Pollutograph Data:

- Requires a large number of samples collected during runoff hydrograph, typically used to acquire research data for theoretical transport models with little practical applicability.

- High laboratory costs per storm event because 10 to 20 samples must be analyzed to characterize each storm event.

- State-of-the-art nonpoint source water quality models can adequately predict total storm loads not instantaneous pollutant concentrations.

Monitoring to Develop Event Mean Concentration Data:

- Requires laboratory analysis for only one flow proportional composite sample per storm event to estimate total storm event pollutant loading.

- Does not allow "first flush" phenomenon or peak concentration to be characterized. However, this data is of limited use if the receiving water is larger and dilution occurs.

- Requires automatic sampling equipment with interface to flowmeter.

- Laboratory cost savings may permit sampling of a greater number of storm events.

3.3 FLOW MONITORING

Flow monitoring is essential because storm loads cannot be estimated without accurate flow measurements. Therefore, storm event sampling should only be considered at stations where flow monitoring will be performed.

There are several types of flow meters available, including ultrasonic, submerged probe and bubbler flow meters. Due to its suitability for use with weirs, flumes, pipes and channels, a bubbler type flow meter to continuously monitor runoff flow is recommended. Flow rates are recorded on a built-in strip chart recorder. The flow meter can be programmed to produce signals proportional to flow rate so that automatic samplers collect flow proportional composite samples. The flow meter puts an event mark on the flow chart record each time a sample is collected:

The event mark serves two purposes:

1) The mark will check the operation of the sampler and samples collected. For example, if 10 event marks are noted, then 10 samples should have been collected. Any deviation may require elimination of the storm event.

2) The marks can be used to verify that flow proportional sampling is occurring by integrating the total flow volumes between marks. Or, if time incremental sampling is employed, the event marks can be used to determine flow volume for each sample so that flow proportional composite samples can be generated.

3.4 SAMPLE COLLECTION PROTOCOL

Automatic samplers can typically be configured to collect samples on uniform or non-uniform time intervals, or if the sampler is interfaced with a flowmeter, sample collection can be based upon flow interval (e.g., a sample is collected after every 5,000 gallons of flow). It will be very difficult to obtain information about the expected flow regimes at each of the monitoring stations prior to the start of the monitoring program. Therefore, it is recommended that, initially, discrete samples be collected on a uniform time basis and that these samples be manually composited in the laboratory based on observed/recorded flow information.

A sampling program of this type must step through an initial "startup" period until site specific characteristics (e.g., ranges of flows and depths encountered during storm events, flow velocities, susceptibility to vandalism) can be established in the field. Experience with this type of monitoring program has shown that it is unlikely that good data will be collected during the "startup" periods (one to three months). The startup period will be minimized by evaluating typical Corpus Christi rainfall data to characterize "typical" storm events in terms of both duration and volume (see Section 2.4). This evaluation will be used to set initial sampling intervals and facilitate capture of representative storm samples.

3.5 RAINFALL MONITORING

Installing a rain gage at each sampling site is required to allow correlation between rainfall and runoff measurements. One consideration for the Corpus Christi area is the localized rainfall patterns which generally cannot be extrapolated to other sites within the City. Stand alone rain gages are available from many vendors, including weighing, tipping bucket, and electronic type gages. Alternatively, flow meter manufacturers provide rain gages that directly interface with the flow meter, recording rain and flow on a common strip chart or digital recorder. These integrated rain gages are recommended because they are more cost-effective and there is less likelihood that rain and flow measurements would diverge over time.

3.6 APPROACH USING AUTOMATED EQUIPMENT

A flow meter is required at each monitoring station to activate the automatic sampler. Initially, based on representative storm data, the sampler is activated at the onset of a precipitation event and will continue sampling in discrete sampling aliquots at 15-minute time intervals sufficient to provide pollutograph characterization for the total duration of the discharge or for three hours, whichever comes first. Shorter time intervals between sampling aliquots may be used in subsequent sampling events if sampling is not successful at the longer time intervals. It is likely that several samples will probably be discarded since storm events often do not sample all storms described in Section 2.4. A pre-calibrated rain gage will be used to assist in the identification of representative storms. A tipping bucket rain gage which will measure and record rainfall volumes in 0.01-inch volumes will be interfaced with the flow meter at each monitoring station installation.

Each station must be secure from the elements and from vandalism. Therefore, a fiberglass or metal shed will be required to house the equipment. Permanent concrete pads will be constructed at each site to anchor the housing. Fencing and sheds to hold the equipment set-up should be configured to be mobile if a station must be relocated.

In summary, a typical monitoring station of the type described in the preceding paragraphs would consist of the following major components:

* FLOWMETER
    - Basic Unit
    - Internal Modem
    - Liquid Level Activator
    - Lead Acid Battery or AC Power Converter
    - Printer Paper and Ribbons
    - Integrated Tipping Bucket Rain Gage with Connector
    - Sampler-Flowmeter-Actuator

* SAMPLER
    - Basic Unit (w/24 1L Bottles)
    - Lead Acid Battery or AC Power Converter
    - 0.25" ID Suction Line (25')
    - Extra Base (w/24 1L Bottles)

* HOUSING/INSTALLATION
    - Fiberglass Housing (4'x4'x4')
    - Concrete Pad
    - 6-Foot High Chainlink Fence

To reduce the cost of this program, we suggest that only five complete stations be purchased, and that they be moved from site to site, if necessary, as data is collected. As these stations generally cost about $12,000 per unit, a capital outlay of no more than $60,000 is expected.

3.7 LABORATORY ANALYSIS

A field crew of two people will be mobilized soon after each storm event to retrieve the discrete samples and to ensure that the minimum sample holding times are maintained. Section 2.2 listed potential parameters to be monitored. Appropriate laboratory analytical procedures (40 CFR Part 136) will be followed in analyzing each parameter. Appendix A provides a preliminary summary of analytical parameters, corresponding EPA method number, container volume, preservatives, and analytical holding times.

A major limitation of the automated sampling equipment available for the wet weather monitoring program is the inability to collect optimal volumes of samples that will be necessary if all required EPA parameters are to be analyzed. Due to the inherent difficulty in obtaining representative samples for organic analysis using automated equipment, CDM recommends a screening method to determine their general presence before mobilizing a field crew during the next representative storm event to manually collect the total sample volume required to analyze for individual organic constituents. The recommended method is to screen for toxic organics with Total Organic Halogens (TOX) and Total Petroleum Hydrocarbons (TPH) analyses.

Although total organic carbon (TOC) analysis is used to commonly screen for organics, TOX is a better screening method since no naturally occurring organic hydrocarbons are monitored by this analysis. Positive TOC values could result from the presence of naturally occurring organics such as humic or fulvic acid. Positive results for TOX would indicate that further investigation of the specific organic analyses is warranted. If monitoring to meet federal NPDES permitting requirements, manual or automatic grab samples may be required to facilitate the analysis of volatile organic compounds.

The total estimated cost for the laboratory analysis of the parameters listed in Section 2.2 is expected to be $1,500 to $1,800 per sample, resulting in a total of $45,000 to $54,000 for 30 samples (six storm events at five stations) based on June 1991 prices at commercial laboratory facilities. During the startup period and screening period for organics, it is likely that approximately 10 additional samples could be selected for analysis of selected constituents. The extra cost will be approximately $500 per sample for an additional total of $5,000. In short, the total estimated laboratory cost for monitoring six storm events will be in the range of $50,000 to $59,000, depending to a large extent on results from the initial sampling efforts.

3.8 DATA MANAGEMENT

The descriptive and analytical data collected during the wet weather sampling program will be compiled in a computer database. Efficient data compilation will depend largely on good record-keeping practices during the conduct of the field programs and also on the reporting mechanisms of the laboratory used. As part of an ongoing, long-term monitoring program, an appropriate data management system is recommended to ensure that the data can be represented in various forms, such as graphical displays of spatial and temporal trends. Additionally, a data management system will allow appropriate statistical analysis to be conducted as additional data becomes available.

Two types of data that will become available during the wet weather sampling program will be descriptive and analytical. Descriptive data will include field observations made during the field screening and sampling activities. The analytical data will include field screening chemical analysis results, laboratory results, and flow measurements made during the sampling programs.

Descriptive data is recommended to be kept in database and hard copy records format since their utility for any analysis using computerized techniques is limited. As long as common identifiers are retained for all samples relating analytical data to descriptive data, any future relational information could be extracted from the database or hard copy field activities records. Analytical data are strongly recommended to be entered into a data management system that would allow statistical interpretations and analysis.

Statistical analysis will be required to adequately represent the various forms of analytical data that will become available in the long term. Both spatial and temporal analysis will be required to develop appropriate Best Management Practices (BMPs) during the permit compliance period that take into account any particular trends. The analytical database will facilitate the calculation of EMCs for specific land use. Numerous statistical analysis methods and computer packages are available, depending on what is needed and currently available to the analyst. Available methods include trend analysis, hypothesis testing, probability analysis, simple statistics (mean, median, and variance), and seasonal analysis (e.g., Box and Whisker plots).

4.0 MONITORING AND SAMPLING EQUIPMENT

4.1 GENERAL

This section presents an overview of the available types of field testing equipment and automated monitoring and sampling equipment. Descriptions are provided of representative equipment models which have been applied and found to be appropriate to meet the requirements of wet weather monitoring programs. Appendix B contains manufacturers' information covering the automatic monitoring and sampling equipment discussed in this section. Appendix C contains an additional listing of manufacturers of automated sampling equipment found in the 1990 Public Works Manual. Specific equipment models will be selected after approval of the protocol and in-depth discussions are conducted with vendors. Equipment availability and future support should be investigated before purchase. Local resources, including rain gages and sampling equipment, will also be considered and used to the extent possible.

4.2 AUTOMATED FLOW MONITORING EQUIPMENT

Four manufacturers of automatic flow monitoring and sampling equipment are listed below that could be used at the wet weather monitoring sites. In addition, a brief equipment operations description is included.

Stevens Company - Manufactures flow meters and water level recorders. This hardware produces a strip chart output from a float input or submersible depth transmitter input. With float input, the float turns a pulley which moves the position of the pen on the strip chart drum. Limitations include range of flow that can be measured. Samplers can be actuated through a cam-operated switch that triggers sampling on a specified volume interval. (Power and space requirements not provided).

Montedoro-Whitney - Provides flow and velocity meters and water level recorders. Measuremetn is accompanied by a pressure transducer mounted in the flow stream to indicate depth and a probe that indicates velocity by "ultrasonic doppler velocity technology". The system is designed primarily for gravity pipes and may not be appropriate for open channels. It has a battery power supply and a logger size of 9.75" diameter and 12" height. It has optional interfaces to a rain gage and/or sampler (sampler triggered on intervals of flow). Future availability and support of this equipment should be investigated prior to purchase.

ISCO - Series 3200 w/Ultrasonic sensor (submerged probe or bubbler input) is a two-piece system containing a 10.75" x 11.5" x 18" unit and a remote probe. The system measures water level and records level, flow rate, total flow on a strip chart (optional), and digital formats. Three types of probes are available: an ultrasonic sensor, which is mounted above the flow stream and measures level by timing an ultrasonic pulse reflected from the water surface; a submerged probe, which is mounted at the bottom of the stream and measures level by a pressure transducer; and a bubbler, which is mounted in the stream and measures level by sensing the differential pressure head required to discharge air into the water at the bottom of the flow section. Power can be provided by batteries or an AC converter, and external inputs/outputs can be provided to a rain gage and/or samplers (plotter will mark each sampling event).

4.3 AUTOMATED SAMPLING EQUIPMENT

American Sigma- Streamline 700/702 and **ISCO** 3700 Series is available for automated sampling. Each system operates essentially the same. A peristaltic pump that operates by compressing and decompressing the inlet tube pumps water into the sampler. Both samplers can take individual or composite samples. For both, individual samples can be collected in either 24 350 ml glass bottles, or 24 1-liter plastic bottles (Sigma-Polyethylene, ISCO-Polypropylene). The ISCO sampler collects composite samples in either a 2-1/2 gallon glass or polyethylene container or, with an optional base, a 4-gallon polyethylene container. The Sigma sampler collects composite samples in either a 2-1/2 gallon glass or 3-gallon polyethylene container. Both samplers can collect samples on either a time or flow basis. Both can vary sample volumes in 1 ml increments (ranges: Sigma - 50 to 999 ml; ISCO - 10 to 990 ml). The Sigma sampler requires either 120 V, 60 Hz; 220 V, 50 Hz; or 12 VDC power. The ISCO sampler requires 50 VDC, which can be supplied by battery or AC power converters.

Dimensions: Sigma 19.75" Diameter, 21.62" Height, 34.5-39 lbs
ISCO 19.875" Diameter, 25.25" Height, 37 lbs

Samplers can be configured to automatically rinse the suction lines with the source liquid before each sample is collected. Up to three rinse cycles can be specified. In addition, the sampler can be programmed to perform an air purge of sample lines before and after each sample is collected.

Samplers typically will not have any recording capability, however, state-of-the-art samplers will have programmable controllers which allow the sampler to be programmed to follow a specified sampling routine. Samplers can typically be configured as sequential or composite. Sequential samplers typically have a carousel of 24 or more individual sample bottles which are filled based upon a predetermined programming sequence. Composite samplers have a single large sample container (e.g., 2.5 to 4 gallon carboy). Both sequential and composite samplers can be programmed to collect samples on either a time or flow incremental basis.

Other samplers are available from various manufacturers. The 1990 Public Works Manual contains a listing of the addresses and telephone numbers of 14 manufacturers as presented in Appendix C.

5.0 QA/QC PROCEDURES

5.1 GENERAL

In order to ensure the accuracy of the data collected as part of the wet weather sampling program, Quality Assurance/Quality Control (QA/QC) procedures will be followed. As referenced in Sections 3.0 and 4.0, automatic flow monitoring and water quality sampling instruments will be utilized for the Corpus Christi wet weather monitoring program. Resulting samples will be transported for laboratory analysis. Associated field and laboratory protocols are discussed herein.

The personnel responsible for setting up and maintaining the automatic sampling systems will have access to copies of operating instructions, as well as hands-on training by qualified personnel in the field prior to the initiation of the sampling program. Training will include details on how to install, program and load and unload the samplers.

Periodically, grab samples may also be collected and on-site measurements taken for physical/chemical parameters such as pH, dissolved oxygen, temperature and conductivity. All of these parameters can be measured with portable meters. Standard Operating Procedures (SOPs) are attached.

Standard laboratory QA/QC procedures detailing the analysis of internal QA/QC samples and chain-of-custody protocols will be followed.

5.2 FIELD PROCEDURES

The field team will document all of their activities, observations and measurements in either field logbooks or on pre-printed data collection forms. An example of a possible format for the data collection form is shown in Figure 5-1.

FIGURE 5-1

WET WEATHER MONITORING DATA COLLECTION FORM

Task 2.I.B.(2)(c)

MONITORING SITE ID.______________________ DATE: ______________

RAINFALL EVENT	DATE: ______________			START TIME ________ PM AM	
	DEPTH (INCHES): ______________				
	DURATION (HOURS): ______________				
	FLOW RECORDED: YES NO				
PREVIOUS RAINFALL EVENT	DATE: ______________			START TIME ________ PM AM	
	DEPTH (INCHES): ______________				
	DURATION (HOURS): ______________				
	FLOW RECORDED: YES NO				
GRAB SAMPLE(S)	NUMBER TAKEN: ______				
	GRAB NUMBER 1	2	3	4	5
	DATE ______	______	______	______	______
	TIME ______	______	______	______	______
	ID. ______	______	______	______	______
AUTOMATIC SAMPLE(S)	COMPOSITE OR DISCRETE			(______ NO. OF DISCRETE SAMPLES)	
	COLLECTION DATE: ______ TIME: ______				
LABORATORY ANALYSIS	YES NO (ATTACH CHAIN OF CUSTODY FORM)				
QUALITY CONTROL	TRAVEL BLANK? YES NO				
	FIELD BLANK? YES NO				
	FIELD REPLICATE? YES NO				

COMMENTS: ____

____

____

____

DATA COLLECTED BY: ______________ DATABASE INPUT BY: ______________

As referenced in Section 3.8, all sampling data collected under the storm event sampling program will ultimately be compiled in a database management system. The database will include general information about each outfall, such as:

- Outfall location (description, latitude and longitude)
- Outfall type (pipe, channel)
- Drainage area
- Receiving water
- Land use (% impervious, residential, commercial, industrial activity)
- Upstream BMPs (type, coverage, removal efficiencies)
- Precipitation (total, duration, antecedent dry period)
- Runoff hydrograph (volume, peak flow)
- Event mean concentrations (EMCs) for each pollutant

Also included in the database will be the results of all field measurements and laboratory analytical results when analyses are completed.

Quality Assurance/Quality Control (QA/QC) samples will be generated in the field. The laboratory will not be able to differentiate the field QA/QC samples from the original samples and, therefore, the QA/QC samples will be handled as if they were original samples by the laboratory. All samples will be transported from the field to the laboratory in ice chests.

The following QA/QC samples will be submitted for analysis:

- Travel blanks
- Field blanks
- Field replicates
- Blind standards

As recommended by EPA, travel blanks will be employed to determine potential sample contamination occurring during: 1) shipment and storage of the samples; and 2) during laboratory handling and analysis of the samples. Travel blanks are created at the laboratory by filling a sampling bottle with reagent-grade deionized water. The blank is then transported to the sampling site and returned to the laboratory for analysis. Travel blanks for each sample container type will be included and will be prepared and analyzed at a minimum frequency of one per 20 stormwater samples collected.

Field blanks will be employed to determine potential sample contamination occurring during: 1) field collection; 2) handling; 3) shipment; 4) storage; and 5) laboratory handling and analysis of stormwater samples. The field blanks are created by filling sampling containers with reagent-grade distilled water in the field and handling them with procedures identical to those used for the original samples. Field blanks for each container type will be prepared and analyzed at a minimum frequency of one per 20 stormwater samples collected annually.

Field replicates will be used to assess natural sample variability, or variability attributable to field collection, sample handling, shipment and storage methods, and for laboratory handling and analysis. Field replicates are created by filling grab sample containers at the same location at the same time. Replicate samples will not be collected from the automatic samplers. Replicate samples for each container type will be prepared and analyzed at a minimum frequency of one per 20 stormwater samples collected annually.

Blind standards will be used to assess the laboratory's ability to accurately prepare and analyze the samples for the parameters of concern. Blind standards are created either by spiking a sample container of reagent grade deionized water with known amounts of the target analytes or by purchasing prepared solutions of the target analytes and transferring them to the appropriate sample containers. Blind standards will be submitted to the laboratory as original water samples at a target frequency of one per 20 stormwater samples collected annually. The actual frequency will be dependent on the availability of the standard materials.

5.3 LABORATORY PROCEDURES

The suite of parameters to be analyzed by the laboratory for a given stormwater sample will be determined according to 40 CFR Part 136. Appendix A lists all of the potential parameters for analysis, as well as the appropriate analytical methodology, the method detection limit, the required container type and preservative, any special sample handling requirements and the analytical holding time. The laboratory will be required to follow the requested analytical methodology (40 CFR Part 136 or other any suitable method if no analytical method is approved) for each parameter in order to produce reliable results.

The laboratory will also analyze internal QA/QC samples, as appropriate to the methodology employed. The laboratory QA/QC samples may include:

- Initial and continuing calibration standards
- Performance check standards
- Method blanks
- Surrogate spikes
- Matrix spikes
- Duplicates

The initial calibration standards are analyzed at the start of the project and establish the instrument's working linear range. Continuing calibration standards are generally analyzed on a daily basis and demonstrate that the instrument's response has not drifted out of control. The limits for the initial and continuing calibrations are either specified in the methods or will be specified in the analytical request submitted to the laboratory.

Performance check standards are prepared by the laboratory separately from the calibration standards. They are analyzed as a sample by the laboratory and are used to assess accuracy of the analytical procedures.

Method blanks are generally in the lab at the time of sample preparation. Method blanks are analytical controls consisting of all reagents, internal standards and surrogate standards, that are carried through the entire analytical procedure. Method blanks are used to define the level of laboratory background contamination.

Surrogate spike compounds are added to every blank, sample, matrix spike, matrix spike duplicate, and standard, and are used to evaluate analytical efficiency by measuring recovery.

A matrix spike is an aliquot of a stormwater sample fortified (spiked) with known quantities of specific compounds and subjected to the entire analytical procedure in order to indicate the appropriateness of the method for the matrix by measuring recovery.

A duplicate sample is a second aliquot of an existing sample that is also analyzed in order to determine the precision of the method.

5.4 CHAIN OF CUSTODY

The ability to trace the possession and handling of samples from the time of collection, through analysis and reporting of results and final disposition is necessary to ensure the integrity of the sample results. This is achieved through sample documentation procedures referred to as "chain-of-custody".

To establish the documentation necessary to trace sample possession from the time of collection, a chain-of-custody record shall be completed and accompany every sample. A typical chain-of-custody record is shown in Appendix D. The record shall contain the following minimum information:

- Sample number (linked to the sampling location);
- Signature of collector;
- Date and time of collection;
- Sample tag number;
- Signatures of people involved in the chain of possession; and
- Inclusive dates and times of possession.

A sample is considered to be under a person's custody if it is: 1) in a person's physical possession; 2) in view of the person after he has taken possession; or 3) secured by that person so that no one can tamper with the sample. A person who has samples under custody must comply with the chain-of-custody procedures.

In order to maintain chain-of-custody, each person in custody of the sample shall sign the form at the time of accepting and relinquishing custody of the samples. The samples shall not be left unattended unless placed in a secured and sealed container (custody seals) with the chain-of-custody record inside the container.

In addition, the sampling team will document all field activities in field logbooks. Custody of samples prior to shipment to the laboratory should be traceable through both the chain-of-custody record and the field logbooks.

6.0 REFERENCES

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APPENDIX A

PRELIMINARY SUMMARY OF ANALYTICAL PARAMETERS, CORRESPONDING EPA METHOD NUMBER, CONTAINER VOLUME, PRESERVATIVES, AND ANALYTICAL HOLDING TIMES

TABLE 1

METALS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling[1]	Analytical Holding Time
Arsenic	EPA 206.2	1	500 ml Plastic Bottle	HNO_3	6 months
Cadmium	EPA 213.2	0.1	500 ml Plastic Bottle	HNO_3	6 months
Chromium	EPA 200.7	7	500 ml Plastic Bottle	HNO_3	6 months
Copper	EPA 220.2	1	500 ml Plastic Bottle	HNO_3	6 months
Lead	EPA 239.2	1	500 ml Plastic Bottle	HNO_3	6 months
Selenium	EPA 270.2	2	500 ml Plastic Bottle	HNO_3	6 months
Zinc	EPA 200.7	2	500 ml Plastic Bottle	HNO_3	6 months
Mercury	EPA 245.1	0.2	500 ml Plastic Bottle	HNO_3	28 days
Nickel	EPA 249.2	1	500 ml Plastic Bottle	HNO_3	6 months
Silver	EPA 272.2	0.2	500 ml Plastic Bottle	HNO_3	6 months

[1] Filter to analyze for dissolved metals.

TABLE 2

WATER QUALITY PARAMETERS

Parameter	Method	Detection Limit (mg/L)	Container Type	Preservative/ Handling	Analytical Holding Time
TDS	EPA 160.1	10	500 ml Plastic Bottle	4°C/filter	7 days
TSS	EPA 160.2	4	500 ml Plastic Bottle	4°C	7 days
NO_2 - N	EPA 300.0	0.01	500 ml Plastic Bottle	4°C/filter	28 days
NO_2 + NO_3 - N	EPA 353.1	0.01	500 ml Plastic Bottle	4°C, H_2SO_4/filter	14 days
NH_3 - N	EPA 350.2	0.05	500 ml Plastic Bottle	4°C, H_2SO_4/filter	28 days
TKN	EPA 351.2	0.1	500 ml Plastic Bottle	4°C, H_2SO_4	28 days
BOD	EPA SM 507		2L Plastic Bottle	4°C	48 hours
COD	EPA 410.4	3	125 ml Plastic Bottle	4°C, H_2SO_4	28 days

TABLE 3

MISCELLANEOUS ANALYSES

Parameter	Method	Detection Limit (mg/L)	Container Type	Preservative/ Handling	Analytical Holding Time
Phosphorous (Total)	EPA 365.1	0.01	50 ml Plastic/Glass	40°C, H_2SO_4	28 days
Phosphorous (Dissolved)	EPA 365.1	0.01	50 ml Plastic/Glass	4°C, H_2SO_4/filter	28 days
Oil and Grease	EPA 413.1	5	2 x 1000 ml Glass	4°C, HCI	28 days
TPH	CA DHS		100 ml Glass	4°C	14 days
Fecal Coliforms	"Standard Method"		250 ml Sterile Plastic	4°C, $Na_2S_2O_3$	6-8 hours
TOX	SW-846 9020	5 ug/L	250 ml Glass	4°C, H_2SO_4	40 days
Chlorinated volatiles	SW-846 8010	[a]	2 x 40 ml Glass	4°C	7 days

[a] The detection limit is compound dependent, but is approximately on the order of 0.1 ppb (ug/L).

TABLE 4

ORGANIC PRIORITY POLLUTANTS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
Semivolatiles	EPA 625		3 x 1000 mL Glass	4°C, $Na_2S_2O_3$	40 days
Acenaphthene		10			
Acenaphthylene		10			
Anthracene		10			
Benzidine		10			
Benzo(a)anthracene		10			
Benzo(b)fluoranthene		10			
Benzo(k)fluoranthene		10			
Benzo(ghi)perylene		10			
Benzo(a)pyrene		10			
Bis(2-chloroethoxy)methane		10			
Bis(2-chloroethyl)ether		10			
Bis(2-chloroisopropyl)ether		10			
Bis(2-ethylhexyl)phthalate		10			
4-Bromophenyl phenyl ether		10			
Butyl benzyl phthalate		10			
p-Chloro-m-cresol		10			
2-Chloronaphthalene		10			
2-Chlorophenol		10			
4-Chlorophenyl phenyl ether		10			
Chrysene		10			
Di-n-butyl phthalate		10			
Dibenz(a,h)anthracene		10			

TABLE 4

ORGANIC PRIORITY POLLUTANTS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
Semivolatiles (Continued)	EPA 625		3 x 1000 mL Glass	4°C, $Na_2S_2O_3$	40 days
O-Dichlorobenzene		10			
m-Dichlorobenzene		10			
p-Dichlorobenzene		10			
3,3'-Dichlorobenzidine		20			
2,4-Dichlorophenol		10			
Diethylphthalate		10			
2,4-Dimethylphenol		10			
Dimethyl phthalate		10			
1,2-Diphenylhydrazine					
4,5-Dinitro-o-cresol		50			
2,4-Dinitrophenol		50			
2,4-Dinitrotoluene		10			
2,6-Dinitrotoluene		10			
Di-n-octylphthalate		10			
Fluoranthene		10			
Fluorene		10			
Hexachlorobenzene		10			
Hexachlorocyclopentadiene		10			
Hexachloroethane		10			
Hexachlorobutadiene		10			
Idndeno(1,2,3-cd)pyrene		10			
Isophorone		10			

TABLE 4

ORGANIC PRIORITY POLLUTANTS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
<u>Semivolatiles</u> (cont.)	EPA 625		3 x 1000 mL Glass	4°C, $Na_2S_2O_3$	40 days
Naphthalene		10			
Nitrobenzene		10			
o-Nitrophenol		10			
p-Nitrophenol		10			
n-Nitrosodimethylamine		10			
n-Nitrosodiphenylamine		10			
n-Nitroso-di-n-propylamine		10			
Penta chlorophenol		50			
Phenanthrene		10			
Phenol		10			
Pyrene		10			
1,2,4-Trichlorobenzene		10			
<u>Pesticides/PCBs</u>	EPA 608		2 x 1000 mL Glass	4°C	40 days
PCB-1242		0.5			
PCB-1254		1.0			
PCB-1221		0.5			
PCB-1232		0.5			
PCB-1248		0.5			
PCB-1260		1.0			
PCB-1016		0.5			

TABLE 4

ORGANIC PRIORITY POLLUTANTS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
Pesticides/PCBs (Continued)	EPA 608		2 x 1000 mL Glass	4°C	40 days
Toxaphene		1.0			
Aldrin		0.05			
Alpha-BHC		0.05			
Beta-BHC		0.05			
Gamma-BHC		0.05			
Delta-BHC		0.05			
Chlordane		0.5			
4,4'-DDT		0.10			
4,4'-DDE		0.10			
4,4'-DDD		0.10			
Dieldrin		0.10			
Endosulfan		0.05			
Endosulfan II		0.10			
Endosulfan Sulfate		0.10			
Endrin		0.10			
Endrin Aldehyde		0.10			
Heptachlor		0.05			
Heptachlor Epoxide		0.05			

TABLE 4

ORGANIC PRIORITY POLLUTANTS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
Volatiles	EPA 624		2 x 40 mL Glass	4°C	7 days
Acrolein		5			
Benzene		5			
Bromodichloromethane		5			
Bromoform		5			
Carbon tetrachloride		5			
Chlorodibromomethane		5			
2-chloroethylvinyl ether		5			
Chlorobenzene		5			
Chloroethane		10			
Chloroform		5			
Chloromethane		10			
1,1-Dichloroethane		5			
1,2-Dichloroethane		5			
1,1-Dichloroethene		5			
Trans-1,2-Dichloroethene		5			
1,2-Dichloropropane		5			
Cis-1,3-Dichloropropene		5			
Trans-1,3-Dichloropropene		5			
Ethylbenzene		5			
Methylene Chloride		5			
1,1,2,2-Tetrachloroethane		5			
Tetrachloroethene		5			

TABLE 4

ORGANIC PRIORITY POLLUTANTS

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
Volatiles (Continued)	EPA 624		2 x 40 mL Glass	4°C	7 days
Toluene		5			
1,1,1-Trichloroethane		5			
1,1,2-Trichloroethane		5			
Trichloroethene		5			
Trichlorofluoromethane		5			
Vinyl Chloride		10			

TABLE 5
PRIORITY POLLUTANT
HERBICIDES

Parameter	Method	Detection Limit (ug/L)	Container Type	Preservative/ Handling	Analytical Holding Time
2,4-D	EPA 8150	1.2	1 L amber glass bottle; TFE-lined cap	4°C	40 days
2,4-DB	EPA 8150	0.91	1 L amber glass bottle; TFE-lined cap	4°C	40 days
2,4,5-T	EPA 8150	0.20	1 L amber glass bottle; TFE-lined cap	4°C	40 days
2,4,5-TP	EPA 8150	0.17	1 L amber glass bottle; TFE-lined cap	4°C	40 days
Dalapon	EPA 8150	5.8	1 L amber glass bottle; TFE-lined cap	4°C	40 days
Dicamba	EPA 8150	0.27	1 L amber glass bottle; TFE-lined cap	4°C	40 days
Dichloroprop	EPA 8150	0.65	1 L amber glass bottle; TFE-lined cap	4°C	40 days
Dinoseb	EPA 8150	0.07	1 L amber glass bottle; TFE-lined cap	4°C	40 days
MCPA	EPA 8150	249	1 L amber glass bottle; TFE-lined cap	4°C	40 days
MCPP	EPA 8150	192	1 L amber glass bottle; TFE-lined cap	4°C	40 days

APPENDIX B

MANUFACTURER'S INFORMATION COVERING AUTOMATED MONITORING AND SAMPLING EQUIPMENT

STEVENS Model 61 Total Flow Meter

Lightweight, portable for easy installation, servicing, and relocation

Interchangeable flow cams and gears for greater accuracy and easy in-field changes

Seven-digit totalizer for continuous volume indication

Choice of AC synchronous motor drive or Quartz Multispeed Timer

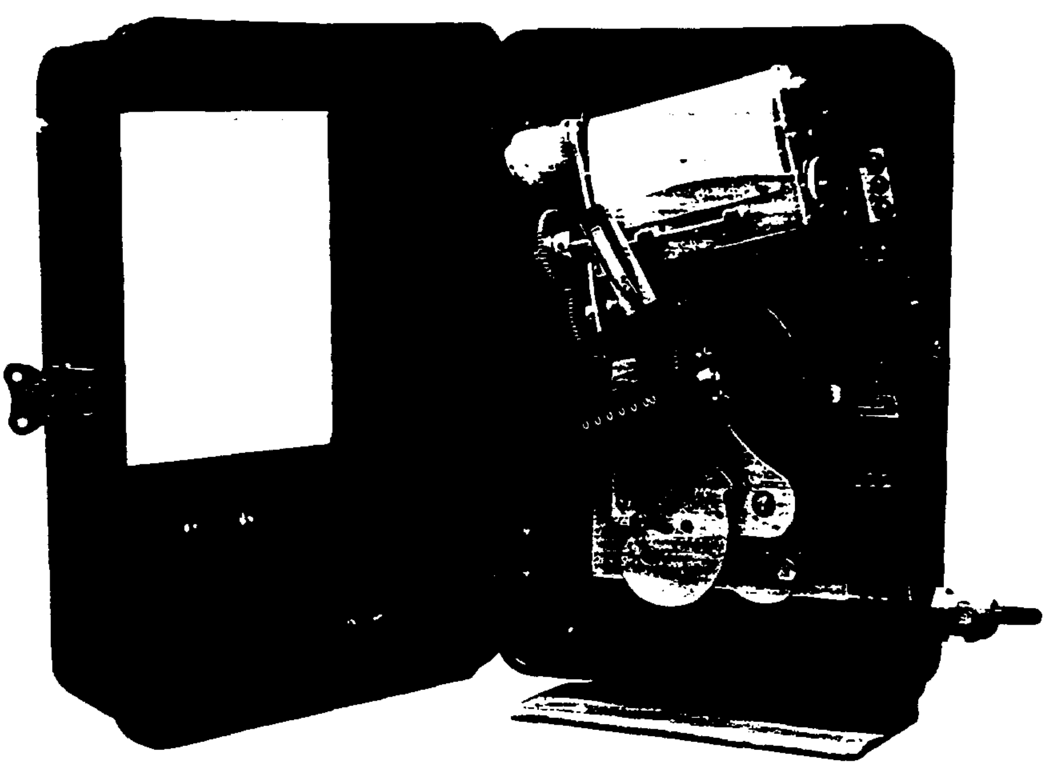
The Stevens Model 61 Total Flow Meter (TFM) is designed for on-site measuring of open channel flows. Instruments can be furnished to record and totalize in either English or metric units, and can be used with virtually any type and size of weir or flume. A full-scale measuring range may run from as low as 14,000 gallons per day (GPD) through a 22-1/2° V-notch weir to as much as several hundred million gallons per day (MGD) through large sizes of Parshall and other types of flumes.

The volume of liquid flowing through a primary measuring device is a function of the height of the surface above a reference point. The TFM uses a float to detect this height and converts it into a reading of instantaneous flow.

Stevens' Reputation for Quality
The Model 61 Total Flow Meter represents Stevens' continuing effort to provide a high-quality product which meets customer needs at a cost-effective price.

Convenience
The TFM converts water level measurement to flow data for continuous indication (61M) or graphic record (61R), and uses a mechanical totalizer for continually indicated volume. The unit is housed in a compact case for portability, and comes equipped with a bracket for shelf or table mounting. The seven-digit totalizer and chart drives are powered by AC synchronous motors or, if preferred, by a battery-driven Quartz Multispeed Timer.

Flexibility
A major feature of these instruments is the ability to convert them for other flow ranges by an easy in-field change of flow cam and flow gears. For infiltration studies and similar applications the operator may use the meter on a V-notch weir in the morning, a Parshall flume in the afternoon, and something else later in the week. These portable meters are compact, lightweight, and simple to install, service, maintain, or relocate.



STEVENS Model 88 Remote Total Flow Meter

Easy to understand, install, and operate

Reliable, accurate for remote total flow monitoring

Easy to convert for any weir or flume

Float- or pressure-operated input devices

The STEVENS Model 88 Remote Total Flow Meter (RTFM) is designed to allow for the recording instrument to be located remotely from the gaging site, which provides for more convenient monitoring of RTFM data. The RTFM should be used in environmentally controlled areas such as a control room or office, and receives transmitted data from the Stevens Position Analog Transmitter (PAT) or Stevens Submersible Depth Transmitter (SDT).

Stevens' Reputation for Quality

The Model 88 Remote Total Flow represents Stevens' continuing efforts to provide a high quality product which meets customer needs at a cost-effective price.

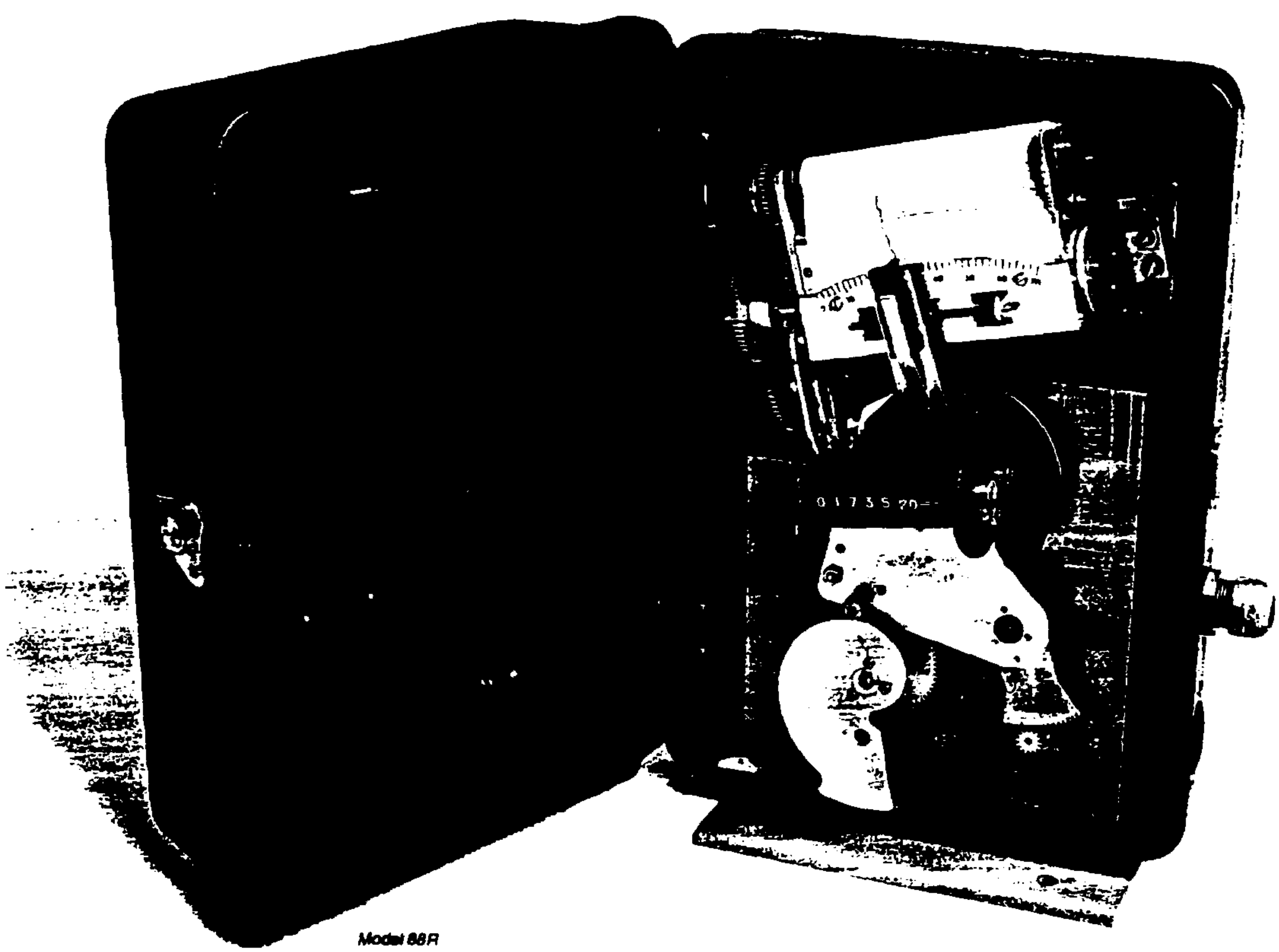
Convenience

The RTFM converts water level measurement to flow data for continuous indication (88M) or graphic record (88R), and uses a mechanical totalizer to continually indicate volume. The unit is housed in a compact case which can be mounted either on a shelf or wall, or is available for panel mounting. It is easy to install, service, maintain, or relocate.

Flexibility

Interchangeable parts are available for simple field conversion to increase or decrease the instrument's flow range, change over to another weir or flume, or change chart speed (four speeds available).

The RTFM is designed for remote measuring of open channel flows when connected to a float-operated PAT or pressure-operated SDT. The unit operates on 24 VAC, 60 Hz. This is provided by a UL approved



Model 88R

STEVENS Type F Water Level Recorder

Compact, portable, self-contained power

Use for ground water studies, irrigation, sewerage, stream gaging, water supply

Choice of Quartz Multispeed Timer, AC synchronous motor drive, or weight drive

Easy field conversion to vary recording ratio

English or metric models

The Stevens Type F Water Level Recorder was introduced in the 1930's. It quickly became a favorite with hydrologists and technicians who appreciated its accuracy, compact size, easy portability, and low cost. Through the years many improvements have been made to the Type F Recorder, and its worldwide acceptance has grown. Today, the Type F is the most versatile — and popular — of all Stevens instruments, and is an inexpensive, accurate recorder for general-purpose use.

Stevens' Reputation for Quality

The Type F Water Level Recorder represents Stevens' continuing effort to provide a high-quality product which meets customer needs at a cost-effective price.

Flexibility

The Type F recorder is a labor and time-saving instrument for permanently recording the varying levels of any liquid surface. Flow data may also be obtained by using it with weirs, flumes, or where water depths are an index of flow. Additional non-typical uses include special magnified recording ratios for ground subsidence and earth movement studies.

Convenience

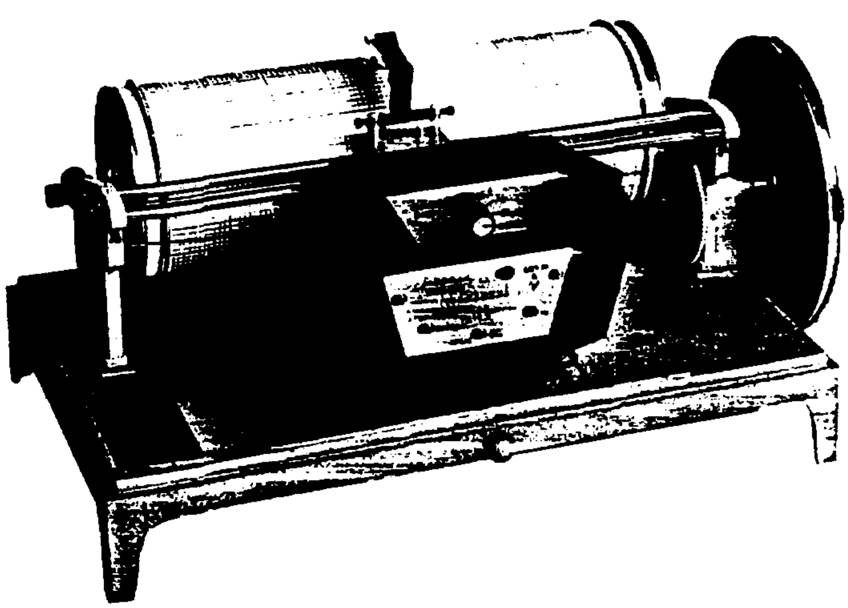
The movement of the float on fluctuating water surfaces causes the chart drum to be turned proportionally as the timer-controlled pen moves across the chart at a constant speed. The resulting graph shows the water level against a record of time. The range in stage is limited only by the length of the float line and float size since the chart drum may make any number of revolutions.

The ball-bearing mounted chart drum responds to 0.01 foot (3 mm) change at 1:1 scale, using a 5 inch (127 mm) float. The instrument is actually sensitive to 0.002 foot (0.6 mm) and can record to such a degree of accuracy if a large enough float is used.

The cast metal base has four legs for support. A sheet metal cover, with convenient carrying handle, can easily be removed for servicing.

Choice of Clock Drives

The Type F Recorder offers a choice of three clock drives: Quartz Multispeed Timer (QMT), AC synchronous drive, and a weight drive. The drives are geared to the pen carriage and move the pen across the chart once in a period of hours, days, or a month, depending on the clock and time scale selected. Clock drives can be easily changed in the field.



STEVENS Type A-71 Recorder

Provides unlimited range in stage

Easy field change of chart speed and recording ratio

Up to 6 months of unattended operation

On-site chart recording with telemetry options

The STEVENS Type A-71 Recorder was first introduced in 1911, and has been improved and perfected over the years. Today it is still the worldwide standard in quality and reliability for river hydrography and other installations where long-term operation is required.

The A-71 is a float-operated recorder that provides a permanent, long-term graphic record of water-level fluctuations. A clock movement controls the rate at which a strip chart is advanced. The rise and fall of the float moves a marking stylus laterally across the chart. The stylus will reverse at each margin so that any range of water level can be accommodated.

Stevens' Reputation for Quality

The A-71 Recorder represents Stevens' continuing efforts to provide a high-quality product which meets customer needs at a cost-effective price.

Convenience

The A-71 Recorder uses a strip chart and pen marker to provide a permanent on-site record of water-level fluctuations. Both metric and English models are available. The A-71 Recorder stands on a three-legged cast metal base, and has an ABS plastic cover with a full-face gasket and a clear viewing port. Double-jointed hinges permit maximum cover movement for servicing in cramped quarters. Key-shaped hasps ensure secure closing and easy release of the cover even with gloves on.

Telemetry and Data Logging Options

The Type A-71 Recorder may be used with the Stevens Type A/F Logger, a micro-processor-based, low-power data logger. The Type A/F Logger offers a convenient, cost-effective way of getting water-level data in a computer-compatible format, and it does so without disrupting the chart recording function. See Bulletin 76.

Type A-71 Recorder with QMT

Montedoro-Whitney

- Depth and Mean Velocity Datalogging
- Rain Gage Input and Sampler Triggering

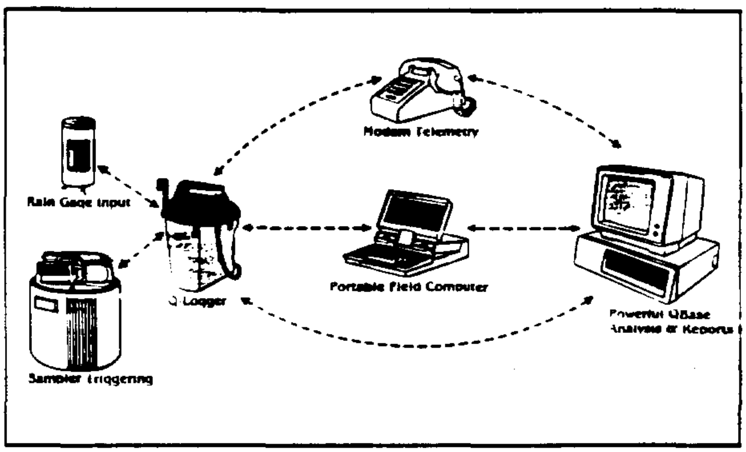
SystemQ – Complete Flow Monitoring and Control

SystemQ Applications:

- Infiltration and Inflow studies
- Sewer System Evaluation Surveys
- Combined Sewer Overflow monitoring
- Industrial Surveillance programs
- User discharge billing
- System capacity planning and control
- Remote telemetry data collection

SystemQ Features:

- SonicStar reads Mean Velocity directly from the flow
- 64 Kbyte solid-state memory with battery back-up
- Powerful QBase™ software for IBM-compatible computers
- All electronics sealed in waterproof compartment
- Battery power with standard lantern-type batteries
- Optional rain gage input
- Optional flow proportional sampler triggering output

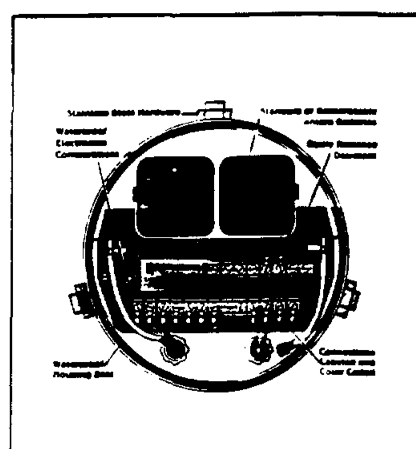


SystemQ – the complete, state-of-the-art system to portable flow monitoring. The Q-Logger™ uses the reliable and accurate SonicStar probe to directly read bi-directional mean velocity and depth to calculate flow, and requires little or no maintenance, even in flows containing grease or contaminants. Flow data may be correlated to rainfall with the optional rain gage input. The Q-Logger also offers flow proportional triggering of wastewater samplers with the optional sampler trigger output.

SystemQ – Powerful QBase software collects and processes data on field or office computers. QBase offers many easy to use functions. Remote data telemetry and automatic polling is optionally available with the SystemQ telemetry module. Flow monitoring has never been so economical, accurate, and easy.

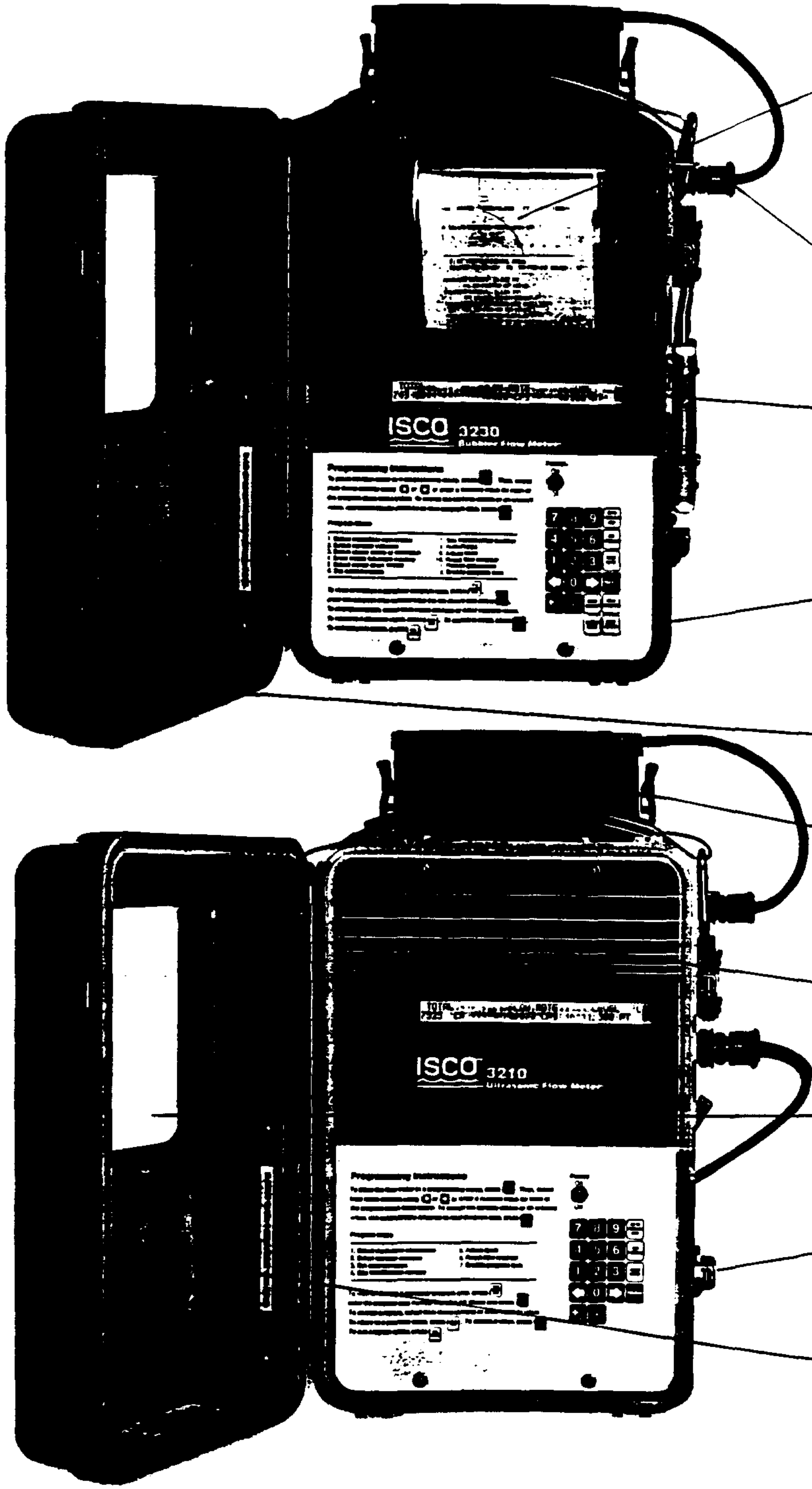
Q-Logger – Rugged, Reliable Performance

Q-Logger has been designed for reliable operation in harsh field conditions present in sanitary sewers. Field serviceable, solid-state electronics are isolated in a separate waterproof compartment inside Q-Loggers polypropylene housing. No calibration adjustments are required, which allows interchangeable circuit boards. Q-Logger uses standard lantern-type alkaline batteries which are easily replaced without exposing the electronics. 64 Kbytes of solid-state memory will hold 55 days of flow data at typical 5 minute recording intervals. Data integrity is assured by a memory back-up battery. The Q-Logger even gives a charge status indication of both the back-up and primary batteries!



- 64 Kbyte, battery-protected memory
- Slate or Wrap-around data storage
- Rugged, waterproof enclosure
- Desiccant protects depth sensor from damage


ISCO



Easy to follow flow charts, detailed flow summary reports, print-outs of programming parameters, and sampler event marks are printed by the built-in plotter.

Electrical connections are kept clean and dry by sealed cable connectors.

Level, flow rate and total flow information are displayed on the alpha-numeric LCD. It also visually prompts you through programming.

The rugged case is corrosion resistant, dust-tight and water-tight to meet NEMA 4x requirements.

Humidity and corrosive gasses are sealed out by a fully gasketed door.

Flexible AC or DC power source options are available for portable or permanent monitoring applications.

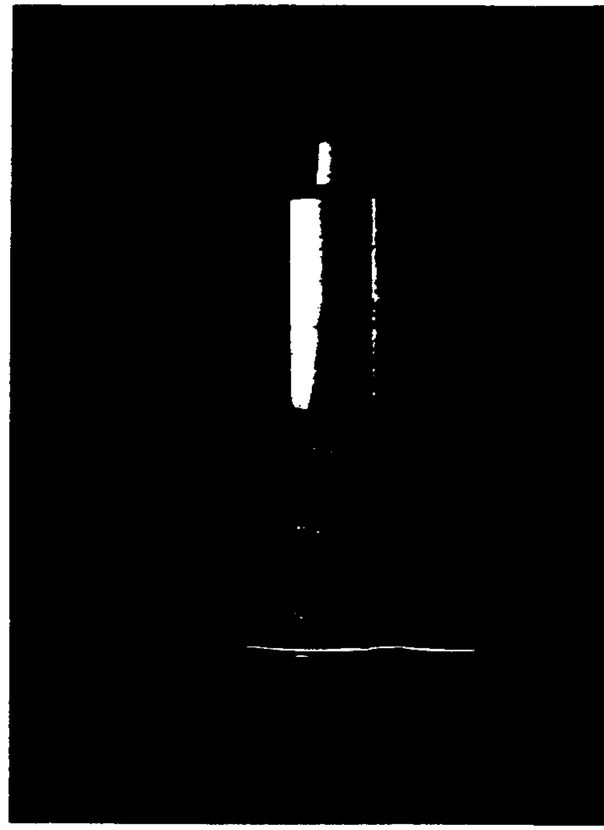
For applications where a built-in plotter is not required, a plotterless version is available.

Readouts can be viewed through a large window eliminating the need to open the door.

To assure dependable operation, corrosion resistant hardware is used throughout.

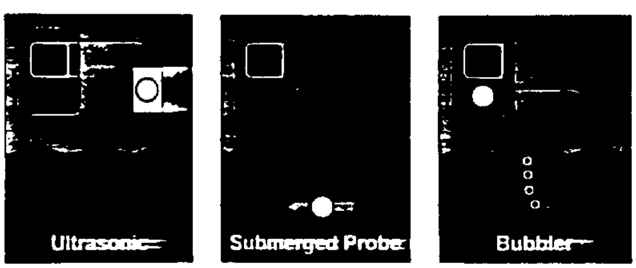
Internal components are kept dry by a rechargeable desiccant canister.

Select the level measurement technology best suited to your monitoring site and conditions.



Site Conditions

Open channel flow measurement site conditions vary widely. The flow stream may contain corrosive elements. The liquid surface may be choppy or foamy. Air or liquid temperature can fluctuate. All of these conditions can adversely affect measurement accuracy. It is important to select a level measurement method that minimizes the effect of site conditions.



○ Transducer Location

The Isco 3200 Series offers you three different level measurement technologies. The 3210 Ultrasonic, 3220 Submerged Probe, and 3230 Bubbler Flow Meters allow you to choose the method best suited for your specific site conditions.

Installation

Isco offers a complete line of mounting hardware for mounting sensors in streams, manhole inverts, round pipes and flumes. To speed installation, some flumes are available with built-in ultrasonic mounting brackets, molded recesses to accommodate submerged probe sensors, or integral bubbler tubes.

Our technical support staff and sales representatives will be glad to work with you to provide the best solution for your monitoring application. If you need help with your application give us a call, toll free 800 228-4373.

3210 Ultrasonic Sensor

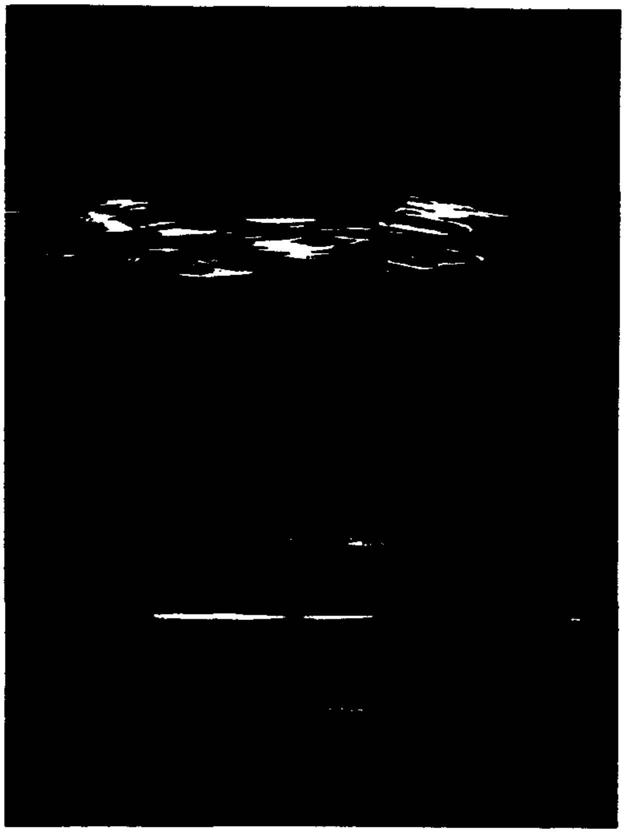
The Isco 3210 Ultrasonic Sensor transmits a sound pulse which is reflected from the surface of the flow stream. The elapsed time between sending the pulse and receiving an echo determines the level in the flow stream.

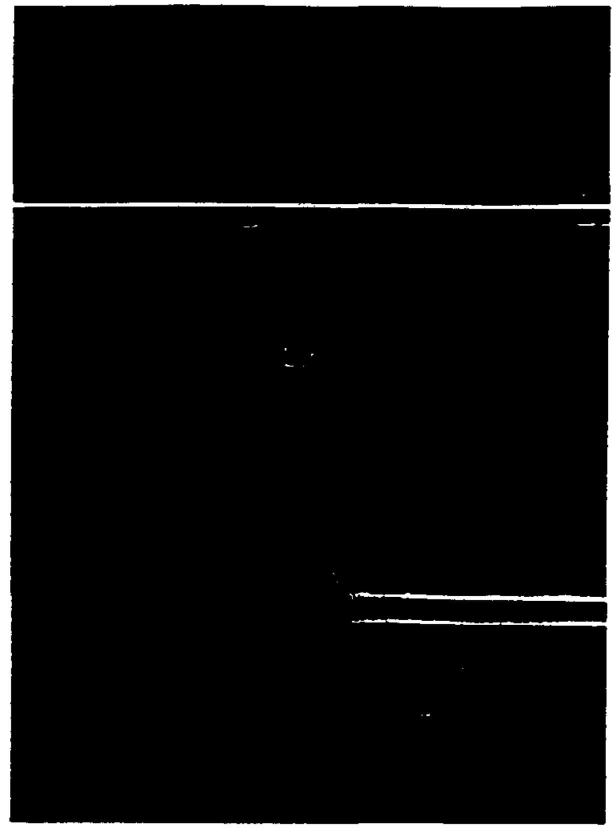
The advantage of ultrasonic measurement is that the sensor does not contact the liquid being measured. The 3210 uses a single-head sensor design, sealed in a corrosion resistant, acetal plastic housing. The ultrasonic sensor requires no scheduled maintenance.

A Teflon® coated, stainless steel temperature probe measures air temperature around the sensor and compensates for changes in air temperature that can affect accuracy. Debris or foam on the water can fool a sensor into giving inaccurate readings. For these conditions, the internal flow meter software uses false echo detection and multiple level reading averaging. These techniques eliminate signals outside of an acceptable range, helping extend the useful range of applications for ultrasonic measurement.

The ultrasonic sensor can be mounted over the flow stream using an optional mounting bracket. For temporary or portable applications, the sensor can be suspended over the flow stream by its steel reinforced cable. An optional cable stiffening weight is available to aid suspension mounting.

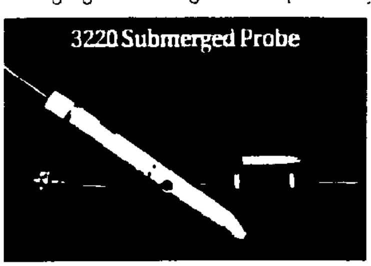
® Du Pont





3220 Submerged Probe

The Isco 3220 Submerged Probe contains a miniature differential pressure transducer that measures hydrostatic pressure above the probe, and converts the pressure reading into an analog signal. The signal is amplified by an in-line electronics package, transmitted to the flow meter, and converted into a level reading.



The probe uses a streamlined, low-profile design to minimize flow stream obstruction. A small diameter plastic tube located within the connect cable allows the pressure transducer to be referenced to atmospheric pressure to ensure measurement accuracy.

The submerged probe is not affected by changes in air temperature or by solids and silt. However, large fluctuations in water temperature can affect accuracy.

The probe can be quickly installed in a flow stream using Isco mounting rings or mounting straps. In addition, several flume manufacturers offer flumes with an integral recess for mounting the Isco Submerged Probe Sensor.

3230 Bubbler

Isco 3230 Bubbler Flow Meters use a compact, internal air compressor to force a metered amount of air through a line submerged in the flow channel. By measuring the pressure needed to force air bubbles out of the line, the level of the water above the reference point can be accurately determined.

Rapidly rising and falling heads and suspended solids can cause problems for some bubbler flow meters, but not the 3230. Isco Super Bubble™ software is a built-in feature that senses rapidly rising heads and increases the bubble rate to compensate. The exclusive Isco automatic bubble line purge prevents the build-up of potentially clogging solids. The purge can be set to occur at selected time intervals, or can be activated manually.

New Isco Automatic Drift Compensation allows the 3230 to compensate for errors caused by transducer drift and changes in temperature that can affect accuracy.

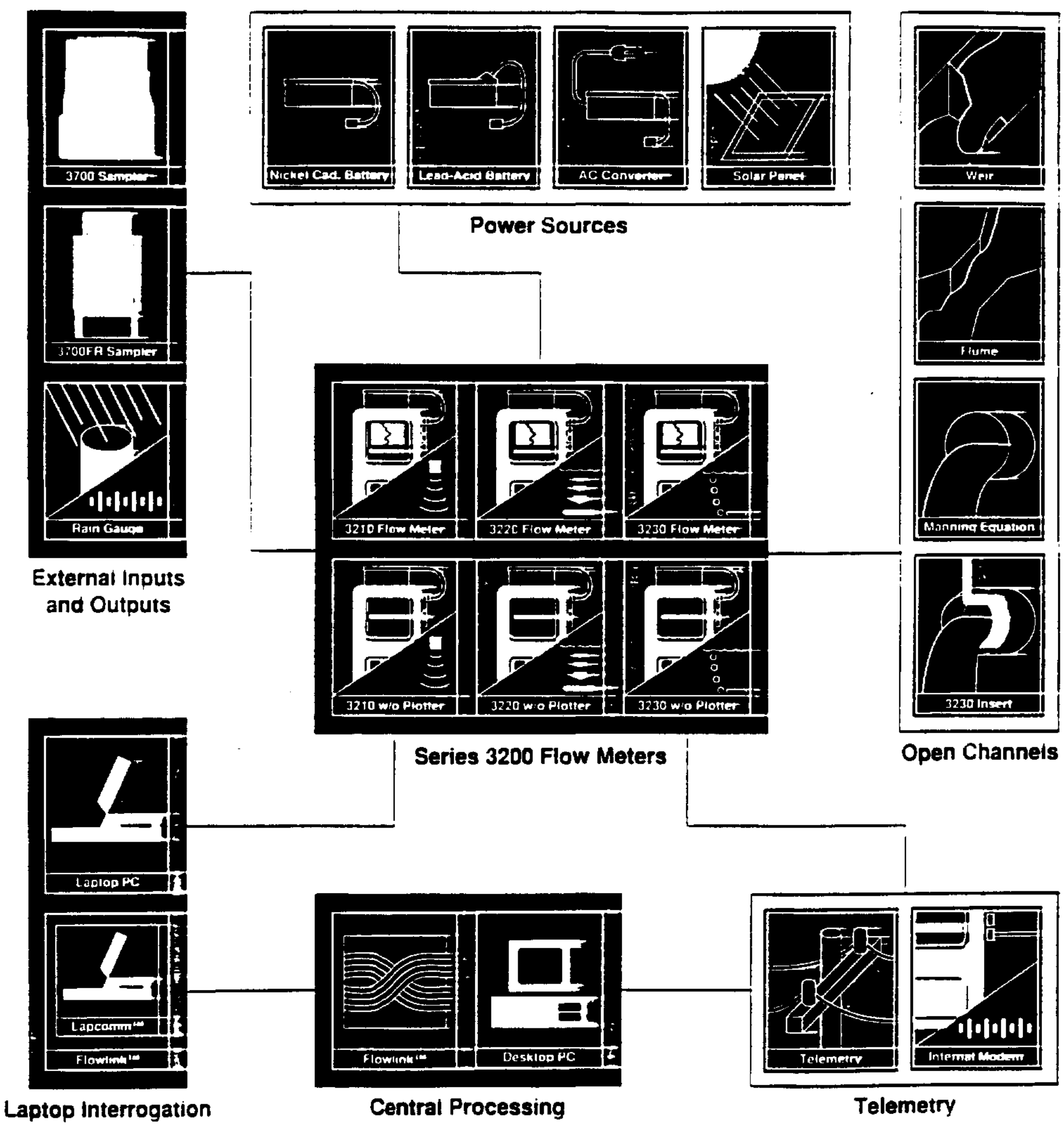
The Teflon or vinyl bubble lines are easily installed in the flow stream. Flumes are available from several manufacturers with integral bubbler tubes. Special metering inserts are also available for the 3230 Bubbler Flow Meters for quick and accurate temporary monitoring in pipes without primary devices.

Isco 3200 Series Open Channel Flow Meters & Flowlink Software Overview.

The modular nature of the 3200 Series Flow Meters and Flowlink Software allows you to configure a system to fit your exact needs.

As your flow monitoring requirements change, additional components can be added to your system with the knowledge that they will all work together.

If you need additional information on the Isco 3200 Series Flow Meters or Flowlink Software, please contact your local Isco representative or phone toll free 800 228-4373.



Chemical compatibility

Continuous Exposure at 140°F (60°C)*

CHEMICAL (Suspension or Solution in water)	MODEL 2870 Bubble Tube	MODEL 2300 & 2400 Submerged Probe	MODEL 2400 Ultrasonic Sensor
Organic Solvents >5%	Compatible	Not Recommended	Compatible
Organic Acids >20%	Compatible	Not Recommended	Compatible
Alcohols	Compatible	Compatible	Compatible
Esters >5%	Compatible	Not Recommended	Compatible
Inorganic Acids >20%	Compatible	Not Recommended	Compatible
Inorganic Bases >25%	Compatible	Not Recommended	Compatible
Inorganic Salts	Compatible	Compatible	Compatible

If questions arise concerning compatibility, samples of materials used in construction are available from Isco for testing.

*The submerged probe has a compensated temperature range of 30° to 100°F (−1° to 38°C)

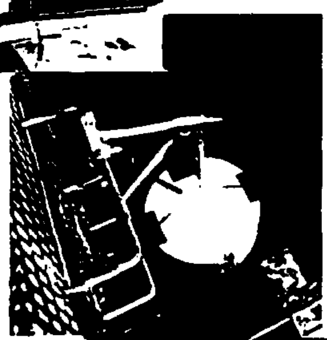
Level sensor selection guide

Application requirements and site conditions	Bubbler (Model 2870)	Submerged probe (Models 2300 & 2400)	Ultrasonic (Model 2400)
Factors affecting accuracy:	**Performance:**		
Silting in	use with caution*	very good	excellent
High cross winds	excellent	excellent	not recommended
Floating debris	excellent	excellent	poor
Suspended solids (high concentration)	use with caution*	very good[1]	excellent
High grease concentration	use with caution*	very good[1]	excellent
Foam on liquid	excellent	excellent	not recommended
Narrow channel	excellent	excellent	use with caution
Air temperature	good[2]	excellent	good[2]
Water temperature	excellent	good[3]	good[3]
Factors necessitating on-site maintenance:	**Maintenance required:**		
Silting in	occasional/often*	non-occasional[1]	none
Suspended solids	occasional/often*	non-occasional[1]	none
High grease concentration	occasional/often*	non-occasional[1]	none
Channel application:	**Installation:**		
Weirs and flumes	very easy[4]	very easy[5]	easy
Small round pipes	moderately easy	very easy	use with caution
Large round pipes with swift current	difficult	difficult	easy
Irrigation channel or small stream	somewhat difficult	somewhat difficult	easy
River or other large stream	difficult	difficult	easy[6]

1. Probes are affected only by a mixture of grease and solids.
2. Large air temperature fluctuations will affect accuracy.
3. Large water temperature fluctuations will affect accuracy.
4. Most flumes can be ordered with an integral bubble tube fitting.
5. Flumes can be ordered with a recess in the bottom to accommodate an Isco probe.
6. Installation is easy if a structure exists over the stream.

* Automatic purge may reduce clogging and maintenance.

*Model 700 Portable Composite Sampler**
*Model 702 Portable 24 Bottle/Composite Sampler**



Refrigerated Sampler in Fiberglass Enclosure. STREAMLINE Portable Samplers Easily Convert To Refrigerated Units

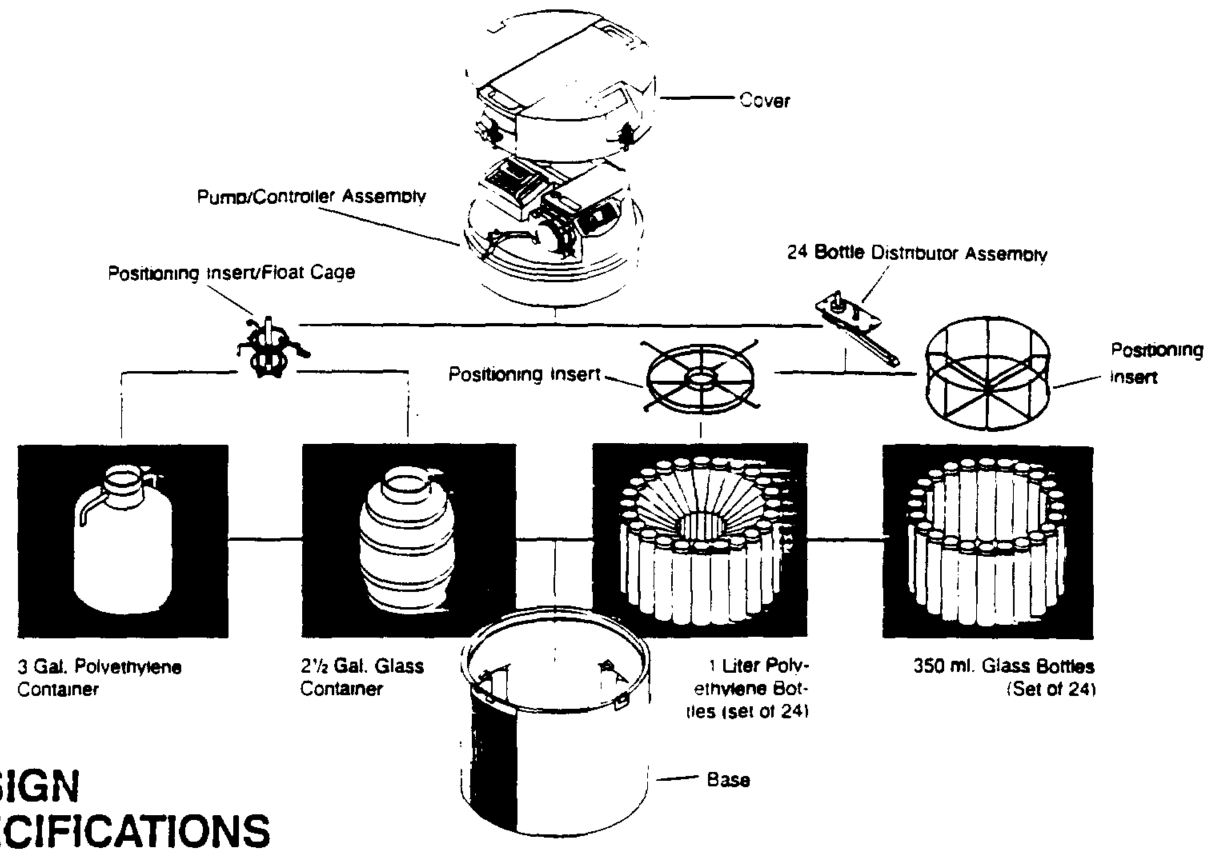
Rugged Roto-Molded Construction
While other samplers are constructed of vacuum formed ABS (acrylonitrile, butadiene, styrene), STREAMLINE has a tough, rotationally molded polyethylene case. The vacuum forming process concentrates material in the straight wall section leaving the corners thin, making such units prone to cracking. Conversely, STREAMLINE's rotationally molded process produces an increasing wall thickness at the corners making it better able to withstand the rigors of field use.

STREAMLINE's Pump/Controller Assembly Separates From The Base For Easier Carrying

Sampler Suspended

SIGMA

*PATENTED



DESIGN SPECIFICATIONS

- **Application:** For conventional, toxic, & suspended solids sampling; permanent or portable installation.
- **Dimensions:** Diameter: 19.75 in. (50.2 cm) Height 21.62 in. (54.9 cm) Dry Weight 34.5 lbs. (15.6 kg.) (Model 700), 39 lbs. (17.7 kg.) (Model 702) nominal, including integral AC power converter.
- **Sample Pump:** High speed peristaltic, dual roller with 3/8" ID x 5/8" OD Dow Corning Silastic Rx50 medical grade silicone rubber pump tube.
- **Pump Body:** Impact/corrosion resistant Delrin*.
- **Vertical Lift:** 27 ft. maximum.
- **Sample Transport Velocity:** 2.7 ft./sec at 3 ft. vertical lift in 3/8" ID intake line.
- **Pump Flow Rate:** 3.518 ml/min. at 3 ft. vertical lift in 3/8" ID intake line.
- **Sample Volume:** Programmed in milliliters, in one ml. increments from 50 to 999 ml.

Repeatability ±5%, typical; volume unaffected by changes in lift.

- **Liquid Sensor:** Constructed of stainless steel and silicone.
- **Sample Bottle Capacity:** Discrete (24) bottles: 350 ml. glass, 1 liter polyethylene. Composite container: 2-1/2 gal. glass, 3 gal. polyethylene.
- **Sampling Modes:** Discrete Time, Discrete Flow, Composite Time, Composite Flow, Time Override*, Variable Interval*, Start/Stop* & Level Actuation.
- **Interval Between Samples:** Time Mode: 1 to 9,999 minutes in one minute increments. Flow Proportional Mode: 1 to 9,999 flow pulses (momentary dry contact closure, or 12 VDC pulse, 25 msec minimum duration). 4-20 mA interface optional.
- **Multiplex:** 24 bottle mode*

Samples per Bottle: 1 to 20, in 1 sample increments.
Bottles per Sample: 1 to 24, in 1 bottle increments.

- **Intake Purge:** Air purged before and after each sample; purge duration automatically compensates for varying intake line lengths.
- **Electronic/Mechanical Components Housing:** Impact/corrosion resistant polyethylene; submersible, watertight, dusttight, corrosion & ice resistant: NEMA 4x 6.
- **Electronics:** CMOS circuitry, 100% solid state.
- **Control Panel:** Hermetically sealed 18 position, 32 function membrane switch keypad with 16 character alphanumeric liquid crystal display.
- **Internal Clock:** Indicates real time and date with 0.007% time base accuracy.
- **Program Delay:** Actual sampler start time and day is user programmable.
- **Manual Bottle Advance:** Discrete 24 Bottle Mode, distributor advances to next bottle.
- **Manual Sample:** Initiates a sample sequence (pre-purge/sample/post-purge).
- **Intake Rinse:** Intake line rinsed with source liquid prior to each sample, from 1 to 3 rinses.
- **Intake Fault:** Sample collection cycle automatically repeated from 1 to 3 times if sample not obtained on initial attempt.
- **Intake Tubing:** 3/8" ID vinyl or Teflon* with protective outer cover.
- **Intake Strainer:** Weighted, Teflon* & 316 stainless steel construction.
- **Automatic Shut-Down:** Discrete (24 bottle) Mode: After 24 advances of distributor arm.

Composite Mode: After preset number of samples have been delivered to composite container, from 1-999 samples, in one sample increments or upon full bottle with float switch.

- **Sampler Case:** High impact resistant polyethylene, 3 section construction. Double walled base; direct ice contact with bottle(s).
- **Cooling Capacity:** 38°F below ambient after 24 hrs. with 65°F sample liquid (32 lbs. with 350 ml. glass bottles in base).

26°F below ambient after 24 hrs. with 65°F sample liquid (15 lbs. w/1 liter polyethylene bottles in base).
35°F below ambient after 24 hrs. with 65°F sample liquid (26 lbs. with 2-1/2 gal. glass container in base).
34°F below ambient after 24 hrs. with 65°F sample liquid (24 lbs. w/3 gal. polyethylene container in base).

- **Power Requirements:** 120 VAC, 60 Hz (220 VAC, 50 Hz optional) or 12 VDC.

External Battery: Rechargeable 6 amp-hr. gel cell or 7 amp-hr rechargeable Nickel-Cadmium. External battery takes over automatically with AC line power failure. Display indicates low battery condition. External Battery Current Draw: With pump running 1.7 to 2.2A (typical), @ 11.8 VDC. Without pump running 5mA (typical).

Internal Battery: Lithium battery, 1.9 Amp-hr.; maintains program logic memory and real time clock for a minimum of five years. Internal battery current draw less than 40 microamps.

- **Overload Protection:** 5 amp DC line fuse, and 1 amp AC line fuse.
- **Operating Instructions:** Laminated to sampler controller.
- **Temperature Range:** General use: 32°F to 120°F (0°C to 50°C) Liquid Crystal Display: Operating -14°F to 158°F (−10°C to 70°C). Storage −40°F to 176°F (−40°C to 80°C).

*Model 702 ** Advanced Sample Program Required
* E.I. DuPont

Represented by:

SIGMA

AMERICAN SIGMA

ONE ELIZABETH STREET • PO BOX 300 MIDDLEPORT NEW YORK 14105-0300
800-635-4567 • 716-735-3616 • FAX: 716-735-3711 • TELEX: 750101

PRINTED IN U.S.A.

APPENDIX C

1990 PUBLIC WORKS MANUAL LISTING OF SAMPLING EQUIPMENT MANUFACTURERS

APPENDIX D

TYPICAL CHAIN-OF-CUSTODY RECORD

F6260

CHAIN OF CUSTODY RECORD

Camp Dresser & McKee Inc. **CDM**

PROJECT NAME ______________________ PROJECT NUMBER ______________________

Field Log Book Reference No. ______

SAMPLE NUMBER			DATE	TIME	SAMPLE LOCATION	SAMPLE TYPE	ANALYSES: EXTR. ORG.	VOA	PEST./PCB	TRACE METALS						NUMBER OF CONTAINERS	LOG BOOK PG. NO.	REMARKS

SAMPLED BY (SIGN)

______________ / ______________ / ______________ / ______________

RELINQUISHED BY (SIGN)	RELINQUISHED BY (SIGN)	RELINQUISHED BY (SIGN)	RELINQUISHED BY (SIGN)	RELINQUISHED BY (SIGN)
1 ________ DATE/TIME (/)	2 ________ DATE/TIME (/)	________ DATE/TIME (/)	4 ________ DATE/TIME (/)	5 ________ DATE/TIME (/)
RECEIVED BY (SIGN)	RECEIVED BY (SIGN)	RECEIVED BY (SIGN)	RECEIVED BY (SIGN)	RECEIVED BY (SIGN)
1 ________ DATE/TIME (/)	2 ________ DATE/TIME (/)	3 ________ DATE/TIME (/)	4 ________ DATE/TIME (/)	5 ________ DATE/TIME (/)

METHOD OF SHIPMENT	SHIPPED BY (SIGN)	RECEIVED FOR LABORATORY BY (SIGN)	DATE/TIME
________	________	________	(/)

LEGEND: Original: Return to Sample Traffic Control Center Copies: Ship with Samples

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 PURPOSE

During the course of the Regional Stormwater Master Plan study information has been collected which can best be accessed through the use of detailed maps and a corresponding database.

The use of maps allows information such as watershed and sub-watershed boundaries, as well as outfall locations to be presented in a spatial format. In addition to the actual mapped location of the previously mentioned entities, the relational database will provide additional information such as acreage, soil type, and runoff coefficients for watershed and sub-watershed areas; and in the case of outfalls, structure sizes and construction material. Access to the database information from the maps can be accomplished either from hard copies provided or digitally by computer. This information has been developed for compatability with the City's GIS computer system.

2.0 METHODS

2.1 DIGITAL MAPS

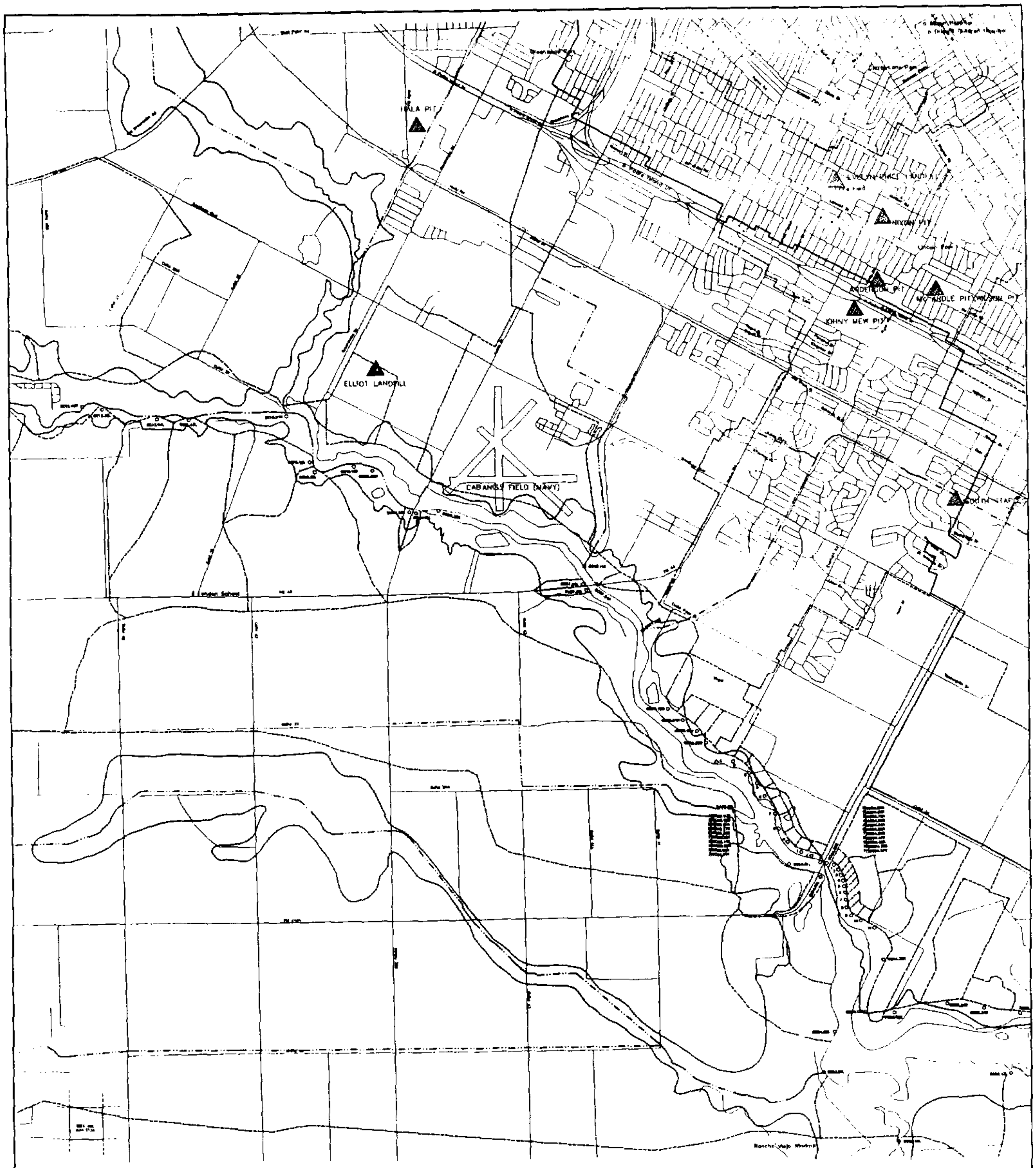
Digital mapping was accomplished using predigitized USGS Quadrangle maps. These maps provided the base over which master plan study information was overlaid.

The base maps contain all the information on a standard paper quadrangle map other than contours, lines and spot elevations. "Tiger" files listing street names are also included. Base map entities are:

1) Major, minor and secondary roads
2) Landmark entities (schools, airports, churches, hospitals)
3) Pipelines, railroad tracks
4) Water bodies
5) Creeks
6) Rivers
7) Street names
8) Landmark names
9) Texas State Plane Coordinate System

Additional information mapped by the consultant from information prepared by CCSU student forces under City direction include:

1) Outfall locations
2) NPDES discharge locations
3) Landfill locations
4) Structural control locations
5) Industrial facility locations



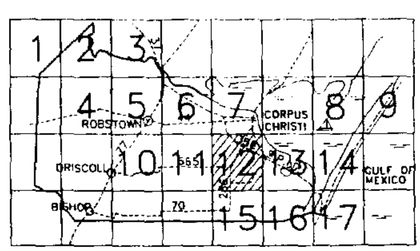
LEGEND

- DRAINAGE BASIN DIVIDE
- DRAINAGE AREA BOUNDARY
- 100 YR. FLOOD PLAIN
- OUTFALL LOCATION & I.D.
- STORMWATER STRUCTURE
- LANDFILL LOCATION
- CELL DESIGNATION FOR 1/4 MILE GRID

N

SCALE 1:24000

KEY MAP



PREPARED FROM PPI-DIGITIZED U.S.G.S. 7.5 MIN QUAD MAP

CDM CAMP DRESSER & McKEE INC. AUSTIN, TEXAS

ARCHIE WALKER ENGINEERING INC. CORPUS CHRISTI, TEXAS

STORMWATER SYSTEM OUTFALLS

OSO CREEK N.W.

STORMWATER MASTER PLAN
SOUTH TEXAS WATER AUTHORITY
CITY OF CORPUS CHRISTI AND NUECES COUNTY

REVISION				
REV. BY	DATE	DESCRIPTION	APP'VD.	

SCALE 1:24000

DATE OCTOBER, 1991

MAP 12

Additional information to be prepared and mapped by the consultant includes:

1) Major watershed boundary delineations
2) Flood plain delineation
3) Outfall contributing drainage area delineation
4) Cell Nomenclature System on quarter mile grid over study area

All of the described information is contained within the digital drawing files. Portions of the digitally mapped information is selectively "turned off" for clarity in plotting the maps, which are provided as hard copies.

2.2 DATABASE

The relational database for the Digital Mapping System was generated in the Lotus 123 spreadsheet program using information collected during mapping data collection and dry weather sampling by student forces under City direction and by the Corpus Christi City Planning Department and Urban Development Department. Outfall site data information input into the database by student forces under City direction is as follows:

1) Outfall Size
2) Construction Material
3) Sideslopes (Ditches)
4) Date of Inspection
5) Condition of Outfall
6) Presence Of:

- Debris	- Flow
- Ammonia	- Detergents
- Phenols	- Copper
- Chlorine	- Scum

7) Observed Land use (Visual)

Drainage area information as provided by Corpus Christi Planning and Urban Development Department input into the database by the consultant is as follows:

1) Land use information (existing, 2010, ultimate)
2) Development scenario (existing, 2010, ultimate)
3) Allocation of drainage area information to outfall ID numbers
4) Soil types present in drainage areas
5) Runoff coefficients

3.0 OUTPUT OF DIGITAL MAPPING/RELATIONAL DATABASE TASK

Output from the Digital mapping task will be available in several forms:

<u>Hard Copies</u>

1) Printed maps (color pen plotted) (24 x 36)
2) Reproducible mylars (provided to City of Corpus Christi, Nueces County and South Texas Water Authority) (24 x 36)
3) Blueline reproductions (24 x 36) of mylars
4) Printed copy of database (8-1/2 x 11)

<u>Disk Copies</u> - (5-1/4 High Density IBM Format)

1) Digital Maps (DXF Format)
2) Database (DOS Format)

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(Cont'd)

1.0 INTRODUCTION

1.1 BACKGROUND

One of the critical elements of the Regional Stormwater Master Plan is the development of a Control Plan designed to detect and correct illicit discharges to the local storm sewer system. This Control Plan is intended to facilitate the identification and removal of illicit storm sewer system connections and prevent illegal dumping to the municipal separate storm sewer system. Its chief purpose is to prevent subsequent discharge of potentially harmful pollutants to local receiving waters such as Corpus Christi and Oso Bays. The Control Plan also contains a schedule for monitoring suspect outfalls on a regular, systematic basis.

EPA defines "illicit discharge" as "any discharge to a municipal separate storm sewer that is not composed entirely of stormwater except discharges pursuant to a National Pollutant Discharge Elimination System (NPDES) permit ...." Conversely, "stormwater" is defined by EPA as "stormwater runoff, surface runoff, ... and drainage related to storm events and snow melt". Examples of illicit discharges, or non-stormwater pollutant sources, include commercial car wash effluent, fugitive floor drain releases, cooling tower blowdown discharges, and non-NPDES permitted industrial process wastewater. Examples of illegal dumping include improper paint, solvent, and waste oil disposal, automotive radiator fluid discharge, and indiscriminate littering and trash dumping.

In developing this Control Plan, a two-phase field screening survey of all major outfalls has been recommended to identify and monitor potential illicit connections and improper disposal practices. The Phase One field screen of all major outfalls was performed under Task 2.I.A (Mapping Data Collection Plan). This task is responsible for identifying all outfalls that demonstrate dry weather flow (flow independent of stormwater) or the presence of standing water, which may be indicative of an illicit connection located upstream within the contributing drainage area (or subbasin). Task 2.I.A also monitors the presence of diagnostic pollutant parameters--primarily visual -- that may indicate dry weather discharge or illegal dumping that has recently occurred within the subbasin. These diagnostic pollutant parameters include odor, color, turbidity, oil sheen, surface scum, algae, weed growth, and debris. Findings from the comprehensive Phase One outfall characterization survey will then be condensed into a list of suspect outfalls that will be field sampled and analyzed during Task 2.I.D - Dry Weather Sampling.

The Dry Weather Sampling task will serve as the Phase Two field screen for illicit connections and will scrutinize all potentially suspect outfalls through field sampling and on-site testing of dry weather flows. EPA-approved field test kits will be used to analyze for the presence and concentration of various parameters (see Section 3.4 for a complete listing). An initial Control Plan schedule for suspect outfall investigation is developed herein based on Phase One data. Upon completion of Task 2.I.D, the results of the two-phase field screening process will serve as the basis for re-prioritizing the outfall monitoring schedule for the Control Plan. Furthermore, it will assist field and management personnel with the process of pinpointing and eliminating non-stormwater discharges from the local storm sewer system.

1.2 PURPOSE

The basic premise for developing a Control Plan for the detection and correction of illicit connections within the regional storm sewer system is to protect water quality by preventing point and non-point source discharges from reaching the local receiving waters. It is well established that storm drainage systems are commonly polluted by numerous discharge sources. Some notable examples of these sources include non-regulated industrial waste streams, indiscriminate waste dumping, and cross-connection or inflow from leaking wastewater lines. The negative impacts caused by these pollution sources and the associated degradation of water quality in the valuable receiving waterways is now recognized as a significant problem by local, state and national agencies. Therefore, the purpose of this Control Plan is to identify potential illicit connections to the local storm sewer system and to provide a logical, prioritized schedule for pollutant discharge detection and location, utilizing the most economic, time efficient methods available. Ultimate correction and removal of illicit connections will cause responsible parties to either: 1) disconnect from the stormwater system and discharge to the sanitary sewer system (pretreatment options may be necessary) or 2) modify discharges into compliance with NPDES permit regulations and continue to discharge to the stormwater system.

1.3 FORMAT

This Control Plan document is arranged into six sections. Section 1.0 provides an Introduction to the Control Plan by describing general background information and citing the purpose of the Control Plan. Section 2.0 states the methodology used to identify suspect outfalls and then presents the results of the receiving waterway (outfall) analyses. Section 3.0 outlines Control Plan Strategy by describing suspect outfall prioritization methodology based on outfall field-screening results. A listing of suspect, prioritized outfalls is also presented. Section 3.0 further evaluates screening parameters, presents supplemental procedures, and describes a periodic outfall inspection program. Section 4.0 presents the actual Control Plan, outlining physical connection location techniques and strategies, and further describes a prioritized schedule for suspect outfall monitoring. Section 5.0 provides sampling health and safety guidelines and Section 6.0 presents references used in the preparation of this document.

2.0 SUSPECT OUTFALL IDENTIFICATION

The identification of suspect outfalls for the presence of illicit connections and/or improper dumping is intended to incorporate the data results generated from the two-phase field screen of all major outfalls from the local storm sewer system. Phase One - Mapping Data Collection Plan (Task 2.I.A) - provides the initial field screen of all major outfalls, narrowing the list of inventoried outfalls to those which possess a combination of the following characteristics:

- Dry weather flow
- Dry weather standing water
- Diagnostic pollutant parameters

Phase Two - Dry Weather Sampling (Task 2.I.D) - focuses on the suspect outfalls identified during Task 2.I.A. Sampling crews will measure dry weather flows, in addition to field-analyzing the presence and concentrations of such pollutants as total chlorine, total copper, total phenol, detergents (or surfactants) and pH (and others recommended in Section 3.5).

This Control Plan is based on Phase One (Task 2.I.A) field screening results. The following discussion details the methods used to perform the Phase One field screen for illicit connections and presents the results generated from the outfall characterization effort. Outfalls prioritized for Control Plan scrutiny (presented in Section 3.2) are based upon the observed Phase One findings. Outfalls may be reprioritized in the future based on Phase Two findings.

2.1 METHODOLOGY

Task 2.I.A (mapping data collection) served as the primary basis for the identification of suspect outfalls located within the regional storm sewer system. Besides determining the precise location and dimensions of all major outfalls found along the banks of receiving waterways, the mapping data collection task also entailed Phase One field screening for suspect outfalls. Central to this task was the determination of the presence/absence of dry weather flows, standing water, diagnostic pollutant parameters, and determination of the land use source area. The field data collection sheet used for outfall characterization during Task 2.I.A is shown in Figure 2-1. The subsequent discussion explains the rationale used to develop a prioritization of suspect outfalls (presented in Section 3.2), based upon Phase One field screening results.

2.1.1 FLOWING OUTFALLS

The primary indicator for locating suspect outfalls is the presence of flow in the storm sewer system during dry weather conditions. A dry weather flow is defined as a flow that occurs independent of a rainfall event (no rainfall during the previous 48 hours). Therefore, the presence of a dry weather flow is indicative of a non-stormwater release to the system and is the leading cause for concern that an illicit connection is present within the outfall's drainage subbasin. Presence of dry weather flow is also an automatic mechanism for a given outfall to be field-tested during the dry weather sampling phase. A summary of flowing outfalls detected during the mapping data collection task is presented in Section 2.2.2.

2.1.2 STANDING WATER OUTFALLS

A secondary consideration for identifying suspect outfalls is the presence of standing water at the storm sewer system's discharge point into the receiving waterway. The existence of standing water at an outfall during dry weather conditions (those not influenced by rainfall during the previous 48 hours) may or may not be indicative of a non-stormwater release. Standing water may indicate normal drainage conditions at the outfall location. In most cases, outfalls partially submerged by standing water are influenced by tidal or conveyance related effects.

For these outfalls, field crews should locate a non-submerged point of the sewer system upstream to inspect for flow. If flow is verified, then field-testing analysis should be performed during the dry weather sampling phase. A presentation of outfalls that

DATA COLLECTION SHEET

FILL IN BLANKS/CIRCLE APPROPRIATE ITEMS
PROVIDE DESCRIPTION OF ITEMS CIRCLED AS APPLICABLE

INVESTIGATOR:-______					
DATE:______			TIME:______		
OUTFALL I.D. #______			OUTFALL DIMENSIONS:______		
OUTFALL MATERIAL:	CONCRETE		METAL	EARTH	OTHER
OUTFALL STRUCTURAL CONDITION:			GOOD	FAIR	POOR
OUTFALL SILTATION DEPTH: NONE	1/4FULL		1/2FULL	3/4FULL	PLUGGED
DEBRIS:	YES	NO	STANDING WATER:	YES	NO
WEED GROWTH:	YES	NO	FLOW:	YES	NO
COLOR:	YES	NO	ODOR:	YES	NO
TURBIDITY:	YES	NO	SCUM:	YES	NO
OIL SHEEN:	YES	NO	ALGAE:	YES	NO
LAND USE:	UNDEV.	AGRI.	IND.	RES.	COMM.

COMMENTS: ______

SITE SKETCH:

Figure 2-1

Field Data Collection Sheet

Mapping Data Collection Task

displayed standing water during the Mapping Data Collection task is discussed in Section 2.2.3. All outfalls that demonstrate presence of suspect diagnostic pollutant parameters should be investigated first.

2.1.3 DIAGNOSTIC POLLUTANT PARAMETERS

Another significant component of the mapping data collection task is the presence/-absence inventory of diagnostic pollutant parameters field screened during the Phase One outfall characterization survey. Eight diagnostic pollutant parameters (see Figure 2-1) were inventoried to assist with the prioritization of suspect outfalls. These parameters may be rank-ordered in importance from highest concern to lowest concern as follows: oil sheen, color, odor, turbidity, scum, algae, weed growth, and debris. However, this rank-ordered listing of parameters is not based upon a rigid matrix framework and these parameter categories may overlap each other in subjective degrees of concern or importance. Nevertheless, a qualitative ranking system is still necessary to create a prioritization of suspect outfalls for future investigation. Therefore, the most important function that these diagnostic pollutant parameters provide is their cumulative combinations with flowing (and standing water) dry weather conditions and, thus, their utility in prioritizing outfalls for the Control Plan. A summary of the diagnostic pollutant parameters identified during Task 2.I.A is presented in Section 2.2.4.

2.1.4 LAND USE CHARACTERIZATION

Similar to the diagnostic pollutant parameters, the Task 2.I.A field screen also investigated the predominant land uses surrounding respective outfalls. These land use determinations were based upon visual inspections made at each outfall's location. Five types of land use categories were noted and may be subjectively ranked by potential for illicit connection. Presented in descending order of level of concern, they are as follows: industrial, commercial, agricultural, residential, and undeveloped. Again, some outfalls will represent a combination of land use areas and there may also be subjective overlap among importance of land use types. Regardless, their function will be served in the prioritization of suspect outfalls for the Control Plan. Emphasis will be placed on developed areas rather than undeveloped areas. A summary of land use categories identified during the mapping data collection Phase One field screen is outlined in Section 2.2.5.

2.1.5 FUTURE DRY WEATHER SAMPLING RESULTS

As was discussed earlier, this Control Plan will utilize Phase One (Task 2.I.A) field screening observations. However, the results generated from the future Phase Two dry weather sampling (Task 2.I.D) of suspect outfalls will allow the Control Plan prioritization to be further refined by its contribution of analytical field test results. All monitored outfalls will be sampled and field-tested for presence and concentration of five EPA-recommended pollutants. Field analysis of total chlorine, total copper, total phenol, detergents (or surfactants), pH, and measurement of dry weather flow will be determined by this effort. Supplemental procedures have also been recommended in Section 3.4. The field data collection sheet used for the dry weather sampling task is shown in Figure 2-2. Control Plan priority refinement, based on these future dry weather sampling results will be addressed in Section 3.3.

2.2 RECEIVING WATERWAY ANALYSIS

Outfall characterization for the eight major receiving waters is complete. The drainage system receiving waterways that were inventoried include:

- Corpus Christi Bay
- Oso Bay
- Oso Creek
- West Oso Creek
- Nueces River
- Nueces Bay
- Laguna Madre
- Inner Harbor Area (Port of Corpus Christi/Corpus Christi City Limit Boundary)

The subsequent discussion summarizes the findings generated by the Phase One field screening task and presents the following data:

- Mapping outfall results
- Flowing outfall statistics
- Standing water outfall statistics
- Diagnostic pollutant parameters
- Land use

2.2.1 MAPPING OUTFALL STATISTICS

Mapped outfall characterizations that were inventoried during the Phase One Field screen totaled 340 outfalls for the eight receiving waterways. Outfall totals generated by Task 2.I.A per individual receiving waterways are as follows:

Receiving Water	Identified Outfalls
Corpus Christi Bay	72
Oso Bay	54
Oso Creek	88
West Oso Creek	11
Nueces River	41
Nueces Bay	23
Laguna Madre	26
Inner Harbor Area	25
Total outfalls	340

2.2.2 FLOWING OUTFALL STATISTICS

Of the 340 total outfalls characterized by the Mapping Data Collection inventory, a total of 55 outfalls were identified as demonstrating flow. This ostensibly indicates that 16 percent of the located and mapped outfalls were flowing at the time of inspection.

However, this value of 55 outfalls does not actually represent the true number of outfalls that demonstrate dry weather flow. Twenty-six of the 55 identified flowing outfalls were potentially influenced by rainfall events that occurred within 48 hours prior to their respective outfall inspection. It remains unknown how many of these 26 outfalls truly contain a dry weather flow. Presence of flow field screening served as a secondary purpose during the mapping data collection task and due to time constraints, it could not always be performed during dry weather periods. Phase Two field screening will revisit these 26 outfalls during "dry" weather. At that time, dry weather flow will be confirmed.

2.2.3 STANDING WATER OUTFALL STATISTICS

Out of the 340 total outfalls characterized by Task 2.I.A, a total of 135 outfalls (or about 40 percent) were identified as having standing water present. Similar to the flowing outfall statistics, this value of 135 outfalls is inflated because of rainfall events that occurred within 48 hours prior to outfall inspection or that normally have standing water present due to submergence by the receiving water. Forty-three of the 135 outfalls identified as having standing water present were potentially influenced by rainfall. Again, it remains unknown how many of these outfalls with standing water present actually represent dry weather flows released from within the outfall's drainage basin. As discussed in Section 2.1.2, these outfalls will be revisited and an investigation performed for the presence of flow in the contributing drainage system (upstream from that outfall).

2.2.4 DIAGNOSTIC POLLUTANT PARAMETERS

Presence of the eight diagnostic pollutant parameters inventoried varied greatly from the 340 mapped outfall characterizations. A data summary compilation of the Task 2.I.A findings is presented in Table 2-1. Results from the Mapping Data Collection Plan effort indicate a wide range of parameters present at the outfall field screening points. The parametric extremes ranged from a low value of 2 outfalls noted for unusual color to a high value of 127 outfalls noted for presence of weed growth. Four of the higher

TABLE 2-1

SUMMARY TABLE
DIAGNOSTIC POLLUTANT PARAMETER STATISTICS

Receiving Waterway	Number of Outfalls with Presence of Diagnostic Pollutant Parameter							
	Color	Odor	Turbidity	Oil Sheen	Scum	Algae	Debris	Weed Growth
Corpus Christi Bay	1	2	1	4	7	20	5	3
Oso Bay	0	1	0	2	14	9	19	27
Oso Creek	1	1	4	0	5	8	20	47
West Oso Creek	0	0	0	0	1	2	2	6
Nueces River	0	1	1	0	3	2	16	22
Nueces Bay	0	0	0	0	2	2	7	0
Laguna Madre	0	1	1	2	10	12	13	7
Inner Harbor	0	3	2	6	2	8	14	15
Total Outfalls	2	9	9	14	44	63	96	127

concern level parameters (oil sheen, color, odor and turbidity) were all found to be present in less than five percent of the inventoried outfalls. The other four parameters diagnosed as present at the outfall field-screening points ranged as follows: scum, 12.9%; algae, 18.5%; debris, 28.2%; and weed growth, 37.4%. These four parameters (scum, algae, debris, and weed growth) are all elements that may be found at outfalls during normal conditions, and are not necessarily indicative of illegal dumping or illicit connections. These findings will be used in the prioritization process of suspect outfalls that are presented in Section 3.2.

2.2.5 LAND USE STATISTICS

Land use characterization findings generated from the Mapping Data Collection Plan task for all 340 identified outfalls are summarized in Table 2-2. General observations derived from the land use classification process verify expected notions for the four analyzed receiving waterways. One, Corpus Christi Bay is primarily comprised of residential and commercial source area land uses. Two, Oso Bay and Laguna Madre are chiefly comprised of residential drainage areas with some commercial, agricultural, and undeveloped land usage also represented. Three, Oso Creek appears to drain the greatest variety and balance of land use types. Four, West Oso Creek is wholly comprised of agricultural land usage. Five, the Nueces River and Nueces Bay are mainly comprised of undeveloped and residential land uses. Six, the Inner Harbor (Port of Corpus Christi) is dominated by industrial land usage. Categorical breakdown of outfall land use characterization ranges from 5% industrial to 43% residential in the Corpus Christi/Nueces County municipal separate storm sewer system study area. These land use characterizations will also be taken into consideration in the suspect outfall prioritization process that is presented in Section 3.2. These findings also served to confirm the information provided in the Demographic Projections section (Task 2.II.A).

TABLE 2-2

SUMMARY TABLE
LAND USE CHARACTERIZATION STATISTICS

Receiving Waterway	Number of Outfalls Per Land Use Type					
	Industrial	Commercial	Agricultural	Residential	Undeveloped	Mixed
Corpus Christi Bay	0	34	0	36	0	2
Oso Bay	0	5	3	39	5	2
Oso Creek	0	1	18	27	28	14*
West Oso Creek	0	0	11	0	0	0
Nueces River	0	2	0	13	24	2
Nueces Bay	2	0	0	11	10	0
Laguna Madre	0	0	1	18	2	5**
Inner Harbor	15	1	0	2	3	4***
Total Outfalls	0	40	29	102	35	17

* Primarily U/A or U/R Mixed-Uses
** All are R/C Mixed-Use
*** 3 of the 4 Mixed-Uses Contain Industrial

3.0 CONTROL PLAN STRATEGY

3.1 SUSPECT OUTFALL PRIORITIZATION METHODOLOGY

Suspect outfall prioritization for this Control Plan is based solely upon Phase One field screening results. For identification and ranking of the outfalls of concern (presented in Section 3.2), the following prioritization guidelines were applied. First, the primary indicator of suspect outfalls located within the storm sewer system is the presence of dry weather flow. Presence of dry weather flow is the only mechanism for automatic inclusion on the list of suspect outfalls. Outfalls that have been field-verified for dry weather flow will be given Tier One priority in the Control Plan's schedule for illicit connection inspection.

The secondary indicator for identifying suspect outfalls is the presence of standing water. These outfalls will be given Tier Two priority in the Control Plan's schedule for illicit connection inspection. A submerged outfall or the presence of standing water suggests that potential exists for a given outfall to have dry weather flow within its drainage basin. However, standing water outfalls are not considered suspect unless either a dry weather flow is field-verified or a suspicious combination of diagnostic pollutant parameters and/or land use is also present. It is recommended that submerged or standing water outfalls be inspected by field crews during the dry weather sampling phase. Inspections for presence of flow should be made at the nearest nonsubmerged point located upstream in the storm sewer system. If a dry weather flow is field-verified for a given standing water outfall, then it should be reclassified as a Tier One outfall. For the remaining standing water outfalls that do not demonstrate a dry weather flow at an upstream point in the system, yet demonstrate presence of suspect diagnostic pollutant parameters (such as unusual color, oil sheen, odor, or turbidity), will be included as Tier Two suspect outfalls.

3.2 PRIORITIZED OUTFALLS

Previously, presence of dry weather flow (Tier One Priority) and standing water outfalls with suspect conditions (Tier Two Priority) have been discussed as screening indicators of illicit connections located within the local stormwater system. Inclusion on the suspect outfall list is strictly based on Phase One field-screening results of flow versus no flow conditions. Since standing water (Tier Two) outfalls have not yet been field-verified for dry weather flows, they will occupy a lower priority than those (Tier One) outfalls where flowing conditions were observed. Table 3-1 presents the Tier One outfalls and Table 3-2 presents the Tier Two outfalls to be monitored for the potential of having illicit connections. Each tier is further subdivided into two classes (Class A and Class B). Class A groups shall have a higher priority within their tier than Class B groups. Class A groups, within both Tier One and Tier Two outfalls, must have been observed to have either unusual color, oil sheen, odor, or turbidity present during the Phase One outfall characterization. Class B groups within Tier One outfalls were observed to have possessed any of the remaining diagnostic pollutant parameters, while Class B groups within Tier Two outfalls were limited to the presence of standing water with either scum or algae observed. A prioritized schedule for monitoring these outfalls is presented later in Section 4.3. For exact locations of these outfalls, please refer to the digital maps provided as part of the regional stormwater master plan submittal.

3.3 PRIORITIZATION REFINEMENT

The above discussion of suspect outfall prioritization methodology and the listing of outfalls suspected for having illicit connections is based upon Phase One field screening results. It is recommended that this prioritized listing of outfalls be revised or refined based on Phase Two (dry weather sampling) field screening results. This refinement process will be two-fold in scope. First, Phase Two field screening procedures will determine how many of the standing water outfalls truly represent dry weather flows. This will be done by inspecting the outfall's given channel or conduit at its nearest, nonsubmerged point located upstream for the presence of flow. If dry weather flows are observed then those outfalls should be reclassified as Tier One priority outfalls. If

TABLE 3-1
TIER ONE – SUSPECT OUTFALLS

OUTFALL ID	COLOR	OIL SHEEN	ODOR	TURBID	SCUM	ALGAE	DEBRIS	WEEDS	LAND USE
CLASS A OUTFALLS									
CB06.99L		X			X				RES
CB12.99L		X		X					COM
OB01.00R		X			X	X			RES
OC02.54R	X		X						RES
OC06.03R				X					RES
OC10.10R				X			X		U/C
OC16.61R				X					AGR
OC23.86L				X			X		AGR
NR07.35L				X	X	X	X		RES
LM00.32L				X		X		X	RES
LM04.84L		X			X	X	X		R/C
IH00.70L		X					X		IND
IH01.40L		X	X	X			X		IND
IH11.50L		X				X	X		IND
CLASS B OUTFALLS									
CB06.37L								X	RES
CB07.74L					X			X	RES
CB08.36L									RES
CB09.29L						X			RES
CB09.93L						X			RES
CB10.97L									RES
CB11.12L									RES
CB11.15L									RES
CB12.10L									COM
CB12.19L						X	X		COM
CB12.85L						X			COM
OB01.08R									RES
OB03.23R									RES
OB04.09R					X	X			RES
OC04.13R						X			RES
OC04.38R									RES
OC04.78R								X	RES
OC04.88R						X			RES
OC04.91R								X	UND
OC05.01R					X	X	X	X	UND
OC05.26R							X		UND
OC07.39R									RES
OC09.98R							X	X	UND
OC18.87R								X	AGR
OC20.17R									AGR
OC03.43L								X	UND
OC04.09L								X	UND
OC05.50L							X	X	UND
OC09.50L							X	X	RES
OC10.35L									U/A
OC10.40L									UND
OC15.93L								X	U/A
OC15.97L								X	U/A
OC16.91L							X	X	AGR
WO02.42R								X	AGR
WO02.42L								X	AGR
WO02.49L					X	X		X	AGR
WO03.40L									AGR
IH05.85L						X	X	X	IND
IH10.73L							X	X	IND
IH11.50L						X		X	COM

TABLE 3–2
TIER TWO – SUSPECT OUTFALLS

OUTFALL ID	COLOR	OIL SHEEN	ODOR	TURBID	SCUM	ALGAE	LAND USE
CLASS A OUTFALLS							
CB06.76L	X	X			X		RES
CB10.07L			X				RES
CB16.53L			X			X	RES
OB02.38R			X		X	X	RES
NR08.92L			X				RES
LM00.09L		X					RES
LM02.15L			X		X	X	RES
IH06.04L		X	X			X	IND
IH12.15L				X		X	U/I
IH17.70L		X	X		X	X	UND
CLASS B OUTFALLS							
OB00.28R					X		RES
OB05.48R					X	X	COM
OB05.84R					X		RES
OB09.47R					X		RES
OB09.89R					X		RES
OB04.73L					X	X	RES
OB04.80L					X	X	RES
OB05.32L					X	X	COM
OB06.85L					X	X	UND
OB08.63L					X	X	RES
OC04.69R						X	RES
OC05.09R					X		UND
OC05.81R					X		U/R
OC05.90R						X	U/R
OC24.60R					X		AGR
OC00.29L					X	X	RES
OC01.14L					X	X	UND
OC03.81L						X	UND
NR06.50L					X		UND
NR11.70L					X		COM
NB00.98L					X		UND
NB01.50L						X	IND
NB01.51L					X	X	IND
LM00.41L					X	X	RES
LM00.66L					X	X	R/C
LM02.29L						X	R/C
LM03.02L					X		RES
LM03.34L					X		RES
LM03.81L						X	RES
LM03.95L						X	RES
LM04.28L					X	X	RES
LM04.51L					X	X	RES
LM04.75L					X		RES
LM05.26L						X	UND
IH07.32L					X	X	U/R
IH12.15L						X	U/I

no dry weather flow is observed, then they should be deleted from Tier Two (unless there is a suspect combination of diagnostic pollutant parameters and/or land use, in which case they should continue to be monitored on a lower priority basis).

The second aspect of outfall prioritization refinement will be the availability of new outfall data, based on the dry weather sampling task findings. Five chemical parameters will be field-analyzed for presence and concentration using EPA-recommended test kits. The five parameters include: 1) total chlorine, 2) total copper, 3) total phenol, 4) detergents (or surfactants), and 5) pH. Each of these parameters will be discussed in greater detail in Section 3.4 below. Flow measurements will also be taken during the dry weather sampling phase. This new outfall data should be implemented into refining the list of prioritized, suspect outfalls. Presence of any of the five EPA-recommended parameters for a given outfall should automatically elevate that outfall to a Tier One, Class A, priority concern level. There are currently not any EPA published guidelines for maximum concentration levels of concern for these five chemical parameters, so it is assumed that presence of a given parameter is a cause for elevated concern.

In summary, the Phase Two field screening results will provide new outfall data concerning the verification and measurement of dry weather flow, plus the presence and concentrations of the selected chemical parameters. These Phase Two findings should be used to refine the current list of prioritized, suspect outfalls per the recommended guidelines outlined above.

3.4 EPA-RECOMMENDED PARAMETERS

This section will provide a detailed discussion of the five EPA-recommended chemical parameters that will be field-analyzed during the Phase Two dry weather sampling task. Field analytical testing shall be performed using the Chemetrics (or equivalent EPA-approved field test kits) as specified by the Dry Weather Sampling Plan.

3.4.1 TOTAL CHLORINE

Chlorine (Cl) is a non-metallic halogen element, possessing gaseous and liquid properties, utilized widely in the industrial sector. It is an important reagent that is universally applied in extractive metallurgy processes and in chlorinated hydrocarbons used for the production of plastics, solvents, and household bleaches. It is also widely employed in the form of Cl_2 as a bleaching agent for wood pulp and textiles. Cl_2 is also used under controlled conditions to kill bacteria in public water supplies and to control algae in swimming pools. Chlorine is not found free in nature, but is a component of the common mineral, halite (rock salt), and other minerals, sylvite and carnallite. The reason for its scrutiny as a stormwater pollutant is due to its ubiquitous nature in the manufacturing sector.

3.4.2 TOTAL COPPER

Copper (Cu) is a soft, inorganic, heavy metal element used widely in the manufacture of electrical wiring, plumbing, heating, roofing, and building construction components. It is broadly utilized in chemical and pharmaceutical machinery, metal undercoats, platings and alloys, cooking utensils, insecticides, and antifouling paints. Copper is extracted from common rocks and minerals of the earth's crust, usually in the form of sulfides and oxides. Major industrial pollutant sources include smelting and refining industries, coal burning industries, copper wire mills, and iron and steel producing industries. Copper may enter natural waterways either directly from these industrial source waste streams or through atmospheric fallout of airborne pollutants generated by these industries. Atmospheric fallout may be a significant source of copper to the aquatic environment, especially in industrial and mining areas. Copper is a naturally occurring element found at background levels in natural waterways due to weathering; however, higher concentrations of copper are usually generated by man-made sources.

3.4.3 TOTAL PHENOL

Phenol (C_6H_5OH) is a large volume industrial chemical almost entirely produced as an intermediate agent in the preparation of other chemicals. Commonly referred to as "carbolic acid", phenol is a clear to whitish, crystalline solid in its pure state, and possesses a sweet, acrid odor. Natural phenol is produced through the distillation of coal tar. But, its most common source of derivation is through the oxidation of cumene. Phenol is widely used as a synthetic polymer for phenolic resins, epoxy resins, pentachlorophenol, pharmaceutical products, laboratory reagents, dyes, and as a selective solvent for refining lubricating oils. Industrial phenolic wastes are produced during the coking of coal, distillation of wood, and the operation of oil and natural gas refineries. Generally, its widespread usage as an intermediate chemical agent in the manufacturing industry and the generation of phenolic waste by industrial and agricultural sources necessitate its scrutiny as a potential surface water contaminant.

3.4.4 DETERGENTS (SURFACTANTS)

Detergents are defined as any substance that reduces the surface tension of water by exerting emulsifying action, and thereby aiding in the removal of soils or extraneous matter. The older, still widely used, detergents are common sodium soaps of fatty acids that are relatively weak in strength. The modern, stronger, synthetic detergents are classified by their mode of chemical action; therefore, they are grouped as anionic, cationic, and nonionic detergents. Most detergents contain phosphates, a primary plant nutrient, as one of their major components.

Surfactants, or surface-active agents, are also defined as compounds that reduce surface tension when dissolved in water or water-based solutions. Surfactants also act to reduce interfacial tension between two liquids, or between a liquid and a solid. There are three classes of surfactants: detergents, wetting agents, and emulsifiers (all have similar chemical properties and differ mainly by the nature of the materials involved and their application). An example of surfactant application is as an emulsifying agent applied at an oil-water interface.

The primary concern with detergents and/or surfactants, from a water quality standpoint is their ability to be decomposed by microorganisms. Detergents that are biodegradable are not nearly the threat to water quality, as are the alkyl benzene sulfonate (ABS)-based detergents, which resist decomposition. ABS-based detergents, that have high phosphorous content, degrade water quality through acceleration of the eutrophication process. Detergents and surfactants are also of major concern because of their widespread utility and application. They are easily transported by storm events into local receiving waters.

3.4.5 pH

pH is defined as a value, between 0 and 14, measured to represent the acidity or alkalinity of an aqueous solution as compared to pure water. Pure, de-ionized water is commonly expressed as possessing a pH of 7. Thus, relative to pure water, aqueous solutions that possess a pH of between 0 and 7 are generally considered acidic, while aqueous solutions that possess a pH of between 7 and 14 are generally considered basic. Functionally, pH values in the range of 6 to 8 are considered neutral, while aqueous solutions below 6 are acidic and aqueous solutions above 8 are alkaline. Strong acid solutions are considered to be in the pH 0 to 3 range, while strong basic solutions are considered to be in the pH 11 to 14 range. The pH values are based upon a logarithmic scale; therefore, the numerical difference between pH values, such as 6.0 and 7.0, actually represent an order of magnitude change. pH is probably the single most commonly measured parameter in water quality monitoring. According to Texas Water Commission guidelines, pH values in the range of 6.5 to 9.0 are considered as acceptable water quality, while pH values above and below that range are considered undesirable and may be indicative of an illicit connection.

3.5 SUPPLEMENTAL PROCEDURES

Besides the five EPA-recommended parameters that were discussed above as part of the Phase Two dry weather sampling task (which also includes measurement of dry weather flow), it is recommended that the following procedures be implemented into the Control Plan sampling protocol for illicit connection detection:

- Total Ammonia Field-Testing
- Analytical Laboratory Testing

3.5.1 TOTAL AMMONIA FIELD-TESTING

One of the major water quality problems associated with stormwater runoff is the infiltration and inflow of wastewater effluent into the storm sewer system. In some cases, this is due to cross-connection between the storm sewer and sanitary sewer systems, that were perhaps originally part of the municipal infrastructure, but that have not been corrected. However, in most cases this is due to illegal wastewater connections or infiltration/inflow of wastewater into the storm sewer system, caused by broken or plugged pipes within the sanitary sewer system. In either case, effluent from the wastewater system reaching the storm sewer system creates undesirable water quality effects and health concerns.

Briefly, here is a description of a recent case study outlining the potential problem of wastewater infiltration/inflow into the storm sewer system, as reported by the City of Houston, Texas. Based upon a 9-month study conducted in 1989 along Buffalo Bayou in Houston, Glanton et al. (1991) found that approximately 85 percent of the contaminants detected (which included field-testing of the five EPA-recommended parameters) were related to broken (55%) or plugged (30%) sanitary sewage system lines. The other 15 percent of pollutants were traced to private illicit connections, fugitive floor drains, and illegal dumping. Rattan, Falkenbury et al. (1989), have reported similar findings, concerning the infiltration/inflow of wastewater into the City of Fort Worth's storm sewer system. In response to these findings, it is recommended that additional dry weather sampling include a field-test analysis for ammonia. Ammonia is present in raw sewage in significant concentrations, and, thus, serves as a good indicator parameter for the presence of wastewater in dry weather flows.

Nitrogen ammonia (NH_3) is a colorless liquid (or gas) that has a sharp, intense, irritating odor and is formed as an end product of animal metabolism through the decomposition of uric acid. Ammonia is also a primary constituent in many fertilizers and a host of other manufacturing processes. It was listed as the third highest-volume chemical produced in the U.S., according to a 1979 industrial survey. Total ammonia may be easily tested in the field with only a Nessler reagent process and a clear sample container to conduct the analysis. Nessler reagent kits are inexpensive and readily available at most local scientific supply vendors.

Field-testing of a grab stormwater sample for total ammonia requires approximately 100 ml of water in a sample beaker. One to two drops of Nessler reagent is added to the sample and within one minute, a positive reaction or color change should be apparent. A positive Nessler reaction should be interpreted as follows based on the colormetric response:

<u>Nessler Reagent Responses to Ammonia</u>
(per 100 ml water)

- Clear (no response) - indicates that no ammonia is present;
- Light Green - indicates presence of trace levels of ammonia in the 0-1.5 ppm concentration range; may indicate trace amounts of wastewater effluent.
- Dark Green - indicates presence of low levels of ammonia in the 1.5 - 3.0 ppm concentration range; may indicate diluted wastewater presence.
- Yellow - indicates presence of moderate levels of ammonia in the 3.0 - 8.0 ppm concentration range; usually means that diluted wastewater is present.
- Burnt Orange to Brown - indicates that presence of high levels of ammonia in the 8.0 ppm or above centrations; high probability that wastewater is present.
- Other Colors - or precipitates indicate presence of materials other than ammonia; should be noted, as any positive Nessler reaction is considered undesirable.

The above listed ammonia concentrations should only be used as qualitative guidelines and are not intended to be interpreted as quantitative values. Their usefulness is in their ability to trace and locate sources of wastewater inflow. It should be noted that the presence of ammonia could also be caused by fertilizers or decomposed organic matter.

3.5.2 ANALYTICAL LABORATORY TESTING

In situations where significant dry weather flows are encountered and none of the above listed chemical parameters are detected by the field test analyses, it is recommended that grab samples be collected and taken to an accredited laboratory for analysis. Water samples should be collected into a minimum of 2-40 ml VOA (volatile organic analysis) glass vials and 1-liter glass liquids container for semi-volatiles extraction. A full organic gas chromatograph (GC) scan is recommended to generate qualitative chemical concentrations. Quantitative values may then be determined for the detected parameters, identified by the GC scan, by using mass spectometry. If heavy metals or inorganics were noted to be of concern, they could also be collected in a 1-liter glass container (the VOA vials would not be needed) and laboratory analyzed.

If unusual color or potential contamination was observed in the sediments at an outfall location, it is recommended that a grab sample of the sediment be collected. Sediment should be extracted using a stainless steel trowel after scraping vegetal matter and debris aside, and filling an 8-ounce glass sample jar with the suspect sediment. The sample should be analyzed for total metals (or any specific parameter that may be of concern).

For water or sediment sampling, the suspect samples should be collected using disposable gloves. Any sampling equipment should be decontaminated between sample locations using a distilled water and detergent rinse to prevent cross-contamination. All decontamination wastewater should also be containerized for later disposal. Samples that are collected should be identified by outfall location (or equivalent), date and time of collection, analyses required, and should be stored in an iced cooler until delivery to the laboratory. This contingency program, using analytical laboratory testing, should help to pinpoint unusual pollutant sources that would otherwise not be detected from the target parameter field analyses outlined earlier in this section.

3.6 PERIODIC ROUTINE OUTFALL INSPECTION

As part of the regional stormwater master plan, a recommended approach to periodic outfall inspections is presented. The purpose of this inspection program is to continue monitoring all outfalls for the presence of dry weather flow, while also serving as a preventive maintenance tool whereby structural inspection and outfall restoration may also be accomplished at the same time. A suggested schedule to follow is to monitor outfalls within developed areas at a rate of 2 to 3 times per year, while monitoring outfalls within undeveloped areas about once per year. If flowing or standing water is present, or if there is evidence of stormwater pollutants, such as oil sheen, unusual color, odor, or turbidity, then a sample should be collected and analyzed using the dry weather sampling field-test kit. A periodic, routine outfall inspection program will help insure that all outfalls are being monitored at least once annually and will serve to help control, detect, and correct illicit connections.

4.0 CONTROL PLAN

This section outlines the conventional physical location techniques and strategies that are recommended for as part of the Control Plan for detection and elimination of illicit connections. Following the discussion of physical location techniques is a prioritized schedule for monitoring the suspect outfalls that were earlier identified in Section 3.2.

4.1 PHYSICAL CONNECTION LOCATION TECHNIQUES

Conventional physical location techniques for detecting illicit connections to the storm sewer system are the focus of this section. These recommended techniques have all been widely used by wastewater utilities throughout the U.S. The three most common methods currently utilized for illicit connection detection include:

- Smoke Testing
- Fluorometric Dye Testing
- Television Camera Inspection

The following is a discussion of each of these techniques.

4.1.1 SMOKE TESTING

Smoke testing is a process used to locate improper connections to the storm sewer piping system. The smoke typically used for testing is zinc chloride, an odorless, noncombustible, white particulate that readily disperses into air and leaves no film or residue. The non-toxic smoke is introduced into the storm sewer system piping via manholes. If improper connections are present along the storm sewer system, then smoke will escape from the source drain(s) of the linked facilities. Breaks and cracks along the storm sewer system will also be evident as smoke will rise from the ground above these failed pipe areas. Smoke testing allows field technicians to accurately locate illicit connections and broken pipe areas. It may be used either up or down gradient with the aid of fans, and can also be effectively controlled for isolated test areas by plugging adjacent manholes. To make effective used of this technique will require cooperation from potentially suspect facilities. Access to a given facility's interior and exterior premises would be necessary to effectively monitor the smoke test dispersal. Public notification in the vicinity of the test area would also be recommended.

4.1.2 FLUOROMETRIC DYE TESTING

Fluorometric dye testing is a proven technique used for the positive identification of suspected sources of undesirable waterborne pollutants. The dye typically used as a tracer is Rhodamine, a red, fluorescent, nontoxic, biodegradable chemical that quickly dilutes in water and is available in liquid or tablet form. The dye can be monitored either visually or electronically, with the use of a fluorometer. Visual use of the fluorescent dye as a tracer can be effectively done for pipe distances of approximately 1000 feet or less. Electronic monitoring of the fluorescent dye may be used for much greater distances. The fluorometer is a very sensitive instrument able to detect concentrations as low as five parts per trillion. Fluorometric dye testing differs from smoke testing in that it must be used from an upgradient source as it is a gravity flow-driven method. Similar to the smoke testing process, it will require accessibility or "rights of entry" to potentially suspect facilities. The fluorometric dye must be initiated by being poured directly into source drains and then must be monitored downgradient. Fluorescent dye testing will also require public notification in the vicinity of the test area, because of its similar appearance to radiator coolant. This technique can also be used for accurate determination of flow rates.

4.1.3 TELEVISION CAMERA INSPECTION

Television (TV) camera inspection is another proven technique used for the detection of illicit connections located within storm sewer pipelines. TV camera inspection units generally include a camera with pan and tilt optics, a video cassette recorder, a visual monitor, towing skids, lights, cable, and other miscellaneous downhole equipment. Some units are equipped with a self-propelled camera tractor. For stormwater piping applications a jet router is recommended for clearing debris from the line. The TV camera inspection method is probably the most effective technique for locating improper connections. It allows utility technicians an in-pipe view of the storm sewer system and is able to perform inspections in pipes down to 6" diameter size. It is an expensive option, due to equipment procurement and maintenance costs. Its main drawback for stormwater applications is accessibility and for this reason, portable TV camera inspection units are recommended.

4.2 PHYSICAL CONNECTION LOCATION STRATEGIES

The previous section outlined the conventional location techniques available for pinpointing illicit connections. All three of the methods described above are very useful and should be applied in combination, if necessary, in order to detect improper connections. This section will analyze the various location strategies available for detecting and correcting illicit connections, based upon suspect outfall identification from within regional stormwater systems.

4.2.1 MANHOLE TO MANHOLE UPSTREAM

The first location strategy to be examined is the manhole to manhole upstream method. This method is a search, test, and locate technique that operates beginning with the field testing of the first manhole located upgradient of the outfall. It is a technique that sequentially moves upstream, manhole by manhole, by evaluating in-pipe junctions and sub-basin watersheds, in order to pinpoint the pollutant source. Presence of dry weather flow is the key element of the search and screening analysis using the dry weather sampling field test kits will provide the basis for continuing the search upstream. The search will be based upon scrutiny of the suspect parameter(s) identified during Task 2.I.D., the Phase Two dry weather sampling. Search and detection of the pollutant source will methodically move upgradient as long as indications that the target parameter(s) are increasing in presence and concentration. This will continue until the presence and concentration of the target parameter either decreases or is no longer present. Theoretically, the illicit connection or pollutant source will be located either at or directly upgradient of the manhole with the highest pollution concentration. The physical connection location techniques discussed in the preceding section should then be implemented to pinpoint the illicit connection or source of pollution.

4.2.2 STREAMWAY UPSTREAM

A second location strategy to be considered is the streamway upstream method. This method takes the same approach as the previously described manhole to manhole upstream technique, but is applied to open channel stormwater drainageways. The streamway upstream technique also moves sequentially upgradient, with screening analysis using the field-test kits performed wherever pipe outfalls or stormwater tributaries enter the channel. Again, dry weather flow or evidence thereof is the key search factor, as well as the target parameter(s) identified during the dry weather sampling phase. The search for the pollutant source shall progress upstream, as the pollutant concentration increases, until the presence of the target parameter(s) either decreases or is no longer present. The illicit connection should then be isolated to an area at, or directly upgradient from, the outfall or tributary that represents the highest concentration of the pollutant(s) of concern. The physical connection location techniques described in Section 4.1 should then be utilized to detect the pollutant source or illicit connection.

4.2.3 HALVING INTERVALS UPSTREAM

A third location strategy to be described is the halving intervals upstream method. This method applies the principles described in the preceding discussion, but is intended to expedite the search and detection process. This method would be most appropriate for large watersheds or for watersheds that are largely undeveloped but have concentrated developed areas located within. In theory, this approach would begin sampling of a watershed, at a point halfway between the headwaters of the contributing drainage area and the outfall. At this midpoint (manhole or tributary junction), presence of dry weather flow should be determined and a field-test kit analysis be conducted to determine presence and concentration of the target parameter(s). Dependent upon the findings, the next sampling point would either:

- bisect the drainage area between the sampled midpoint and the headwaters, if the pollutant concentration had increased relative to the outfalls measured concentration; or

- bisect the drainage area between the sampled midpoint and the outfall, if the pollutant concentration was absent or in minute quantities, relative to the outfall's measured concentration.

This half interval search technique continues to bisect distances to locate sampling points, either up or down gradient, until the outfall with the highest concentration is detected.

This technique is much faster than the sampling of successive manholes or tributaries and is especially prevalent for large watershed applications. This technique could also be modified for use in large, undeveloped watersheds whereby sampling would be conducted directly downgradient of the developed areas of the watershed. This modified approach would similarly expedite the search and detect process for watersheds with these characteristics.

4.2.4 SUSPECTED SOURCE TESTING

A completely different technique that would deal with correction of pollution at the source, rather than beginning at the outfall and moving upgradient towards the source, is a program of suspected source testing. A program of this sort would require a city ordinance (or equivalent) that would allow "right-of-entry" access to test for improper connection with the storm sewer system. Suspected source testing could be done using either the smoke testing and/or fluorometric dye testing techniques described earlier. Voluntary compliance could be encouraged for facilities that lie within the suspect outfall watershed, if such facilities were willing to allow source testing on their premises as a means to be removed from the suspect facilities list. Facilities that are found to not be connected to the storm sewer system should have an NPDES stormwater permit if applicable.

Mandatory suspect source testing may have to be initiated if, by process of elimination, a given facility appears to be the source of pollution. The City of Fort Worth (Rattan, Falkenbury et al., 1989) has had some experience in this area and recommends good public relations with the potentially responsible party (PRP) rather than a "hard line" approach. In some cases, the PRP may not realize that they are operating in violation of a regulation and they may respond favorably to the correction of the problem once they have been confronted with it. If that approach fails, then state and/or national regulatory agencies should be contacted and notices of violation may be served to expedite the correction process. Another positive aspect of the voluntary or mandatory source control method is that "word of mouth" communication often occurs between pollution generators prompting other similar generators to correct their problems before stormwater pollution is traced to their activity. At any rate, suspected source testing is the only true method that will actually locate and detect illicit connections.

4.2.5 PUBLIC AWARENESS AND PARTICIPATION

As the problem of stormwater pollution becomes prevalent in the public eye, individual citizens and citizens' watchdog groups could serve an active role in pollution monitoring and illicit connection detection. Public awareness campaigns could assist by providing educational materials to the public in an effort to point stormwater pollution sources and characteristics. Public participation could also be accomplished by encouraging citizens to point out pollution problems to city or county agencies. Public awareness and encouragement to participate could greatly assist in the detection of illicit connections.

4.3 PRIORITIZED SCHEDULE FOR SUSPECT OUTFALLS

This section has described the physical connection location techniques and strategies available for the detection of illicit connections. The following discussion will present a priority-based schedule for monitoring and remediation of the suspect outfalls identified in Section 3.2.

As was presented in Section 3.2, the suspect outfalls were grouped into two categories: Tier One (Flowing Outfalls) presented in Table 3-1, and Tier Two (Standing Water Outfalls) presented in Table 3-2. All Tier One classified outfalls shall have priority above all Tier Two outfalls. Within each tier, further subdivision is made based upon level of concern, by the following designations: Class A and Class B. All Class A identified outfalls shall have priority above all Class B identified outfalls. A complete discussion of the basis for these grouping designations was previously described (see Section 3.2). Hence the prioritized schedule for monitoring and, ultimately, remediating the suspect outfalls is prescribed as follows:

PRIORITIZED SCHEDULE FOR SUSPECT OUTFALLS

Tier One, Class A Outfalls	-	Highest Priority
Tier One, Class B Outfalls	-	High Priority
Tier Two, Class A Outfalls	-	Medium Priority
Tier Two, Class B Outfalls	-	Low Priority

This suggested schedule is priority-based, and should be conducted in conjunction with a routine outfall inspection program. Its goal is to monitor suspect outfalls, based upon their level of environmental concern, in order to detect and remove illicit connections from the regional stormwater system. It is understood that implementation of the above schedule will be greatly influenced by the availability of program funding.

5.0 CONTROL PLAN HEALTH AND SAFETY RECOMMENDATIONS

This section outlines general health and safety procedures to be followed by field personnel during outfall inspections and dry weather flow sampling events as specified by this Control Plan. Field investigations are often conducted at remote locations and should always be performed by a minimum crew of two persons. Field personnel should be equipped with first aid kits and should also have a poison extractor available in case of snakebite. Insect and mace repellents may be appropriate to protect against insects, dogs, and other environmental nuisances.

The field crew should carry two-way radios that can allow communication with a City dispatcher. Periodic communication with City personnel is recommended as a procedure to monitor the field crew's location, especially in the event of an emergency situation. It is also suggested that the field crew has drinking water and/or thirst quenchers (eg. Gatorade) available in order to prevent heat stress or heat exhaustion. Appropriate dress, in the form of layered clothing, is necessary to prevent cold stress during winter's temporary cold weather intrusions.

Disposable sampling gloves (latex or PVC) are recommended for water and/or sediment sampling events. Disposable gloves should be changed and properly disposed of between sample locations for personal health reasons and to prevent cross contamination of samples. Good personal hygiene, such as washing hands with soap, periodically and at the end of each work session should be done by field personnel. Field personnel should be careful not to touch their hands to their mouths to prevent accidental ingestion, lest that pollutants are present.

Coordination by the City Stormwater Department should be arranged to obtain appropriate access to drainage easements and rights-of-way and to avoid entry to private property without owner's approval. Accessibility to remote areas should be coordinated and arranged prior to field investigation.

Emergency contingency procedures need to be implemented based upon the location and terrain being inspected. In the event that sampling personnel require assistance, the City needs to be able to respond expeditiously and with the appropriate equipment. In the case of a medical emergency, the field crew should have a route map to the nearest hospital at their immediate disposition. Finally, via two-way radio communication with the City switchboard, the capability of dispatching emergency medical personnel is another necessary contingency in the event of medical emergency.

6.0 REFERENCES

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TABLE OF CONTENTS

1.0 INTRODUCTION

In Task 2.I.B.(2)(c), a wet weather sampling plan was developed which outlines a program to collect and analyze stormwater samples from representative monitoring sites. The intent of the sampling program is to provide characterizations of typical stormwater quality from various land uses in the Corpus Christi area. This data will be used as input to the NPS Model for determination of pollutant loads and evaluation of pollution management alternatives. The proposed monitoring sites and the selection criteria applied are presented herein.

Major outfalls of the storm sewer system were located and mapped per Task 2.I.A. Outfall contributing drainage area land use information compiled in Tasks 2.I.C.(1) and (2) was analyzed to identify areas which are representative of the land uses shown below:

- Agricultural
- Commercial
- Industrial
- Residential

Three proposed monitoring sites for each of the above land uses were selected. Selection criteria are described in Section 2.0. Candidate monitoring site locations and associated outfall contributing drainage area information are listed in Section 3.0.

2.0 SELECTION CRITERIA

2.1 GENERAL

Site selection and sampling locations were based on contributing drainage area and site location characteristics. Contributing drainage area criteria included subwatershed area and land use, potential for illicit connections or illegal dumping, and the presence of point sources. Site location factors considered were hydraulic characteristics, accessibility, equipment siting, safety, and security.

2.2 DRAINAGE AREA FACTORS

The objective of the wet weather sampling program is to provide the land use characterization data necessary to estimate annual and seasonal pollutant loadings and the storm event mean concentration of pollutants in stormwater discharges.

To collect water quality data representative of a single land use, contributing drainage areas for each major outfall were evaluated. Those sites which drained areas with a predominantly homogeneous land use were identified. In order to ensure the collection of representative data, only those sites which drained areas greater than 50 acres were identified. A two-acre minimum area requirement was applied to potential industrial sites.

Sites were also selected based on the potential for illicit connections or illegal dumping to that part of the storm sewer system being serviced by the site. During the field locating activities performed as part of this Master Plan, major outfalls were screened for dry weather flows. Monitoring sites not located at major outfalls were also field screened. The presence of dry weather flow is indicative of potential nonstormwater discharges to the storm sewer system resulting from improper connections or disposal to the system. Nonstormwater discharges could greatly influence the quality of stormwater discharges, rendering them meaningless for characterization of land use impacts. Therefore, any site which exhibited dry weather flows were not considered as a candidate representative monitoring site.

For similar reasons, sites which drained areas with NPDES permitted point source discharges, such as municipal or industrial wastewater effluent discharges, were not considered.

2.3 SITE FACTORS

Actual monitoring site determinations were based on the hydraulic characteristics of the conveyance, ability to install flow monitoring and sampling equipment, legal and physical accessibility, and safety factors.

To ensure accurate flow monitoring results for open channels, the point at which flow data is collected must exhibit certain hydraulic properties. EPA guidelines recommend that uniform and stable channel characteristics (particularly channel dimensions and slope) extend six channel widths upstream from the flow monitoring point. A stage-discharge curve should exist or be developed for the selected outfall to be monitored. If not, a rating curve should be able to be developed from existing discharge records.

Obviously, rating curves for circular pipes and box culverts are obtained with less difficulty since cross-sectional area characteristics are easily determined. A concern for closed conduit sites is the possibility of surcharging during a representative storm event which affects the results from weir or flume installations. As will be seen in Section 3.0, the majority of outfalls recommended as candidate monitoring sites are conduit conveyances.

Both open channel and closed conduit monitoring sites should not experience tidal or backwater effects. Almost all of the major outfalls located in this study experienced tidal effects. Therefore, the candidate sites are located well upstream of major outfalls within their associated service areas. Also, to allow for complete mixing of stormwater flows, sites have been selected an adequate distance downstream from points of tributary inflow.

In most cases, selected monitoring sites have been chosen which are located on City owned property or areas where an easement exists which will allow legal access by field crews. Physical accessibility to the site is required to transport and install equipment and to collect data. For safety reasons, monitoring sites have been located away from heavily traveled roads or locations where accidents may occur due to noise, speed or sight obstruction factors.

3.0 MONITORING SITES

The outfalls proposed as candidate monitoring sites are shown in Table 3-1. Three monitoring sites have been recommended for each of the following land use types: agricultural; commercial; industrial; and residential. For each proposed monitoring site, the location, subwatershed area, and percentages of current land uses are listed. Proposed monitoring sites are also mapped on Figure 3-1.

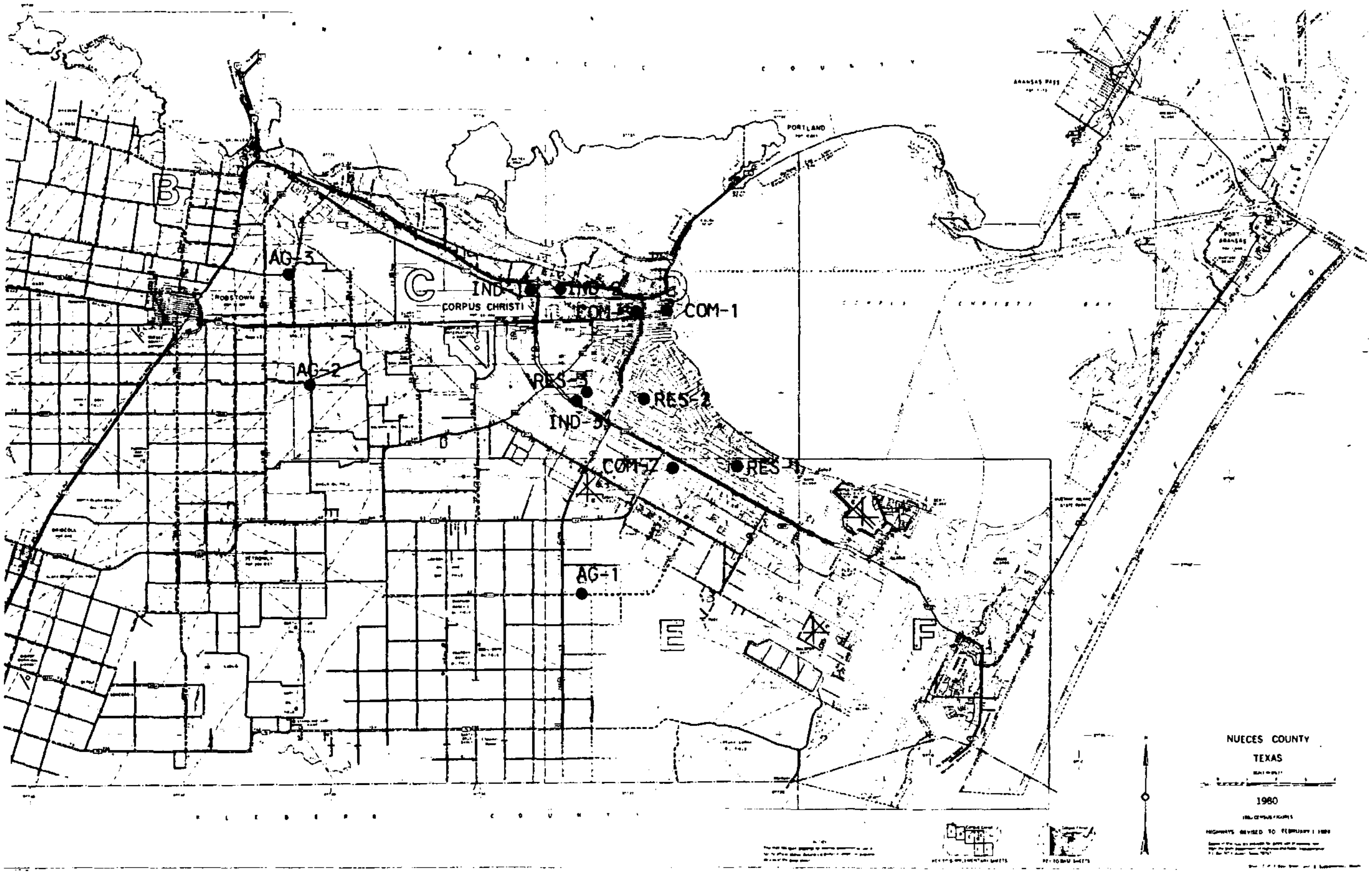
TABLE 3-1
PROPOSED STORM EVENT MONITORING LOCATIONS

Monitoring Site	Approximate Location [1]	Sub-Watershed Area	Land Use
AG-1	On FM 2444 (Staples) 3,150 feet east of the intersection of FM 2444 and State Highway 286 (Chapman Ranch Rd.) at bridge. Upstream of OC03.1L (outfall).	± 3,712 Acres	Agricultural 92% Pasture (grazing) 6% Homesteads (farm) 2%
AG-2	1,350 Feet south of South Violet Rd. from intersection of South Violet and CR-36 (Jalufka Dr.) at bridge. Also location of W.O. 08.67R (outfall).	± 1,621 Acres	Agricultural (crops) 86% Pasture (grazing) 9% Homesteads (farm) 5%
AG-3	50 Feet west of Violet Road on CR-44 Head waters at Oso Creek.	± 193.76 Acres	Agricultural 100%
COM-1	Located at point where two - 4.5' x 4' box conduits discharge into South end of Blucher Park. Park located between Carrizo, Kinney, Tancahua and Blucher Streets. Upstream of CB12.99L (outfall).	± 274 Acres	Industrial 16% Commercial 84%
COM-2	Located 35 feet southwest of Tiger Lane and Flynn Parkway intersection (buried 6' x 6' box discharging into open ditch). Upstream of OC07.39R (outfall).	± 232 Acres	Industrial 21% Residential 6% Commercial 73%
COM-3	Located 80 feet upstream inside 9' x 4' box at the intersection of Commanche and 19th Streets or through manhole at intersection. Upstream of outfall IH00.70L.	± 293.1 Acres	Commercial 73% Residential 12% Industrial 15%

TABLE 3-1
PROPOSED STORM EVENT MONITORING LOCATIONS
(Continued)

Monitoring Site	Approximate Location [1]	Sub-Watershed Area	Land Use
IND-1	Located in grassed area at south side of IH-37 and McBride Lane intersection between eastbound IH-37 access road, IH-37 and McBride Lane (buried 7' x 6' box). Upstream of IH05.90L (outfall).	± 553 Acres	Industrial 82% Commercial 12% Residential 6%
IND-2	Located on south side of IH-37 between Krill Street and railroad track. Site should be placed as near as possible to IH-37, between trach and Krill St. (buried 36" RCP). Upstream of IH05.90L (outfall).	± 37.0 Acres	Industrial 80% Commercial 20%
IND-3	400 Feet southeast of Columbia Street from the intersection of Ambassador Row and Columbia. Upstream of OC10.97R (outfall).	± 20.2 Acres	Industrial 100%
RES-1	Located in Cullen Park. Cullen Park located between open ditch, Belmeade Dr. and Adel Dr. (Buried 42" RCP outfalls into open ditch at rear of park.) Upstream of OB01.30R (outfall).	± 79.15 Acres	Residential 100% - Medium density, single family homes
RES-2	Located in Brawner Park at intersection of Brawner Parkway and Green Grove Dr. (Buried 42" RCP intersecting 10' x 8' box.) Upstream of CB09.71L (outfall).	± 50.17 Acres	Residential 100% - Medium density, single family homes
RES-3	Intersection of Columbia Street, West Point Road and Airport drainage ditch. Upstream of OC10.97R (outfall).	± 200.6 Acres	Residential 93%

[1] Exact locations will be determined in field at time of monitoring plan implementation.



PROPOSED MONITORING SITES

FIGURE NO. 3-I

CDM
environmental engineers, scientists, planners, & management consultants

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