SFWMD

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

MANAGEMENT AND STORAGE OF SURFACE WATERS PERMIT INFORMATION MANUAL VOLUME IV

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

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PERMITTING INFORMATION MANUAL

Volume IV, Management and Storage of Surface Waters

September 1978

Resource Control Department
South Florida Water Management District
P.O. Box V
West Palm Beach, Florida 33402

This public document was promulgated at an annual cost of $1,762.20, or $.881 per copy to provide information on District regulatory requirements for potential permit applicants. RCD R679 4C

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FOREWORD

The South Florida Water Management District (formerly the Central and Southern Florida Flood Control District), is actively pursuing its duties as set forth in Chapter 373, Florida Statutes. Along with this above name change, which became effective January 1, 1977, were some boundary changes which are designed to make the South Florida Water Management District more closely follow nature's watershed boundary lines (reference Figure 1). With these changes, the District has put into operation nearly all of the requirements of the Water Resources Act.

The regulatory procedures the act mandates are well underway, with the District having the responsibility to issue permits for a variety of activities including water use (public water supply, irrigation, etc.), surface water management (generally referred to as drainage), artificial recharge (primarily deep well injection), and right-of-way use of District project works. In performing its regulatory duties, certain questions have arisen as to what the actual practice of these duties include, particularly as to how they supplement, complement, overlap, etc., the duties of local, regional and federal agencies. Therefore, the District has prepared for distribution a series of Information Manuals which capsulize the answers to the most commonly asked questions. This series is comprised of the following volumes (additional volumes may be necessary from time to time).

Volume I, General and Procedural Information

This manual provides a basic overview of the District's regulatory activities, including types of permits required, permit procedures, and references to other volumes for detailed information.

Volume II, District Rules, Regulations and Legislation

This volume contains a reprint of Chapter 373, Florida Statutes (Water Resources Act of 1972, as amended), and the pertinent rules that are applicable to the District's regulatory operation.

Volume III, Permitting of Uses of Water

In this volume, specific information and criteria are presented for preparation and evaluation of water use permit applications, including public water supply, irrigation, and other uses.

Volume IV, Management and Storage of Surface Waters

In this volume, specific information and criteria are presented for preparation and evaluation of permit applications for management and storage of surface waters, including basis of review, SFWMD Project discharge limitations, and an example design.

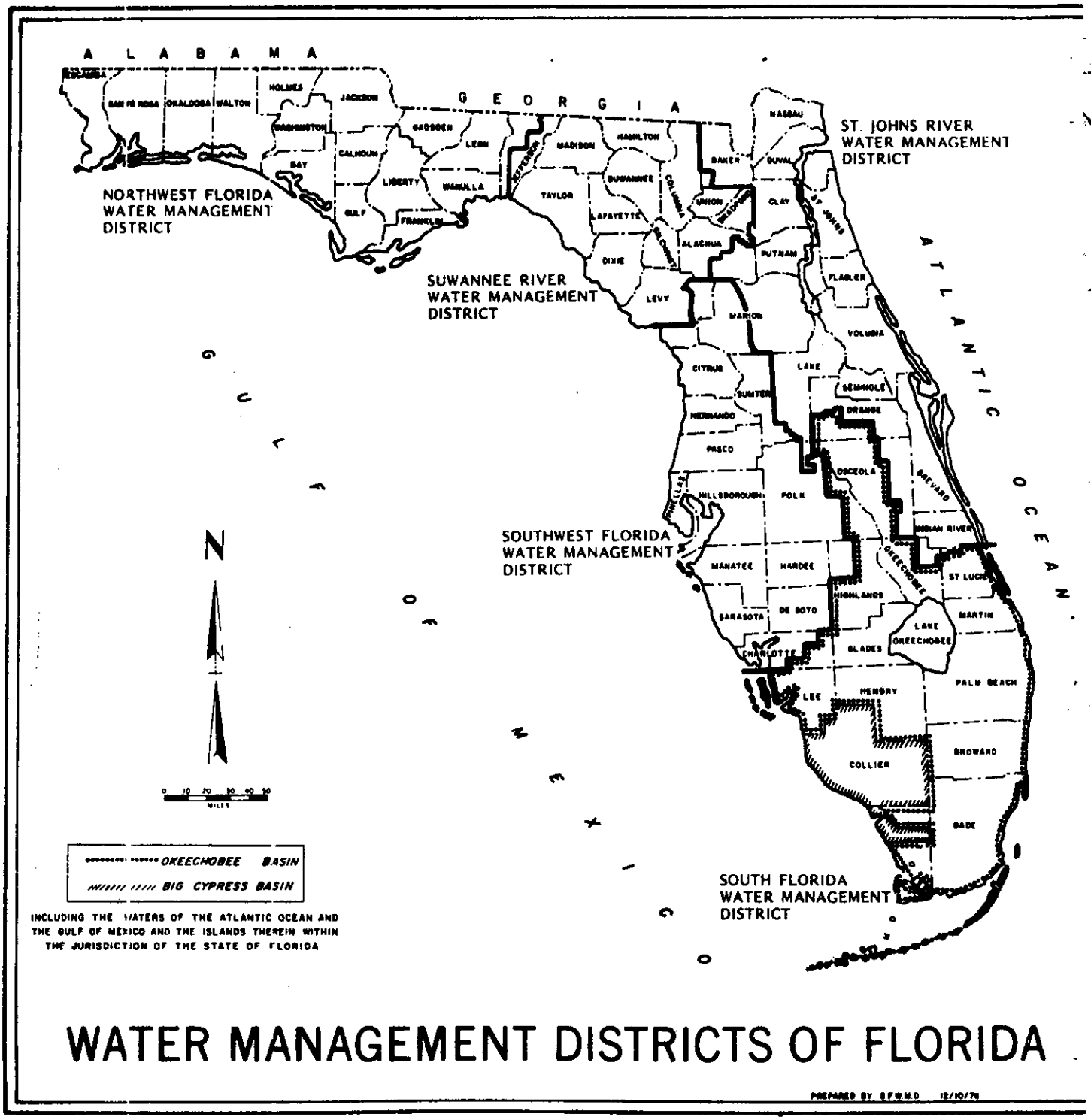
Volume V, Criteria Manual for Utilization of District Works and Lands

This manual provides specific criteria for preparation and evaluation of applications for use of Project Works and Lands, including connection of drainage works, bridge design, permissable right-of-way uses, etc.

Volume VI, Real Property Acquisition and Disposal

In this manual, District procedures and criteria are presented for acquiring property, releasing reservations, easements and rights-of-way, sale of surplus land, spoil material, and leasing District controlled lands.

It is firmly hoped that recognition of these duties, which the District is applying on an across-the-board basis throughout the area under its jurisdiction, will better allow coordination between the District and both public agencies and the private sector. Continued contact and feedback on these matters from both the public and private sectors, is earnestly requested in order to make periodic refinements in the District's regulatory operation.



WATER MANAGEMENT DISTRICTS OF FLORIDA

FIGURE 1

Part A - Surface Water Management Rules

I. General

A. South Florida Water Management District Authority

The Central and Southern Florida Flood Control District was created by Chapter 25270 Laws of Florida (1949) as a multicounty district for purposes of flood control and water conservation. In 1972 the Florida Legislature enacted Chapter 373, Florida Statutes, the Florida Water Resources Act of 1972 (Act), which greatly expanded the District's responsibilities from flood control to the full range of water management activities in addition to changing the name of the District.

The Act is intended to govern the regulation of all waters of the State, unless exempted by law, where waters of the state are defined to include all water on or beneath the surface of the ground or in the atmosphere.

Generally, the purposes for which the Act was adopted are to provide for management of water and related land resources, to promote the conservation, development and proper utilization of surface and groundwater, to provide water storage for beneficial purposes, to prevent damage from floods, soil erosion and excessive drainage, to preserve natural resources, fish and wildlife, and to promote recreational development.

The District is governed by a nine-member board (plus one transitional member from the Big Cypress Basin) which is responsible for the overall administration of District programs, the regulatory program implementing the Act and the development of a water use plan. The District is also divided into two basins (the Big Cypress Basin and Okeechobee Basin), which are governed by basin boards. The primary functions of the basin boards are to plan and approve construction of primary water resource development projects and to plan secondary water control facilities for guidance of local government and private local owners.

The Act provides for the establishment of permit programs for the regulation of consumptive use of water, well construction, surface water management systems, artificial recharge and utilization of works or land of the District. Except for artificial recharge, primary regulatory authority resides in the Department of Environmental Regulation with direction to delegate the authority to the water management districts to the maximum extent practicable.

Pursuant to the Administrative Procedures Act, the District has implemented all the permitting programs authorized by the Act except for Part III, the regulation of wells, by adopting rules which are published as Chapter 16K of the Florida Administrative Code.

B. Permitting Procedures

The District is governed by the Administrative Procedures Act, and Rule Chapter 16K-1. Together they provide an administrative framework for the resolution of conflicts between applicants, objectors and the District. Within this framework, if no objections are received and the applicant agrees with the staff's recommendations, the application can usually be disposed of informally before the Governing Board. If however, the applicant disagrees with the staff's recommendations, or someone whose substantial interest may be affected objects, a formal hearing may be held either before the Governing Board or before a hearing officer from the Department of Administrative Hearings. In either case, adequate safeguards are provided so that disputes can be resolved judiciously and expeditiously.

Upon receipt of an application for a permit, the District will request any necessary additional information from the applicant within 30 days. Upon receipt of a complete application the District will issue or deny the permit application within 90 days unless the matter has been scheduled for a public hearing in which case the 90 day period is tolled.

C. Permitting of Surface Water Management Systems

1. Statutory Provisions (Part IV, Chapter 373 F.S.)

Part IV of the Act deals with surface water management. Generally permits may be required by the water management districts for construction, alteration, maintenance and operation of most real property improvements which are designed to control surface waters.

Permits issued pursuant to this part are permanent unless the surface water management system is abandoned, or the permit is otherwise revoked or modified. No permits are required under this part for a closed system as defined in F.S. 373.403(6). An applicant for a surface water management permit must show that the proposed project is consistent with the goals and policies expressed in F.S. 373.016, Declaration of Policy and F.S. 373.036, State Water Use Plan, and that the construction or alteration of the surface water management system will not be harmful to the water resources of the District, and that the operation and maintenance of the system will not be inconsistent with the overall objectives of the District or harmful to the water resources of the District.

2. Rules of the South Florida Water Management District (Chapter 16K-4 F.A.C.)

Chapter 16K-4 describes the permit requirements for construction alteration, or operation of surface water management systems. Generally, all construction alteration or operation of dams, impoundments, reservoirs, appurtenant works or works as defined in the Act require a permit from the District. Closed systems and some projects in coastal areas may be exempt, however. To satisfy

the permit requirement an applicant must either receive an individual permit or qualify for a general permit. Individual permits are issued by the Governing Board upon application and compliance with Part IV of the Act and Chapter 16K-4 F.A.C. Specific criteria for evaluating urban projects are found in 16K-4.035. Further, additional criteria may be superimposed if the project is to be located within an area in which the District has adopted basin rules (see Chapter 16K-34 for additional criteria applicable in the Western Canal 9 Basin).

General permits have been issued by rule for most small projects (16K-4.021(1)), and certain types of highway construction (16K-4.022) District-wide, and for some larger projects which have received the approval of Dade or Palm Beach Counties (16K-4.021(2)). To qualify for a general permit, an applicant need only file the notice specified in the rules with the District, in advance of construction, alteration, or operation of the qualifying project. Upon receipt of the notice, the District will determine whether the project qualifies for a general permit and respond to the applicant. Once the District has indicated in writing that the project qualifies for a general permit, no further application is required. Both individual and general permits are subject to revocation, suspension or modification in accordance with the provisions of Chapter 16K-4, Part IV of the Act and Chapter 120 F.S.

3. Permit Requirements

In terms of surface water management (generally referred to as drainage), the District currently issues individual permits for all drainage activities except the following:

(a) Certain tidal receiving water activities that are reviewed and/or permitted by numerous other agencies (reference Rule 16K-4.02, F.A.C.).

(b) Certain closed systems (reference Rule 373.406, Florida Statutes).

(c) Projects with less than two acres of impervious area, ten acres of gross area, and requiring a discharge facility no greater than the equivalent of a 24 inch circular pipe gravity discharge (reference Rule 16K-4.021, F.A.C.).

(d) Certain public highway projects (reference Rule 16K-4.022).

(e) Certain projects in Dade County which have less than forty acres total land area with positive storm drainage, or have less than 320 acres total land area and less than 160 acres of impervious area with no positive storm drainage discharge outfall (reference Rule 16K-4.021, F.A.C.).

(f) Certain projects in Palm Beach County which have less than forty acres total land area (reference Rule 16K-4.021).

Drainage activities identified in items (a) and (b) above are exempt from District permitting altogether, either by State statute or by District rule. However, the activities delineated in items (c), (d), (e) and (f) are permitted by District rule (General Permit Categories), provided such activities are conducted according to conditions specified in the appropriate rule. If these activities meet the applicable criteria, the permittee need only file with the District a Notice of Intent to Construct Works pursuant to General Permit at least 30 days prior to commencement of construction. Generally, five review criteria are considered in evaluating surface water management permit applications. These include the following:

(1) Local subdivision protection criteria.

(2) Receiving water acceptance capability.

(3) One hundred year building floor protection.

(4) Potential water quality impacts.

(5) Environmental impacts.

Plans and calculations are required, sealed by a Florida Professional Engineer. When storage of surface water is proposed, stage-storage and stage-discharge calculations must be provided. In addition, when water management facilities such as lakes, pumps, etc. will not be in the public right-of-way and accepted by the local jurisdiction, evidence of a legal entity, which will be responsible for operation of the facilities, must be submitted. Some local agencies require the majority of the above information in their normal platting process.

II. Rule 16K-4.021

A. Justification for Rule

Sections 373.413 and 373.416 and Rules 16K-4.03 and 16K-4.07 require that the District permit all surface water management systems which are encompassed within the definition of "works" as stated in 373.403(5) regardless of size or location. As a result, many small projects which, because of their size, nature or location, plus regulation by local government, will have minimal impact on the water resources of the District, still require a District permit. It was the District's desire to eliminate the need for Rule 16K-4.03 or 16K-4.07 permits in situations of minimal potential for impact which can be adequately handled by local government. To eliminate the unnecessary and duplicative permitting requirements, this rule automatically grants a permit for certain classes of small projects under specified conditions without the necessity of a formal application.

B. Specifics of Rule

1. All works within the District which serve projects with less than 10 acres total land area, with less than 2 acres of impervious area, requiring a discharge facility no greater than the equivalent of one 24-inch pipe gravity discharge, which are located on uplands and within local entities which have adopted subdivision regulations, are permitted by this rule subject to conditions.

2. All works within Dade County which have been approved by the Dade County Department of Environmental Resources Management, are permitted by this rule if they serve projects which have less than 40 acres total land area with a positive storm drainage outfall or if they serve projects which have less than 320 acres total land area and less than 160 acres of impervious area with no positive storm drainage discharge outfall.

3. All works within Palm Beach County which serve projects with less than 40 acres total land area and have been approved by Palm Beach County, are permitted by this rule.

4. The applicant must notify the District 30 days in advance of construction to be permitted under this rule. Form Number 19 dated August 1977, Notice of Intent to Construct Works Pursuant to General Permit, (example form on next page) should be used for this purpose. Upon receipt of the notice, the District will determine whether the project qualifies for a general permit and respond to the applicant. Once the District has indicated in writing that the project qualifies for a general permit, no further application to the District is required.

NOTICE OF INTENT TO CONSTRUCT
*** WORKS PURSUANT TO GENERAL PERMIT ***
(Rule 16K-4.021)

SUBMITTED TO: Governing Board of
South Florida Water Management District
Post Office Box "V"
West Palm Beach, Florida 33402

1. NAME & ADDRESS OF PERMITTEE: _____

_____

2. NAME OF THE PROPOSED PROJECT: _____

_____

3. LOCATION OF THE PROJECT (include sketch): _____

_____

4. BRIEF DESCRIPTION OF THE WORKS TO BE CONSTRUCTED OR ALTERED: _____

_____

_____

_____ (Add extra sheet if necessary)

5. BRIEF STATEMENT OF FACTS WHICH SHOW WHY THE PROPOSED WORKS QUALIFY FOR A GENERAL PERMIT: _____

_____

_____

_____ (Add extra sheet if necessary)

6. DATE CONSTRUCTION OR ALTERATION IS EXPECTED TO COMMENCE: _____

_____

I HEREBY CERTIFY THAT ALL NECESSARY FEDERAL, STATE, LOCAL AND SPECIAL DISTRICT AUTHORIZATIONS HAVE BEEN RECEIVED.

Permittee's Name (type or print) _____

Signature _____ Date _____

FORM 19
AUG 1977

FIGURE 2

III. Rule 16K-4.022

A. Justification for Rule

Sections 373.413 and 373.416, Florida Statutes and Rules 16K-4.03 and 16K-4.07, Florida Administrative Code, presently require that the District permit all surface water management systems which are encompassed within the definition of "works" as stated in 373.403(5), F.S. It has been the experience of the District that surface water management systems associated with certain types of public highway projects will have little, if any, impact upon the water resources of the District. In addition, most such projects are thoroughly reviewed by other state, federal and local agencies. On the other hand, some highway projects obviously have a potential for adversely impacting the water resources of the District. For example, projects which involve District works, major fresh water bodies, environmentally sensitive areas and wetlands are among those projects which the District has identified as having a potential impact. It was the District's desire to eliminate the need for Rule 16K-4.03 and 16K-4.07 permits in those situations which have minimal impact and are adequately handled by other agencies while subjecting the rest to a full review. This rule automatically grants a permit for limited classes of projects under specified conditions without the necessity of a formal application.

B. Specifics of Rule

1. All works within the District which serve public highway projects constructed or funded by state, federal or local government, are permitted by this rule subject to conditions and exceptions. The exceptions specified in the rule apply to projects which are likely to have an impact on the water resources of the District.

2. The applicant must notify the District 30 days in advance of construction to be permitted under this rule. Form Number 19 dated August 1977, Notice of Intent to Construct Works Pursuant to General Permit, should be used for this purpose. Upon receipt of the notice, the District will determine whether the project qualifies for a general permit and respond to the applicant. Once the District has indicated in writing that the project qualifies for a general permit, no further application to the District is required.

16K-4.022 General Permit for Construction, Alteration or Operation of Works in Conjunction with Public Highway Projects.

(1) District-wide General Permit. This subsection provides a general permit for all qualifying projects within District boundaries. Subsection (2) provides a broader general permit within specified jurisdictions.

(a) All entities constructing, altering or operating works in conjunction with public highway projects within rights-of-way dedicated to the public for highway purposes (except Water Management District rights-of-way) or funding such construction, alteration or operation, which would otherwise require a permit pursuant to Rule 16K-4.03 or Rule 16K-4.07 for said construction, alteration or operation, except as provided in paragraph (b), are hereby granted a general permit to construct, alter or operate said works subject to the conditions specified in paragraphs (c), (d) and (e). The term "entity" as used in this rule shall be construed to mean the State of Florida, the U.S. Government, counties, and municipal corporations but shall not be construed to include special districts, however created.

(b) Exceptions - The construction, alteration or operation of the following types of works in conjunction with public highway projects may require individual permits pursuant to Rule 16K-4.03, or Rule 16K-4.07.

1. Projects which use District projects works;

2. Projects involving major freshwater bodies where major freshwater bodies are defined as inland navigable waters of the United States and the freshwater wetlands adjacent or contiguous thereto, the primary tributaries of inland navigable waters and the freshwater wetlands adjacent or contiguous thereto; lakes greater than five acres in size;

3. Projects in environmentally sensitive areas as described

in Part II under Operational Conditions in the District's "Basis of Review of Construction of Surface Water Management Systems Serving Projects with Two or More Acres of Impervious Area within the South Florida Water Management District - May, 1977," which has been adopted by the Governing Board and is hereby published by reference.

4. Projects proposed to have borrow pits which require dewatering;

5. Projects proposed to have borrow pits which function as integral parts of drainage systems;

6. Projects which do not require permits from Florida Department of Environmental Regulation.

7. Projects which drain lands outside the entities' jurisdictional limits.

8. Projects which lower or have the potential for lowering the dry season groundwater table outside of the project's design drainage area.

9. Projects which block, intercept or divert natural drainage patterns or flows.

(c) The general permit authorized in paragraph (1)(a) shall be subject to the following conditions:

1. The permittee shall include in the design of the works, techniques for storm water runoff quality control. Said techniques may include but are not limited to those specified in the District's "Basis of Review of Construction of Surface Water Management Systems Serving Projects with Two or More Acres of Impervious Area within the South Florida Water Management District - May, 1977" which has been adopted by the Governing Board. To determine the effects of the works on the water resources of the District, submission of water quality data for the water discharged from the permittee's property may be required. Parameters of interest include, but are not necessarily limited to: nitrates as N,

nitrites as N, ammonia as N, total phosphorus as P, total suspended solids, 5 day 20°C. BOD, turbidity, conductivity, dissolved oxygen, ph, and oil/grease.

2. The permittee shall prosecute the work authorized by this rule in a manner so as to minimize any degradation of water quality and shall institute necessary measures during the construction period, including full compaction of any fill material placed around newly installed structures, to reduce erosion, turbidity, nutrient loading and sedimentation in the receiving waters, and to minimize any adverse impact of the works on fish, wildlife and natural environmental values.

3. The permittee shall obtain all necessary Federal, State, local and special district authorizations prior to the start of any construction or alteration of works authorized in paragraph (1)(a).

4. The permittee shall permit the authorized representative(s) of the District to make periodic inspections at any time deemed necessary in order to assure that the activity being performed under authority of this permit is in accordance with the terms and conditions prescribed in this rule.

5. This permit does not convey to the permittee any property rights nor any rights or privileges other than those specified in this rule nor relieve the permittee from complying with any law, regulation or requirement affecting the right of other bodies or agencies.

6. The work authorized by this rule shall be done in accord with plans and specifications approved by a Florida registered Professional Engineer on behalf of the entity, subject to the exemptions specified in Chapter 471, Florida Statutes. If so approved, upon completion of construction or alteration, a Professional Engineer shall certify to the

16K-4.021 General Permit for Construction, Alteration or Operation of Works.

(1) District-wide General Permit. This subsection provides thresholds for a general permit for all qualifying projects within District boundaries. Subsection (2) provides higher thresholds for qualifying projects within specified boundaries.

(a) All persons constructing, altering or operating works as defined in subsection 373.403(5), Florida Statutes, which would otherwise require a permit pursuant to Rule 16K-4.03 or Rule 16K-4.07 for said construction, alteration or operation and whose works serve projects that:

1. have less than ten acres total land area,

2. have less than two acres of impervious area,

3. require a discharge facility no greater than the equivalent of one 24-inch pipe gravity discharge,

4. are located wholly on lands which may be classified as uplands as defined in Chapter 17-4, Florida Administrative Code,

5. are located within a local jurisdiction which has adopted subdivision regulations, and

6. are not located in areas governed by District basin rules which specifically provide that General Permit rules are not applicable;

are hereby granted a general permit to construct, alter, or operate said works. For projects which are to be developed in phases the term "total land area" shall be construed to mean total contiguous land holdings.

(b) The general permit authorized in paragraph (1)(a) shall be subject to the following conditions:

1. The permittee shall include in the design of the works, techniques for storm water runoff quality control. Said techniques may include but are not limited to those specified in the District's "Basis of Review of Construction of Surface Water Management Systems Serving Projects with Two or More Acres of Impervious Area within the South Florida Water Management District -

May, 1977" which has been adopted by the Governing Board. To determine the effects of the works on the water resources of the District, submission of water quality data for the water discharged from the permittee's property may be required. Parameters of interest include, but are not necessarily limited to: nitrates as N, nitrites as N, ammonia as N, total kjeldahl nitrogen as N, ortho-phosphorus as P, total phosphorus as P, total suspended solids, 5 day 20° C. BOD, turbidity, conductivity, dissolved oxygen, and pH.

2. The permittee shall prosecute the work authorized by this rule in a manner so as to minimize any degradation of water quality and shall institute necessary measures during the construction period, including full compaction of any fill material placed around newly installed structures to reduce erosion, turbidity, nutrient loading and sedimentation in the receiving waters, and to minimize any adverse impact of the works on fish, wildlife and natural environmental values.

3. The permittee shall design the works to comply with all applicable local subdivision regulations and other local requirements. In addition the permittee shall obtain all necessary Federal, State, local and special district authorizations prior to the start of any construction or alteration of works authorized in paragraph (1)(a). The permittee must obtain a Right-of-Way Occupancy Permit from the District for any works which propose to connect with, place structures in or across or otherwise make use of works or lands of the District prior to the start of any construction or alteration of works authorized in paragraph (1)(a).

4. The permittee shall permit the authorized representative(s) of the District to make periodic inspections at any time deemed necessary in order to assure that the activity being performed under authority of this permit is in accordance with the terms and conditions prescribed in this rule.

5. This permit does not convey to the permittee any property rights nor any rights or privileges other than those specified in this rule, nor relieve the permittee from complying with any law, regulation or requirement affecting the right of other bodies or agencies.

6. The work authorized by this rule shall be done in accord with plans and specifications approved by a Florida registered Professional Engineer, subject to the exemptions specified in Chapter 471, Florida Statutes. If so approved, upon completion of construction or alteration, the Professional Engineer shall certify to the District that the work conforms with the plans and specifications.

(c) 1. At least 30 days prior to the commencement of any construction or alteration of works authorized in paragraph (1)(a), the permittee shall file with the District, in writing, a Notice of Intent to Construct Works pursuant to General Permit. The notice shall include the following information:

a. the name of the permittee,

b. the name of the proposed project,

c. the location of the project,

d. a brief description of the works to be constructed or altered,

e. a brief statement of facts which shown why the proposed works qualify for a general permit,

f. a statement that all necessary Federal, State, local and special district authorizations have been received and that the project is acceptable to the elected officials of the pertinent local jurisdiction as being in the public interest with respect to environmental and economic impacts, and

g. the date on which construction or alteration is expected to commence.

2. The notice required in subparagraph (1)(c)1. is intended to provide the District with information concerning the types of projects which are being constructed or altered pursuant to this general permit. Failure to properly file the notice required in subparagraph (1)(c)1. may result in the District requiring that said works be individually permitted pursuant to Rule 16K-4.03.

(d) Notwithstanding the provisions of this section and pursuant

to the provisions of Chapter 120, Florida Statutes, upon a finding that any works permitted under this rule are shown to be harmful to the water resources of the District or may interfere with the legal rights of others or may be inconsistent with the overall objectives of the District, or may otherwise be contrary to the public interest, the District may require that said works be individually permitted pursuant to Rule 16K-4.03 or Rule 16K-4.07.

(e) All activities identified and authorized in paragraph (1)(a) shall be consistent with the terms and conditions of this permit. Activities which are inconsistent with the terms and conditions of this permit shall constitute a violation of this permit which may result in the revocation, modification or suspension of this permit in whole or part, in accordance with the provisions of Section 373.429, Florida Statutes, and Chapter 120, Florida Statutes.

(2) Thresholds for Specified Counties. Within the below listed boundaries the following thresholds and conditions shall apply.

(a) Dade County

1. All persons constructing, altering or operating works as defined in subsection 373.403(5), Florida Statutes, in Dade County, which would otherwise require a permit pursuant to Rule 16K-4.03, or Rule 16K-4.07, for said construction, alteration or operation and whose works serve projects that:

a. are not located in environmentally sensitive areas as defined in Rule 16K-4.035 and,

b. are not located in areas governed by District basin rules which specifically provide that General Permit rules are not applicable and,

c. (1) have less than forty acres total land area for projects with positive storm drainage discharge outfall, or

(11) have less than 320 acres total land area and less than 160 acres of impervious area for projects with no positive storm drainage

discharge outfall and,

d. have been approved by the Dade County Department of Environmental Resources Management or its successor agency subsequent to the effective date of this rule;

are hereby granted a general permit to construct, alter or operate said works. For projects which are to be developed in phases, the term "total land area" shall be construed to mean total contiguous land holdings.

2. The general permit authorized in subparagraph (2)(a)1. shall be subject to the conditions specified in paragraph (1)(b) and the notice, individual permitting, revocation, modification and suspension provisions specified in paragraphs (1)(c)-(e).

(b) Palm Beach County

1. All persons constructing, altering or operating works as defined in subsection 373.403(5), Florida statutes, in Palm Beach County, which would otherwise require a permit pursuant to Rule 16K-4.03, or Rule 16K-4.07, for said construction alteration or operation whose works serve projects that:

a. are not located in environmentally sensitive areas as defined in Rule 16K-4.035 and,

b. are not located in areas governed by District basin rules which specifically provide that General Permit rules are not applicable and,

c. have less than forty acres total land area and,

d. have been approved by Palm Beach County subsequent to the effective date of this rule;

are hereby granted a general permit to construct, alter or operate said works. For projects which are to be developed in phases, the term "total land area" shall be construed to mean total contiguous land holdings.

2. The general permit authorized in subparagraph (2)(b)1. shall be subject to the conditions specified in paragraph (1)(b) and the notice, individual permitting, revocation, modification and suspension provisions

specified in paragraphs (1)(c)-(e).

Specific authority 373.113 F.S. Law implemented 373.413(1), 373.416, 373.429 FS

History: New 6-15-77, Amended

District that the work conforms with the plans and specifications.

(d) 1. At least 30 days prior to the commencement of any construction or alteration of works authorized in paragraph (1)(a), the permittee shall file with the District, in writing, a Notice of Intent to Construct Works Pursuant to General Permit. The notice shall include the following information:

a. the name of the permittee,

b. the name of the proposed project,

c. the location of the project,

d. a brief description of the works to be constructed or altered,

e. a brief statement of facts which show why the proposed works qualify for a general permit,

f. a copy of the drainage plan,

g. a statement that all necessary Federal, State, local and special district authorizations have been received.

h. the date on which construction or alteration is expected to commence.

2. The notice required in subparagraph (1)(d)1. is intended to provide the District with information concerning the types of projects which are being constructed or altered pursuant to this general permit. Failure to properly file the notice required in subparagraph (1)(d)1. may result in the District requiring that said works be individually permitted pursuant to Rule 16K-4.03.

(e) Notwithstanding the provisions of this section and pursuant to the provisions of Chapter 120, Florida Statutes, upon a finding that any works permitted under this rule are shown to be harmful to

the water resources of the District or may interfere with legal rights of others or may be inconsistent with the overall objectives of the District, or may otherwise be contrary to the public interest, the District may require that said works be individually permitted pursuant to Rule 16K-4.03 or Rule 16K-4.07.

(f) All activities identified and authorized in paragraph (1)(a) shall be consistent with the terms and conditions of this permit. Activities which are inconsistent with the terms and conditions of this permit shall constitute a violation of this permit which may result in the revocation, modification or suspension of this permit in whole or part, in accordance with the provisions of Section 373.429, Florida Statutes, and Chapter 120, Florida Statutes.

(2) General Permits for Specified Counties.

The general permit authorized in subsection (1) shall be applicable within all counties within District boundaries.

Specific authority 373.113 F.S. Law Implemented 373.413(1), 373.416, 373.429 F.S.

History: New

IV. Rule 16K-34

A. Justification for Rule

The Western Canal 9 Basin has in the past been subject to periods of extensive flooding during moderate storm events and to severe overdrainage during dry seasons. The area has not been heavily developed to date, but development pressure is increasing and it is likely that any new development will create flooding problems in the eastern basin, as well as aggravating the overdrainage and flooding already existent in the western basin.

In addition to the criteria for surface water management systems already in effect throughout the District, additional restrictions are necessary in the Western Canal 9 Basin because of the unique water management regime in that area as described above. This rule will preserve the existing flood protection in the Eastern Canal 9 Basin, prevent overdrainage of the Western Basin, while giving a degree of flood protection to the western developments.

B. Specifics of Rule

1. The District's General Permit Rules (16K-4.021 and 16K-4.022) are not applicable in the Western Canal 9 Basin.

2. This rule establishes for design purposes the 10-year, 25-year and 100-year flood frequency elevations as 6.5 feet, 6.8 feet, and 7.3 feet mean sea level, respectively, in the basin.

3. For diked and pumped systems, the allowable discharge is limited by this rule to three-fourths of an inch per twenty-four hours and no pumping is permitted when Canal 9 stages exceed elevation 6.8 feet mean sea level.

4. All direct connections to Canal 9 must be installed at a discharge elevation no lower than six inches below average existing ground for the project. However, discharge facilities designed to temporarily lower the groundwater table below these elevations immediately prior to the arrival of a major storm event are allowed by this rule.

5. This rule restricts the volume encroached by development between average existing ground surface and elevation 7.0 feet mean sea level to 2.0 feet times the total area of the property. The rule restricts diked areas such that the area diked must be less than this encroached volume divided by the difference between average existing ground elevation within the dike and elevation 5.75 feet mean sea level.

Chapter 16K-34 Surface Water Management Criteria - Western Canal 9 Basin

16K-34.01 Policy and Purpose. The purpose of the rules in this chapter is to establish additional surface water management criteria for the Western Canal 9 Basin which will insure that development within the Western Canal 9 Basin incorporates the appropriate water quantity and water quality control measures necessary to protect the integrity of the public investments in the Canal 9 Basin and which minimizes adverse impacts to the water resources of the District. Criteria delineated in this chapter are in addition to criteria specified in Chapter 16K-4 of the District's Rules. The criteria, exemptions and additional requirements specified in this rule are not intended to supercede or rescind the terms and conditions of any valid Surface Water Management Permit issued by the District prior to the effective date of this chapter. General Permit Rules shall not be effective within the Western Canal 9 Basin.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.

History: New10-2-77.

16K-34.02 Western Canal 9 Basin. The Western Canal 9 Basin is generally depicted in Figure 34-1, and specifically shall include the area within the following boundaries:

In Dade and Broward County, Florida, as follows:

Begin at the Southeast (SE) corner of Section 12, Township 52 South, Range 40 East; Thence, bear Westerly along the Section Lines to the intersection thereof with State Road #25; Thence, Northwesterly and Northerly along State Road #25 to the intersection thereof with State Road #820; Thence, Easterly along State Road #820 to the intersection thereof with the East line of Section 14, Township 51 South, Range 40 East; Thence, Southerly along the Section Lines to the Northwest (NW) corner of Section 1, Township 52 South, Range 40 East; Thence, Easterly along the Section Line to the Northeast (NE) corner of said Section 1; Thence, Southerly along the Section Lines to the Southeast (SE) corner of said Section 12 to the POINT OF BEGINNING.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.

History: New 10-2-77

16K-34.03 Implementation. The effective date for the rules in this chapter is October 2, 1977.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.

History: New 10-2-77.

16K-34.04 General Requirements. All projects located within the Western Canal 9 Basin which require permits pursuant to Rule 16K-4.03 or Rule 16K-4.07 shall be constructed, altered, and operated in accord with the criteria specified in Rule 16K-4.035 and Rule 16K-34.06 unless specifically exempted in Rule 16K-34.05. The most restrictive criteria will be applicable unless the applicant can demonstrate to the District's satisfaction through accepted methodology that the purpose and intent of this chapter will be fulfilled using alternate criteria.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.

History: New 10-2-77.

16K-34.05 Exemptions. Projects which have received final approval of construction plans (or equivalent approval) from local government prior to the effective date of this chapter are hereby exempted from the fill encroachment criteria specified in Subsection 16K-34.06(4). All other criteria specified in Rules 16K-4.035 and 16K-34.06 must be strictly adhered to.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.

History: New 10-2-77.

16K-34.06 Criteria Applicable to Western Canal 9 Basin.

(1) For design purposes the 100-year, 25-year and 10-year flood frequency elevations are established as 7.3 feet, 6.8 feet, and 6.5 feet mean sea level, respectively.

(2) For systems designed to be pumped from fully diked areas, discharge shall be limited to three-fourths of an inch per twenty-four hours, or the criteria in Rule 16K-4.035 whichever is more restrictive. In addition, no pumping shall be permitted when Canal 9 stages at pump tailwater exceed the 25-year peak elevation of 6.8 feet mean sea level.

(3) All direct connections to Canal 9 shall be designed to

prevent lowering of the groundwater table below elevation 2.5 feet mean sea level. All indirect connections to Canal 9 shall be designed to prevent lowering of the groundwater table by installing the discharge facilities at a discharge elevation no lower than six inches below average existing ground elevation for the project. Nothing in this subsection shall be construed to preclude the construction and operation of discharge facilities designed to temporarily lower the groundwater table below these elevations immediately prior to the arrival of a major storm event.

(4) Fill Encroachment Criteria.

(a) The volume encroached by development between average existing ground surface and elevation 7.0 feet mean sea level shall not exceed 2.0 feet times the total area of the property.

(b) For diked areas with on-site retention of runoff, the area diked shall not exceed the encroachment volume specified in paragraph 16K-34.06 (4)(a) divided by the difference between average existing ground elevation within the dike and elevation 5.75 feet mean sea level. This will require all such projects on land of average elevation less than 3.75 feet mean sea level to preserve some area outside of the dikes with no fill. Said preserved area shall be located so as to preserve natural basin flow patterns for lands outside said dikes.

(c) Typical development schemes using these criteria are depicted in Figure 34-2.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.
History: New 10-2-77

FIGURE 34-1

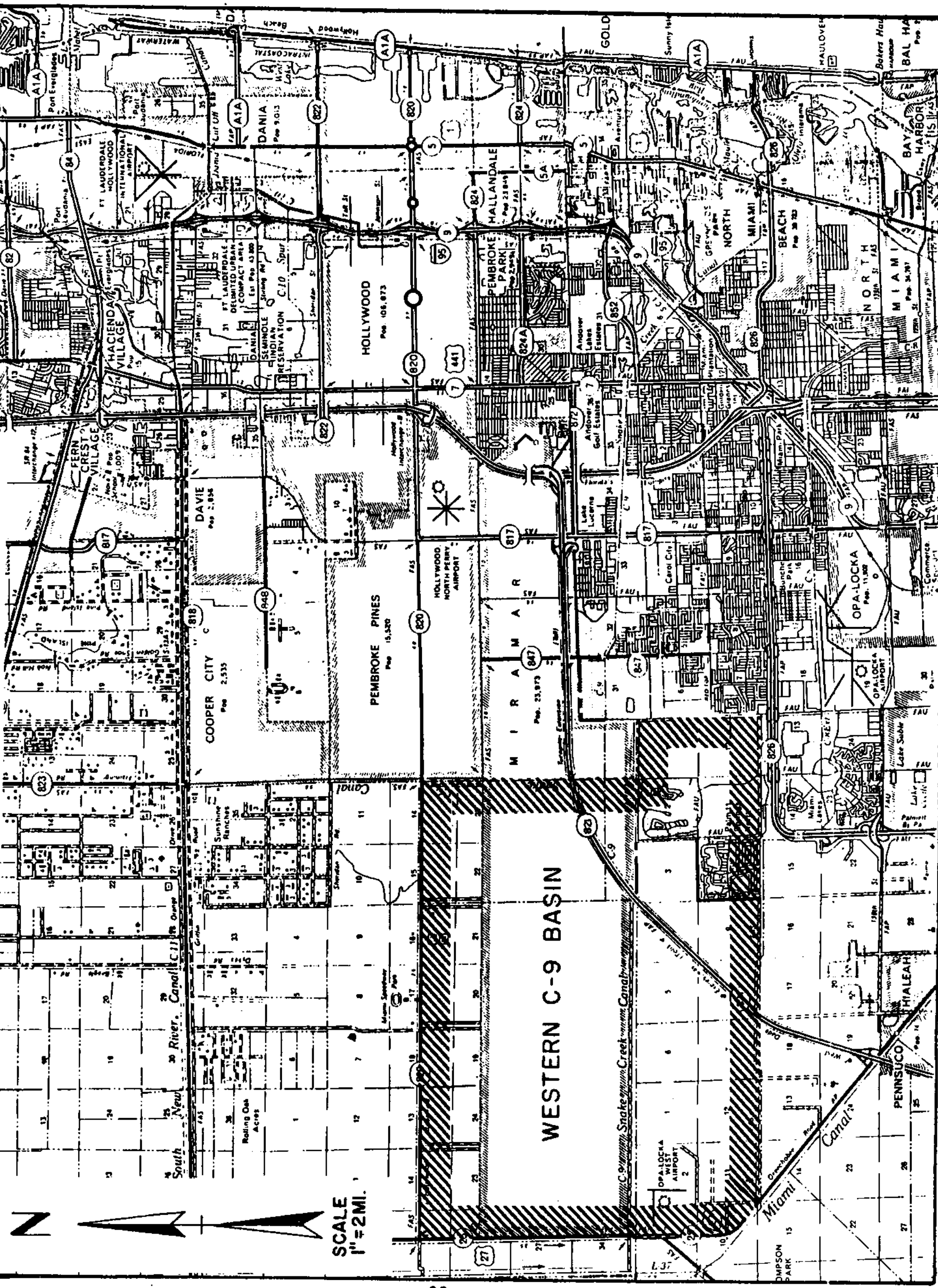
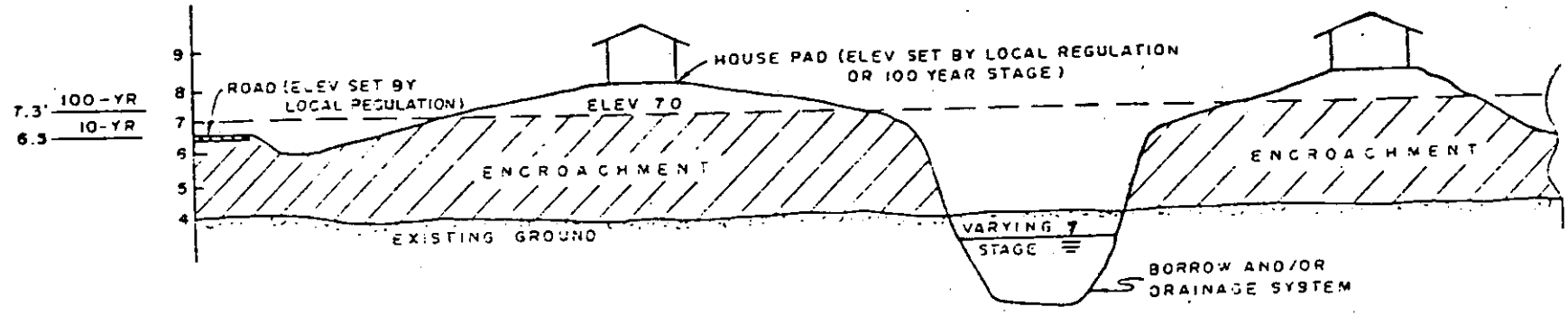
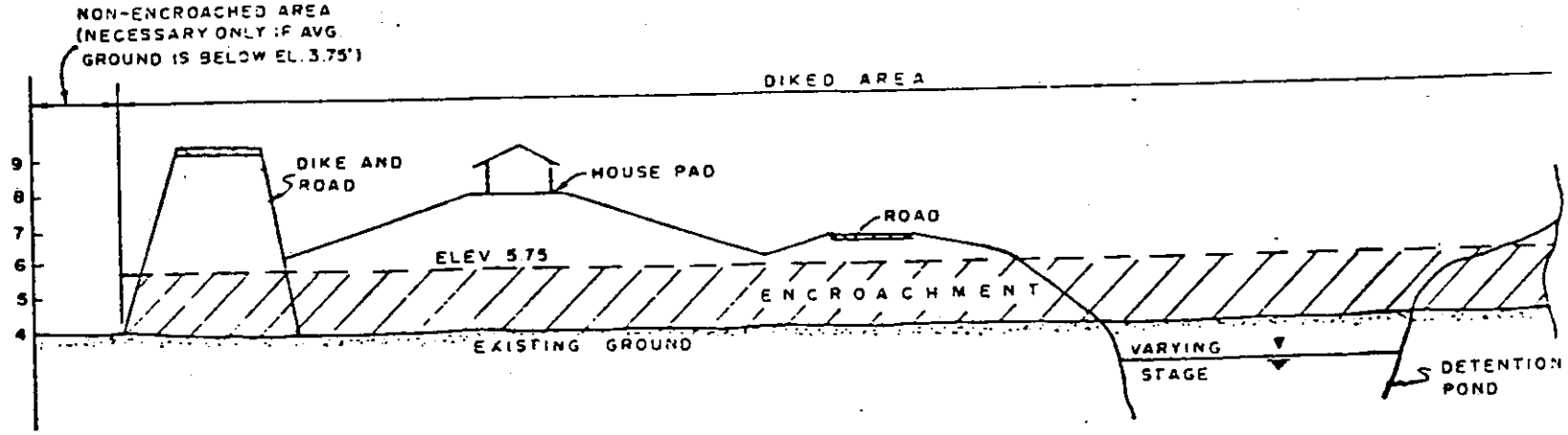

WESTERN C-9 BASIN
SCALE 1"=2MI.
HOLLYWOOD
PEMBROKE PINES
COOPER CITY
DAVIE
MIRAMAR
HALLANDALE
PEMBROKE PARK
DANIA
HACIENDA VILLAGE
FERN CREST VILLAGE
NORTH MIAMI
NORTH MIAMI BEACH
OPA-LOCKA
HIALEAH
PENNSUCO
BAY HARBOR ISLANDS
HOLLYWOOD NORTH PERRY AIRPORT
OPA-LOCKA WEST AIRPORT
OPA-LOCKA AIRPORT
SEMINOLE INDIAN RESERVATION
FT LAUDERDALE HOLLYWOOD INTERNATIONAL AIRPORT
South New River Canal
Snake Creek Canal
Miami Canal
HAULOVER
GOLD

FIGURE 34-2



GRAVITY DRAINAGE SYSTEM



PUMPED RETENTION SYSTEM

TYPICAL DEVELOPMENT SCHEMES

V. Rule 16K-4.035

Section 373.413 F.S. and Rule 16K-4.03 F.A.C. require that the District permit the construction of all surface water management systems which are encompassed within the definition of "works" as stated in 373.403(5). The District may impose necessary reasonable conditions to the permits to assure that such construction will not be harmful to the water resources of the District. To implement this provision, the District has developed criteria and procedures for review of the design and construction of works serving projects which have two or more acres of impervious area. The general and specific criteria and procedures are designed to ensure that such projects are developed in accordance with the District's statutory obligations, and are contained in the District's "Basis of Review of Construction of Surface Water Management Systems Serving Projects With Two or More Acres of Impervious Area Within the South Florida Water Management District," which has been adopted by the Governing Board. This rule publishes the above titled document by reference and provides that pertinent projects will be reviewed in accordance therewith.

FINAL - adopted by Governing Boa
December 15, 1977

16K-4.035 Basis of Review of Applications for Construction of Works.

(1) General and specific criteria and procedures governing construction of works, as defined in Section 373.403(5), Florida Statutes, which will serve projects with two or more acres of impervious area are specified in the District's "Basis of Review of Construction of Surface Water Management Systems Serving Projects with Two or More Acres of Impervious Area within the South Florida Water Management District - December, 1977." This document has been adopted by the Governing Board of the District and is available from the District's main office upon request.

(2) All applications for permit for construction of works, as defined in Section 373.403(5), Florida Statutes, serving projects with two or more acres of impervious area received pursuant to Rule 16K-4.03, Florida Administrative Code, shall be reviewed in accordance with the provisions of the District's "Basis of Review of Construction of Surface Water Management Systems Serving Projects with Two or More Acres of Impervious Area within the South Florida Water Management District - December, 1977" which is hereby published by reference.

Specific Authority 373.113 F.S. Law Implemented 373.413 F.S.
History - New 6-15-77, Amended

South Florida

Water Management District

BASIS OF REVIEW OF CONSTRUCTION OF SURFACE WATER MANAGEMENT SYSTEMS SERVING PROJECTS WITH TWO OR MORE ACRES OF IMPERVIOUS AREA WITHIN THE SOUTH FLORIDA WATER MANAGEMENT DISTRICT

DECEMBER, 1977

ADOPTED BY THE GOVERNING BOARD OF THE

SOUTH FLORIDA WATER MANAGEMENT DISTRICT ON DECEMBER 15, 1977

TABLE OF CONTENTS

OBJECTIVES

Under Part IV of Chapter 373,Florida Statutes, and Rule Chapter 16K-4, the District is responsible for the permitting of construction of surface water management systems within its jurisdictional boundaries. The intent of this document is to set forth in clear and understandable terms, the criteria and requirements that will be applied in reviewing applications for certain specific types of surface water management systems. An effort has been made to eliminate needless duplication and to take into account applicable local criteria to avoid unnecessary conflicts of jurisdiction.

The following information is presented as the basis of review for the construction of surface water management systems which serve projects with two or more acres of impervious area and for which either no more restrictive local criteria apply or for which no acceptable additional or conflicting information is available. For the purposes of this document, the term "impervious" means not allowing or allowing only with great difficulty, the vertical movement of water. If applicable local criteria are more restrictive than the District's criteria indicated herein, the local criteria shall be applied in the District's review. Should the Applicant desire that his design be reviewed on a basis differing from that described herein, such desire shall be discussed with the technica staff prior to submission of the Application. The staff shall respond to such requests in writing within a reasonable time and may make recommendations to the Governing Board that it accept or reject the proposed alternate basis of review for a particular project when the application is presented to the Governing Board.

The basic objectives of the District are to insure that the Applicant's system will not be harmful to the water resources of the District and is consistent with the public interest. This means that the system should function consistentently with the environment and fulfill its intended purpose. Means of satisfying these ends include maintenance of satisfactory water quality, flood and drainage protection,and water conservation.

Because prevention of, rather than solutions to, problems is more feasibly and realistically handled, the District considers new projects primarily from the point of view of problem prevention. Contingencies in the state-of-the-art require that a mechanism exist for problem solution when prevention is not always possible. Thus, the District assumes that there will always be a Permittee who will be legally responsible for the system. Where the responsibility is not totally clear, a condition of the Permit may be the requirement for the establishment of a legally responsible entity. The District objective is therefore projected into the future in this manner.

Problem prevention is particularly important since in recent years it has become increasingly obvious that storm water runoff from streets, shopping centers, and residential areas is a major contributor to pollution problems of surface waters in both urbanized and rural areas. Sediment, animal fecal material, fertilizers, organic material, trace metals, petroleum products, and miscellaneous detrital material all contribute loadings of various parameters to such runoff. In addition, rainwater itself has been shown to be somewhat less pure in some instances than was once assumed, particularly in regard to nitrogen concentrations and pH variation. Therefore, provisions for water quality improvement have become an important consideration for surface water management systems coming under the permitting jurisdiction of the District.

Aside from purely technical aspects, legal and institutional factors must also be considered. Because of legal time constraints for processing permits, it is advisable for the Applicant to contact other interested agencies, organizations, and affected citizens prior to submitting a formal application to the District. Summaries of meetings and copies of responses from appropriate parties should be included with the application.

It may be in the applicant's best interest to seek concurrent approvals from all agencies with jurisdiction. Thus, this provision is not intended to preclude the submission of an application to this District prior to receiving other necessary approvals, but, the application should contain at least a status report on other approvals being sought, with an indication that the surface water management portion of the project will be approved by other pertinent jurisdictions.

PLANNING AND DESIGN

I. Design Frequency

A. Definition - Flood frequency will be assumed to result from rainfall of the same frequency. Areas subject to flooding from rising water as well as storm rainfall will be considered from two points of view.

1. Design frequency rainfall with wet season high stage or spring tide stage, if applicable.

2. Mean year rainfall (2.33 year frequency) with design frequency flood stage in receiving waters, either tidal or non-tidal.

B. Local jurisdiction criteria - internal drainage systems will be reviewed on the basis of their ability to offer protection in accordance with

criteria of the local jurisdiction, as normally published in subdivision regulations.

C. District criteria - Drainage systems will be reviewed for the ability of the system to function in conjunction with receiving waters of the District, at the respective design frequency of the District facilities.

D. Flood insurance criteria - Building floor elevations will be reviewed on the basis of 100 year frequency, 5 day duration rainfall protection as computed by the Applicant or derived from accepted flood studies. Due to possible inaccuracies in base data and design assumptions, floor elevations should be set at least at the next highest one-half foot above calculated 100 year storm stages.

E. Receiving waters without discharge criteria will be reviewed on the basis of peak discharge and total runoff volume after development not exceeding peak discharge and total runoff volume before development, consistent with maintenance of minimum flows if applicable, at the following frequency:

1. Areas less than one square mile - 10 year frequency.

2. Areas equal to or larger than one square mile - 25 year frequency.

F. Base flows and low flows from the developed site should be maintained equivalent to the historic conditions with a five year frequency drought condition being the most extreme event which must normally be considered. Base flows and low flows will usually cease for some more severe drought condition.

II. Rainfall

A. Frequency - Depth and Intensity

1. U.S. Weather Bureau Technical Paper No. 49, "Two-to-Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States" (1964); U.S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States for Duration from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years"(1961); or U.S. Department of Agriculture, Soil Conservation Service, "Rainfall Frequency Atlas of Alabama, Florida, Georgia and South Carolina for Durations From 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years" (1973).

2. U.S. Weather Bureau Technical Paper No. 25, "Rainfall Intensity - Duration - Frequency Curves" (1955).

3. Florida State Road Department, "Drainage Manual" (Second Edition, 1967).

4. Actual gage data analyzed by accepted statistical methods.

B. Duration - For small areas (usually 100 acres or less) where only peak discharge calculations are done the 24-hour duration storm of the design frequency may be sufficient. For larger areas and for areas of such size where stage and volume of runoff is considered a 5 day duration design storm may be necessary.

If the applicant is in doubt as to the duration storm he should use in his calculations for a particular project, he should contact the technical staff of the District prior to submitting an application. The staff will respond to the inquiry in writing within a reasonable time thereafter.

C. Distribution - The actual distribution of rainfall within a period should be consistent with the design duration.

1. 24-hour duration design storm - A general distribution such as the SCS Type II (see U.S. Department of Agriculture, Soil Conservation Service Technical Paper No. 149, "A Method for Estimating Volume and Rate of Runoff in Small Watersheds"-1973), or a locally derived distribution is to be used. A uniform rainfall rate for 24-hours is not reasonable for the type of analysis seeking peak discharge.

2. 5-day duration design storm - The arrangement of daily rainfall should be for a most critical response. The maximum one day event should be preceded by at least the second heaviest rainfall day.

3. If data for rainfall other than the one day depth is not available then a distribution may be used as follows:

Time (hours)	Percentage of One Day Rainfall	
0	14.6	
24	21.3	
48	21.3	
58	5.6	
59	5.0	
59.5	15.0	
59.75	18.7	100% One Day Rainfall
60	7.3	
60.5	3.8	
61	5.1	
62	18.2	
72	11.3	
96	9.6	
120		

III. Water Quantity Computations

A. Checklist for Drainage Projects - The attached checklist, (Appendix 1) if complied with, will normally furnish the information required for review. Additionally, it is requested that all engineering plans and calculations bear the seal of a State of Florida registered professional engineer subject to the exemptions specified in Chapter 471, Florida Statutes. Submission of the items indicated by an asterisk in Appendix 1 will normally furnish the information necessary for review of an application for conceptual approval.

B. Phased Projects - Projects that are to be developed in phases will require the submission of a Master Plan of the Applicant's contiguous land holdings. The primary interest of the District is to insure continuity between phases, satisfactory completeness of individual phases should the project be incomplete as planned and preservation of adjacent property owner's rights. This includes adjacent property owners created by the sale of incompleted phases.

Normally, an application for conceptual approval of the total Master Plan must be submitted first. An application for construction approval of the first phase may also be included as a part of the initial application. As the permittee desires to construct additional phases, these approvals would be included as modifications to the original permit.

Applications for individual project phases where no conceptual approval has been sought may be considered only when the phases are totally independent of, or make sufficient provisions for, adjacent lands.

C. Antecedent Conditions - For groundwater and surface water stages antecedent to the design event the wet season table and stage should be used. For artificially maintained on-site stages the applicant should demonstrate the feasibility of creating a stage lower than the normal wet season water table. It will normally be necessary for the Applicant to demonstrate that soils or discharge structures possess the ability to draw storage stages down preceding the design event, such that initial storage is available in the system.

D. Infiltration and Percolation

1. Ground surface - groundsurface infiltration will be reviewed on the basis of commonly accepted values such as those of Soil Conservation Service (see, U.S. Department of Agriculture, Soil Conservation Service Technical Paper No. 149, "A Method for Estimating Volume and Rate of Runoff in Small Watersheds"(1973), and U.S. Department of Agriculture, Soil Conservation Service Technical Release No. 55, "Urban Hydrology for Small Watersheds"-1975); or rational method (see, Florida State Road Department, "Drainage Manual" (2nd Edition, 1967); or standard civil engineering textbooks), unless test data is submitted to justify other values.

2. Subsurface - subsurface percolation will be reviewed only on the basis of representative or actual test data submitted by the individual applicant. The Dade County Public Works Department is suggested as a reference source to Applicants for test procedures and design and maintenance performance of subsurface percolation systems.

E. Evapotranspiration - Considered only for 5 day (or longer) events. Amounts will be estimated as follows:

1. Groundwater depth 0 to 1' - 0.3" ET/day

2. Groundwater depth 1' to 2.5' - 0.2" ET/day

3. Groundwater depth 2.5' to 4' - 0.1" ET/day

4. Groundwater depth below 4' - 0" ET/day

F. Storage

1. On-site storage - If on-site storage is to be considered in the review, the Applicant should submit stage-storage curves. If on-site storage plus discharge is to be considered, the stage discharge computations should also be submitted. Actual rather than allowable discharges should be used in routing. Often for the more extreme events, such as 100 year frequency, discharge can be ignored because the high tail water stage in the receiving water effectively prevents any but a negligible discharge. In such cases a mass accounting of on-site water will suffice, if adjacent areas can safely be ignored.

2. Ground - The Soil Conservation Service has made the following estimate of soil storage capability for the normal sandy soils found within the District in their average natural state:

Depth to Water Table	Cumulative Water Storage
1'	0.6"
2'	2.5"
3'	6.6"
4'	10.9"

For the same sandy soils which have been compacted intentionally or incidental to earthwork operations the cumulative storage should be reduced 25 percent. For other soil types a storage capacity of 1-inch of water in 6 inches of soil depth above the wet season water table should be used unless soils data indicates otherwise.

Groundwater storage beneath impervious surfaces generally appears impractical to any great degree because of the trapped air which water cannot displace.

3. Side slopes - For purposes of public safety and maintenance, all water bodies utilized as integral parts of the drainage system shall have side slopes no steeper than 7:1 (horizontal:vertical) out to a depth of two feet below the normal dry season groundwater elevation. This criterion may be modified if the applicant or pertinent local jurisdictions can demonstrate that such modification can achieve the desired objectives.

4. Set-back requirements - All water bodies utilized as integral parts of the drainage system will be subject to the following setback requirements from District facilities (except for the actual connections to District canals). Requests for variances from these

requirements shall be submitted to the District when the application is filed. All such requests will be reviewed by the staffs of all relevant departments within the District.

a. For excavations adjacent to District canals, the top of the excavation shall be a minimum distance of 10d feet from the District canal right-of-way line, or (10d + 50) feet from the District canal top of cut, whichever produces the greater set-back (d equals depth of excavation).

b. For all excavations adjacent to the conservation area levees the set-back from the adjacent right-of-way line of the District levee/borrow canal to the top of the excavation shall be computed as in "a" above, but shall not be less than 500 feet.

Example 1: Canal right-of-way line is 35 feet from top of canal cut; proposed excavation is to elevation - 25.0 feet msl, with average natural ground elevation along adjacent perimeter of rock pit at +5.0 feet msl (d=30 feet).

a. 35 feet + (10x30) = 335 feet from top of cut, or 300 feet from right-of-way line.

b. 50 feet + (10x30) = 350 feet from top of canal cut, or 315 feet from right-of-way line.

Required set-back is 350 feet as measured from top of canal cut, or 315 feet from right-of-way line.

Example 2: Canal right-of-way line is 65 feet from top of canal cut, proposed depth as example 1.

a. 65 feet + (10x30) = 365 feet from top of canal cut, or 300 feet from right-of-way line.

b. 50 feet + (10x30) = 350 feet from top of cut, or 285 feet from right-of-way line.

Required set-back is 365 feet, or 300 feet from right-of-way line.

G. Runoff - The usual methods of computation are as follows:

1. Rainfall minus losses and storage.

2. Soil Conservation Service (see, U.S. Department of Agriculture, Soil Conservation Service, "National Engineering Handbook, Section 4, Hydrology" - 1972), with extra attention to hydrologic accounting of water table conditions.

3. Rational method, for systems serving projects of less than 200 acres total land area. (see, Florida State Department of Transportation, "Drainage Manual" (2d Edition 1967); or standard civil engineering texts.

H. Receiving Water Stage

1. Regulated systems - Design and maintained stage elevations should be available either from the local jurisdiction or the District. Stages for frequencies other than the design will be estimated by the District upon request from the Applicant.

2. Non-regulated systems - The Applicant should compute receiving water stages for such systems from the best available data and submit the results to the District for review and concurrence before utilizing such results in further computations.

I. Discharge

1. Regulated systems - Allowable discharges into District works and the Lake Worth Drainage District works are available from the District on request. Some flexibility exists in the values because of nonconcurrent peaks, but the preparation of the values has given consideration to some nonconcurrent peaks as well as areal reductions for non-uniform events, so the values should generally be adhered to in systems design.

2. Non-regulated systems - Non-regulated systems are reviewed as discussed herein under design frequency for receiving waters without limiting criteria.

3. Non-urban gravity systems - Rural gravity systems are generally reviewed on the basis of the discharge culvert operating at a fixed head loss to meet the allowable discharge rate. This basis is justified by the estimate that the upstream headwater generated

by rural runoff will be unable to collect at the upstream culvert end appreciably faster than the rate at which the receiving water rises. The fixed head loss amounts are 0.5' except in South Dade County (south of Canal C-2) where the value is 0.2'.

J. Water Conservation - Although drainage systems are usually designed primarily for the disposal of extreme event storm runoff, considerations for water conservation are necessary if these systems are to function as water management systems. Conservation is most critical where the primary canal system or other receiving water discharges directly into saline bodies of water making such discharges of fresh water irretrievable. Therefore, the surface water management facilities shall be designed to operate so as to prevent lowering of groundwater levels more than one foot below the normal dry season groundwater elevation for the project site. (Groundwater elevations may be determined using United States Geological Survey or Soil Conservation Service data, or other data which may be available for a particular area). For example, invert elevations of culverts and other works can be placed high enough so as not to facilitate groundwater drainage below the accepted level.

In addition, a hydrologic accounting of the project site for pre- and post-development conditions will normally be required, to demonstrate that discharges from the site under fully developed conditions up to and including a five year frequency drought event (maintenance of minimum flows). See Section I.F., page 2. The applicant may contact the technical staff of the District prior to submission of an application to determine whether hydrologic accounting will not be required.

The staff will respond in writing within a reasonable time thereafter.

K. Models - The use of proven models in the design of surface water management systems is acceptable to the District. The choice of models utilized will be left to the applicant; however, the applicant will be required to provide data on model calibration and to substantiate that such data is transferable to the site in question.

IV. Water Quality - System Design Requirements

A. Retention/Detention - Retention and/or detention in the overall system, including swales, lakes, canals, greenways, etc., shall meet all of the following criteria:

1. Retention volume shall be provided for one inch of runoff from the developed project. Preferably, the system should be designed such that discharge normally does not commence until the first inch of runoff has been stored.

2. Retention shall be provided for the runoff from a 3-year, 1-hour rainfall event.

3. Average detention time for runoff from a 25-year, 24-hour rainfall event shall be at least 5 hours.

B. Deep Water Bodies - All water bodies utilized as integral parts of the drainage system shall be no deeper than the bottom elevation of the off-site receiving water, unless the applicant can demonstrate that all of the following criteria can be met:

1. Entrapped salt water, resulting from inland migration of salt water during hurricane tide conditions or penetration of the fresh-water/salt water interface, will not adversely impact on-site or adjacent water users.

2. The penetration of a water-bearing formation exhibiting poorer water quality, in terms of chloride concentrations, will not adversely impact on-site or adjacent water users.

C. Impervious Areas - Runoff shall be discharged from impervious surfaces to retention areas, detention devices, filtering and cleansing devices, and/or subjected to some type of Best Management Practice (BMP) prior to discharge from the project site. For projects which include substantial paved areas, such as shopping centers, roads, and high density developments, provisions shall be made for the removal of oil, grease and sediment from storm water discharges. A listing of BMP's currently used within the District to achieve this design objective is provided in section V.

D. Stagnant Water Conditions - Configurations which create stagnant water conditions such as hydraulically dead end canals are to be avoided, regardless of the type of development.

E. Florida Department of Environmental Regulation Requirements - Chapter 17-4 of the Florida Administrative Code, contains the permitting requirements of the Florida Department of Environmental Regulation.

Additional FDER guidelines are contained in the "Best Management Practices" section of this document. For projects which require FDER permits, the applicant is advised that receipt of a surface water management permit from the South Florida Water Management District in no way relieves him of the necessity of complying with FDER permitting requirements. Copies of all applications submitted to the District are furnished to FDER.

F. Local Requirements - Some counties and municipalities within the District have specific requirements regarding the design of surface water management systems. These are normally included in subdivision regulations, although this may vary from jurisdiction to jurisdiction. Therefore, Applicants would be well advised to contact the appropriate county or municipal office prior to finalizing the design of the systems.

G. Design Alternatives - The listing of design criteria is not intended to preclude the design engineer from utilizing other known state-of-the-art methods and available best management practices, and should not be construed in such a manner as to discourage innovative design concepts.

V. Water Quantity and Quality - Best Management Practices

A. Water Conservation - As discussed in Section III, J. above, water conservation is a desirable feature in design and operation of surface water management systems. Management practices utilized to reduce losses of fresh water also provide water quality benefits since total poundage loadings to off-site receiving waters would be reduced. In addition to those items enumerated in Section III, J., other best management practices for water conservation are encouraged. For example, maximum use of on-site retention is encouraged, consistent with maintenance of minimum flows, also, pump schedules should be determined so that over-pumping does not occur subsequent to relatively minor storm events.

Voluntary conservation practices such as these will be useful in evaluating the need for mandatory measures.

B. Water Quality - Separating design criteria from best management practices for water quality enhancement of storm water runoff does not follow any clear-cut guideline. Although there may be some duplication with previously listed design criteria, the following listing is presented to illustrate general management techniques available to the consultant in the planning and design of surface water management systems.

1. Swales - Drainage systems should utilize swales, greenways, etc.

in lieu of storm drains and curb-and-gutter to the maximum extent possible.

2. Littoral area - Water bodies utilized as integral parts of the drainage system can include substantial littoral areas in order to provide for emergent vegetation for the improvement of nutrient uptake capabilities.

3. Percolation - Infiltration and percolation, covered previously in Section II, C. above, is also useful from a water quality standpoint where conditions are favorable. However, care must be exercised to ensure that such facilities do not create a hazard for potable water supplies.

4. Catch Basins - The use of some type of baffled catch basin for oil, grease, and sediment removal is encouraged, along with a regular maintenance schedule. All catch basins should be located in swales or other pervious areas. In order to provide additional retention and percolation, catch basin lips should be raised 2 inches or more unless doing so would create long duration standing water or traffic safety problems.

5. Golf Courses - Due to heavy fertilization and frequent irrigation, specialized use areas such as golf courses can create additional water quality problems. If major drainage system components (lakes, canals, etc.) are to be located in or adjacent to such areas, component design should include a low berm to induce percolation into the system instead of overland sheet flow. Such a design practice can also be of benefit for residential developments.

6. Recirculation - Recirculating water as much as possible within a development can reduce off-site discharges, thus reducing pollutant poundage loadings to receiving streams.

7. Florida Department of Environmental Regulation Guidelines - In addition to Items 1-6 above, the following listing of BMP's is excerpted from the Department of Environmental Regulation's "Recommendations for the Management of Runoff from Land Alteration Activities."

> "Provisions should be taken during the initial design phase to infiltrate and percolate maximum runoff to remove pollutant materials. Where impervious substances or soil conditions limit the infiltration capacity,

other means of runoff control should be taken. Methods to reduce the impact of runoff (which incorporate erosion and nutrient control) may include, but not necessarily be limited to, the use of:

a. Retention devices or water storage facilities, e.g.:

    1. Holding ponds
    2. Impoundment areas
    3. Dikes
    4. Rooftop storage

b. Detention (pass-through) devices, such as:

    1. Sedimentation traps or basins
    2. Catchment basins
    3. Meandered, broad, shallow interconnected basins
    4. Step weirs
    5. Dams
    6. Grassy swales
    7. Paved transport ditches in conjunction with other controls

c. Filtering and cleansing techniques, such as:

    1. Grassy swales on gentle slopes
    2. Mechanisms for dispersal of discharge as sheet flow
    3. Use of natural vegetation
    4. Marshes
    5. Oil or grease separation equipment

d. Chemical treatment

e. Cleaning of streets

f. Measures for erosion and nutrient control during construction such as:

    1. Regrading to minimize slopes
    2. Seeding, mulching, sprigging or sodding of altered land uses

3. Diking
4. Use of hay bales
5. Turbidity control diapers
6. Temporary sedimentation traps, retention basins, and/or holding ponds
7. Minimization of clearing with utilization of existing vegetation as erosion barriers"

VI. Land Use Considerations

Before an application will be considered for the issuance of a Surface Water Management permit by the District, the proposed land use must be compatible with the applicable zoning for the area. Merely making application to the applicable local agency for rezoning of the land will not suffice; any necessary rezoning must be officially obtained prior to issuance of this District's permit. Any application for a Surface Water Management permit which does not indicate that the proposed land use is compatible with the applicable zoning for the area shall be considered as incomplete until the applicable zoning is received. In addition, applicants should, if applicable, indicate where the project stands in the local review process. For example, it would be extremely helpful to supply the information requested in Appendix I, Items 1.A., 1-7.

VII. Environmental Considerations

An environmental assessment will be made of all Surface Water Management permit applications. The natural resources of the area under consideration (including topography, soils, natural vegetation, terrestrial and aquatic wildlife, and endangered species) will be evaluated. The purpose of this evaluation is to determine the degree of environmental impact on the above listed natural resources. Particular attention will be given to projects proposed in areas classified as land use type 1, Wetlands, as specified in Appendix 2.

VIII. Water and Wastewater Service

For urban developments, potable water and wastewater facilities must be identified. The applicant for a surface water management permit must provide information on how these services are to be provided. If wastewater disposal is accomplished on-site, additional information will normally be requested.

OPERATIONAL CONDITIONS

I. Inspection and Certification

A Florida registered professional engineer will be required to furnish the District with a certification stating that the subject surface water management system has been constructed in accordance with permit authority.

District personnel inspect water management systems to insure that the said systems have been constructed in accordance with approved specifications and plans. Facilities which involve the use of District right-of-way are inspected to insure that facility installation is in accordance with plans and District criteria.

II. Water Quality Monitoring

All new drainage projects will be evaluated based on the ability of the system to prevent degradation of receiving waters and the ability to conform to State water quality standards (see Chapter 17-3 Florida Administrative Code).

There are areas within the District where water quality considerations are extremely important, due to the sensitivity of the area. These areas are as follows:

1. Lake Okeechobee and the Lower Kissimmee River
2. Canals or streams designated as Class I or Class II waters by FDER.
3. Canals back-pumped to Lake Okeechobee or to the Conservation Areas, or proposed for back-pumping.
4. Sensitive areas, including but not limited to the Savannahs in St. Lucie and Martin Counties.

New developments which plan to utilize these areas for disposal of runoff, will be given more detailed evaluation by the District staff.

In performing the more detailed evaluation, certain assumptions regarding pollutant removal efficiencies will be used, as enumerated in the following discussion.

Pollutant removal efficiencies for swales and detention facilities are not well documented at this time. However, available literature indicates that, as a conservative estimate, grassed swales will remove 10% of the nutrients in urban runoff, and retention facilities capable of storing the first inch of runoff will provide an additional 40% removal. If used together, an overall removal efficiency of at least 46% ($X-\{(X-0.1X)-(X-0.1X)\ (0.4)\}=0.46X$) can be anticipated. In addition, use of such facilities will decrease total outflow, resulting in a further reduction of total poundage loadings to receiving waters. The literature also indicates BOD_5 and suspended solids removals by retention facilities up to 87% and 48%, respectively. Ongoing studies by the District, the USGS, and 208 programs will provide additional information regarding pollutant removal efficiencies for various abatement practices.

In addition, new projects in excess of 320 acres entailing a more intensified land use and planning to discharge to a primary receiving water, directly or indirectly, in the first three areas listed above will be required to institute a water quality monitoring program. The following listing of land use intensity is in ascending order:

1. Wetlands (including transition zones adjacent thereto)
2. Forested lands
3. Rangeland
4. Agricultural
5. Urban and built-up land

Therefore, any proposed land use change for areas in excess of 320 acres resulting in a larger number in the above listing would require water quality monitoring if discharge is to go to one of the areas of concern listed above. In addition, some land use changes within the same category would also be considered as more intensified land use. As an example, a change from pasture to sugarcane within the "agricultural" category would be considered as a more intensified land use. Appendix 2 provides a listing of land use types under the general categories.

The necessity of a monitoring program for discharge to other sensitive areas is not based on a size limitation and is considered on a case-by-case basis. Monitoring for existing systems, regardless of size and location, is also evaluated on a case-by-case basis.

In general, there are two reasons for requiring water quality monitoring by permittees, which are as follows:

1. Such data can be used to determine if the pollution abatement practices incorporated into the design of the drainage system are functioning properly.

2. In some cases there may be a real and immediate concern regarding degradation of quality in the receiving waters, regardless of the pollutant removal efficiency of the drainage system.

The reason for the monitoring requirement will normally be stated in the staff report for each permit, as will be the monitoring schedule and the parameters of interest. Although specifics may vary from project to project, samples will normally be collected at discharge locations. A typical sampling schedule will consist of samples collected once per month during the wet season, however; this may also vary between projects. Rate of discharge at the time of sample collection and total monthly discharge each month for the duration of the permit will also be required. Parameters of interest will normally include nitrates as N, nitrites as N, total kjeldahl nitrogen as N, total nitrogen as N, ortho-phosphorus as P, total phosphorus as P, total suspended solids, BOD_5, turbidity, conductivity D.O., and pH. In some cases, fecal and total coliform and fecal strep analyses will be required in addition to other parameters. Where feasible the District's water quality monitoring requirements will be coordinated with applicable FDER monitoring requirements.

As a general rule, monitoring required of permittees will be confined to points within their boundaries. If additional sampling is needed in order to assess off-site impacts of the projects, such sampling will normally be conducted by the District.

Staff reports written and permits issued for projects not requiring monitoring at this time will normally include a statement to the effect that water quality monitoring may be required in the future, along with a list of the parameters of interest. This should not be construed as an indication that the District is contemplating the implementation of a program of intensive water quality monitoring by all permittees. If water quality problems develop in specific areas, however, permittees are in this manner put on notice that they may have to determine the quality of the water which they are discharging.

APPENDIX 1

Checklist for Surface Water Management Permit Applications

I. Land Use/Land Cover Information

A. Indicate where the project stands in the local approval process

*1. Present and proposed (if different) zoning.
*2. Present and proposed land use and density.
*3. Classification under local land use plan.
*4. Indicate if project is a planned unit development and/or subject to special zoning requirements.
5. Indicate if site plan and/or subdivision approval has been granted.
6. Indicate if any final plats have been approved. If so, describe.
7. Indicate if any building permits or other construction permits have been issued.

*B. Development area in acres.

*C. Recent aerial photograph of project site (within one year of date of application, if possible).

*D. Existing and proposed topography (msl datum).

*E. Acreages and percentages of property proposed as:

1. Impervious surfaces
2. Green areas
3. Lakes, ponds, storage areas, etc.
4. Other areas.

II. Surface Water Management Information

*A. Master Drainage Plan (or the like) along with drainage calculations, sealed by a Florida registered professional engineer, subject to the exemptions specified in Chapter 471, Florida Statutes.

*B. Pertinent drainage details on major water control structures; e.g., outfall facilities, intermediate controlling water flow structures, pumps, etc.

C. Construction phasing plans

D. Right-of-way layout for drainage system. Where occupancy of District right-of-way is proposed, pertinent structural details should be submitted.

*E. Locations of internal canals and water bodies with typical sections, including depths.

*F. Location and description of proposed storm sewers, detention/retention areas, and other conveyance and storage facilities.

*G. Best Management Practices proposed to reduce pollutant loadings.

*H. Runoff routing scheme, including calculations with stage-storage and stage-discharge relationships, if storage is utilized.

*I. Delineation of flooding contours for the following storms: local jurisdiction design frequency, receiving water design frequency and 100 year frequency storms. Specify proposed minimum building pad and pavement grade elevations.

*J. Design storm (intensity and duration).

*K. Total acres of off-site property contributing runoff to proposed surface water management system.

*L. Identify receiving stream and/or water body. Identify primary drainage facility serving the area.

M. Typical section of receiving stream, including bottom elevation.

*N. Seasonal water table elevations, including normals, and recurring highs and lows.

*O. Proposed regulation schedules of on-site water bodies.

III. Legal and Institutional Information

A. Identify entity responsible for operation and maintenance of the surface water management system.

B. Identify and give address of adjacent property owners.

*Master plan submission items for letter of conceptual approval (reference page 5, Item III E It is recognized that details and calculations will be in a more simplified form for conceptual approval than for a permit application.

C. Indicate how water and wastewater service will be provided.

D. Identify agencies, organizations, etc., contacted. Include meeting summaries and/or responses.

APPENDIX 2

Land Use Type Examples

Land Use Type	Examples
1. Wetlands (and transition zones adjacent thereto)	
Forested Salt	Red Mangrove Black & White Mangrove Mixed
Forested Fresh	Sweet Bay, Cypress, Willow, Melaleuca, Myrtle, Button-bush, Maple, Mixed
Non-Forested	Sawgrass, Cattail, Sloughs, Bullrush, Wire Cordgrass, Mixed Aquatic Grass
Non-Forested Salt	
Water	Rivers/Streams/Canals Reservoirs, Open Water
2. Forest Land	
Deciduous	Oak
Evergreen	Pine Flatwoods, Coastal Sand Pines, Sand Pine Scrub, Australian Pines, Melaleuca
Mixed	Cabbage Palms, Oak
Other	Pine/Oak, Tropical Hammocks Palms, Brazilian Peppers, Old Field Mixed, Coastal Dune, Scrub Oak

Land Use Type	Examples
3. Rangeland	
Grass Palmetto	
4. Agricultural	
Cropland	Sugarcane, truck crops.
Pasture	Improved, Unimproved
Orchards, groves, vineyards, nurseries, ornamental and horticultural areas	Citrus, Sod farms, Ornamentals
Confined Feeding Operations	Feed lots, Dairy farms, Fish farms, Horse Training and stable, Poultry
5. Urban & Built-up Land	
Residential	Single Family - Low Density - Under 2 DU/Ac.
	Single Family - Med. Density - 2 to 5 DU/Ac.
	Single Family - High Density - Over 5 DU/Ac.
	Multi-family Unit Mobile Home
Commercial & Services	Parking Lot, Shopping Center, Sales and Services, Cultural and Entertainment, Marine Commercial (Marinas)
Industrial	Junkyard
Institutional	Educational, Medical, Religious, Military, Correctional, Governmental (other than military or correctional)

Land Use Type	Examples
5. Urban & Built-up Land (continued)	
Transportation	Airports, Railroad Yards and Terminals, Port Facilities, Electrical Power, Major Transmission Lines, Major Highway and Rights-of-Way, Water Supply Plants, Oil and Gas Storage, Solid Waste Disposal, Radio Stations or other Antenna arrays.

BIBLIOGRAPHY

The following is a list of publications incorporated by reference in this document. A copy of Item 1 may be obtained by writing to: Florida Department of Transportation, Hayden Burns Building, Tallahassee, Florida 32301.

Copies of Items 2 through 7, published by the U.S. Government may be obtained by writing to: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402.

1. Florida State Road Department, Drainage Manual. 2nd ed. 1967.

2. U.S. Department of Agriculture, Soil Conservation Service, Technical Paper No. 149, A Method for Estimating Volume and Rate of Runoff in Small Watersheds. 1973.

3. U.S. Department of Agriculture, Soil Conservation Service, Technical Release No. 55, Urban Hydrology for Small Watersheds. 1975.

4. U.S. Department of Agriculture, Soil Conservation Service, NEH-4. National Engineering Handbook, Section 4 Hydrology. 1972.

5. U.S. Department of Agriculture, Soil Conservation Service. Rainfall Frequency Atlas of Alabama, Florida, Georgia and South Carolina for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. 1973.

6. U.S. Weather Bureau, Technical Paper No. 25, Rainfall Intensity - Duration Frequency Curves. 1955.

7. U.S. Weather Bureau, Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Duration from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. 1961.

8. U.S. Weather Bureau, Technical Paper No. 49, Two-to-Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. 1964.

APPENDIX 3

FCD PROJECT DISCHARGE CRITERIA

Q = allowable discharge in cfs (cubic feet per second)

A = drainage area in square miles

CSM = cfs per square mile

CANAL	ALLOWABLE RUNOFF	DESIGN FREQUENCY
C-1	$Q = \left(\frac{112}{\sqrt{A}} + 31\right) A$	10 year
C-2	Essentially unlimited inflow by culverted connections southeast of Sunset Drive. 54 CSM northwest of Sunset Drive.	200 year +
C-4	Essentially unlimited inflow by culverted connections east of S.W. 87th Avenue. 54 CSM west of S.W. 87th Ave.	200 year +
C-6	Essentially unlimited inflow by culverted connections east of FEC Railroad. 54 CSM west of FEC Railroad.	200 year +
C-7	Essentially unlimited inflow by culverted connection.	100 year +
C-8	Essentially unlimited inflow by culverted connection.	200 year +
C-9	Essentially unlimited inflow by culverted connection east of Red Road. 20 CSM pumped, unlimited gravity with development limitations west of Red Road or Flamingo Blvd.	100 year +
C-10		200 year +
C-11	3/4" in 24 hours west of 13A 1.5" in 24 hours east of 13A	
C-12	$Q = \left(\frac{72}{\sqrt{A}} + 60\right) A$	25 year

CANAL	ALLOWABLE RUNOFF	DESIGN FREQUENCY
C-13	$Q = \left(\frac{72}{\sqrt{A}} + 60\right) A$	25 year
C-14	$Q = \left(\frac{78}{\sqrt{A}} + 54\right) A$	25 year
	$Q = \left(\frac{96}{\sqrt{A}} + 25\right) A$ (Western Reach)	10 year
C-15 C-16	$Q = \left(\frac{90}{\sqrt{A}} + 47\right) A$	25 year
C-17	$Q = \left(\frac{114}{\sqrt{A}} + 34\right) A$	25 year
C-18	$Q = \left(\frac{114}{\sqrt{A}} + 34\right) A$	25 year
	One inch in 24 hrs west of Bee Line Hwy.	Runoff quantity is restricted to any frequency storm.
C-19	$Q = \left(\frac{32}{\sqrt{A}} + 64\right) A$	
C-23	$Q = \left(\frac{47}{\sqrt{A}} + 28\right) A$	10 year
C-24	$Q = \left(\frac{47}{\sqrt{A}} + 28\right) A$	10 year
C-25	$Q = \left(\frac{47}{\sqrt{A}} + 28\right) A$	10 year
C-38	$Q = \left(\frac{109}{\sqrt{A}} + 26\right) A$	10 year
C-40 C-41 C-41A	Istokopoga Indian Prarie Area Canals $Q = \left(\frac{48}{\sqrt{A}} + 33\right) A$	10 year
Hillsboro Canal	35 CSM	Runoff quantity is restricted to any frequency storm.
North New River Canal	$Q = \left(\frac{116}{\sqrt{A}} + 32\right) A$	25 year

CANAL	ALLOWABLE RUNOFF	DESIGN FREQUENCY
Everglades Agricultural Area	Tributary to S-5A: L-8, L-10, L-12, L-13 — $Q = 60.5\ A^{.8}$	5 year
	L-8 west of S-76 — 27 CSM	
	All other canals in Ag. Area — $Q = \left(\frac{81}{\sqrt{A}} + 13\right) A$	
L-28	$Q = \left(\frac{63}{\sqrt{A}} + 4\right) A$	
C-51	65 CSM east of Turnpike 27 CSM west of Turnpike (subject to change upon implementation of backpumping plan).	Runoff quantity is restricted to any frequency storm.
C-100 C-100A C-100B C-100C C-100D	$Q = \left(\frac{104}{\sqrt{A}} + 43\right) A$	10 year
C-102	$Q = \left(\frac{119}{\sqrt{A}} + 25\right) A$	10 year
C-103 north C-103 south	$Q = \left(\frac{107}{\sqrt{A}} + 39\right) A$	10 year
C-110	$Q = \left(\frac{137}{\sqrt{A}} + 9\right) A$	10 year
C-111	$Q = \left(\frac{117}{\sqrt{A}} + 29\right) A$	10 year
C-113	$Q = \left(\frac{142}{\sqrt{A}} + 3\right) A$	10 year

Allowable runoff curves to be used for the area within Lake Worth Drainage District are depicted on the following charts.

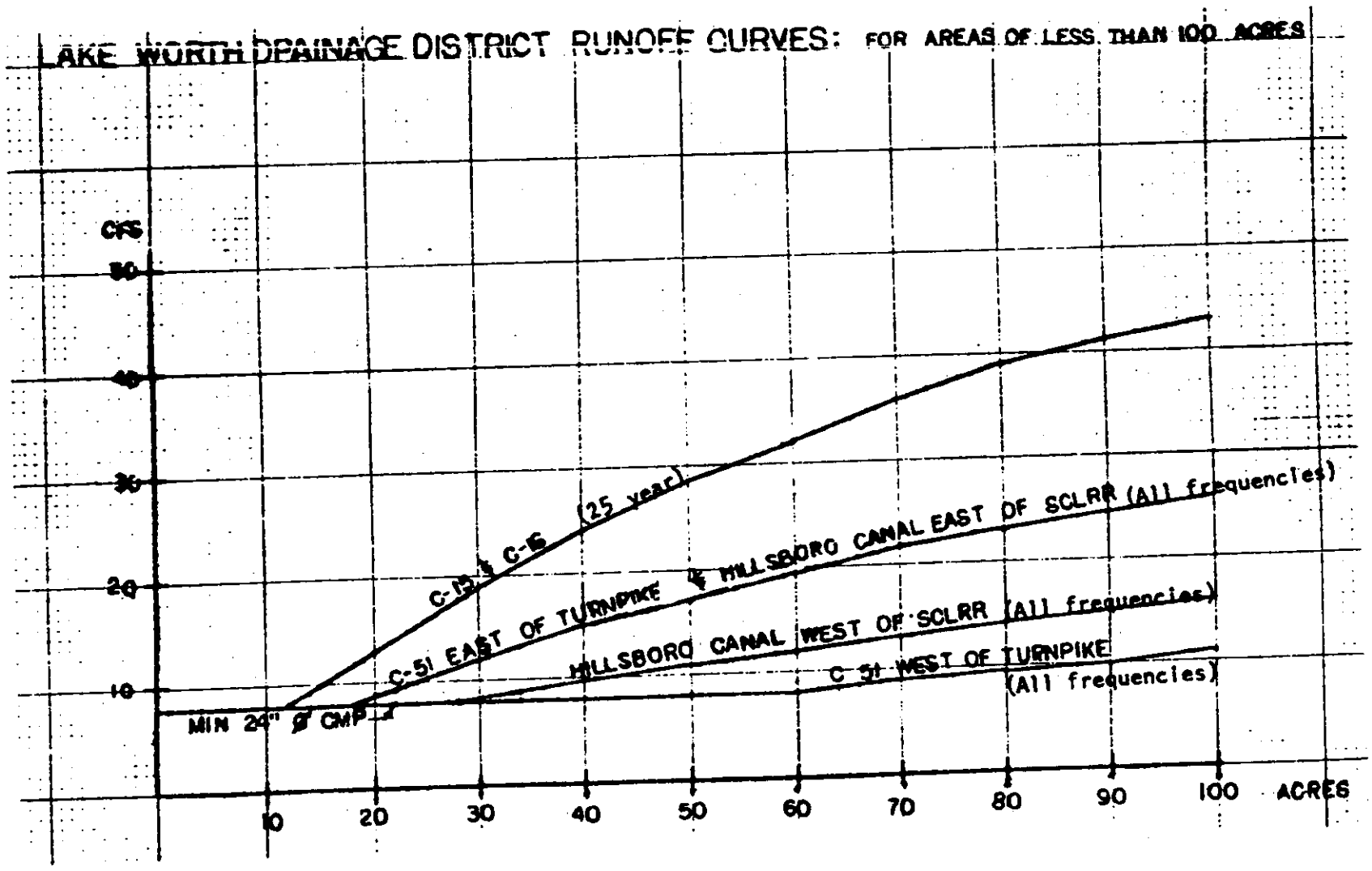

LAKE WORTH DRAINAGE DISTRICT RUNOFF CURVES: FOR AREAS OF LESS THAN 100 ACRES
CFS
50
40
30
20
10
C-51 & C-16 (25 year)
C-51 EAST OF TURNPIKE & HILLSBORO CANAL EAST OF SCLRR (All frequencies)
HILLSBORO CANAL WEST OF SCLRR (All frequencies)
C 51 WEST OF TURNPIKE (All frequencies)
MIN 24" Ø CMP
10
20
30
40
50
60
70
80
90
100
ACRES

FIGURE 5

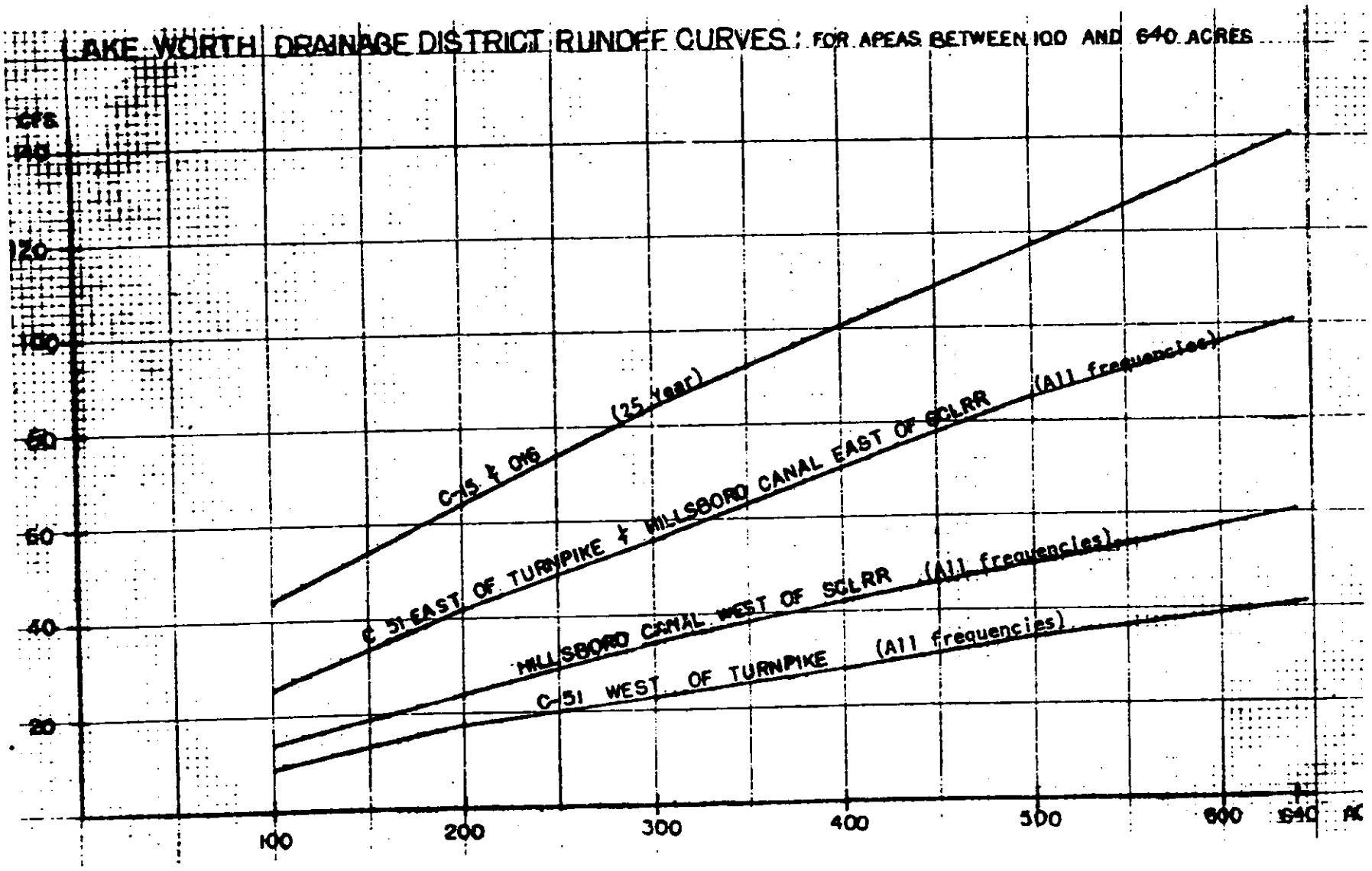
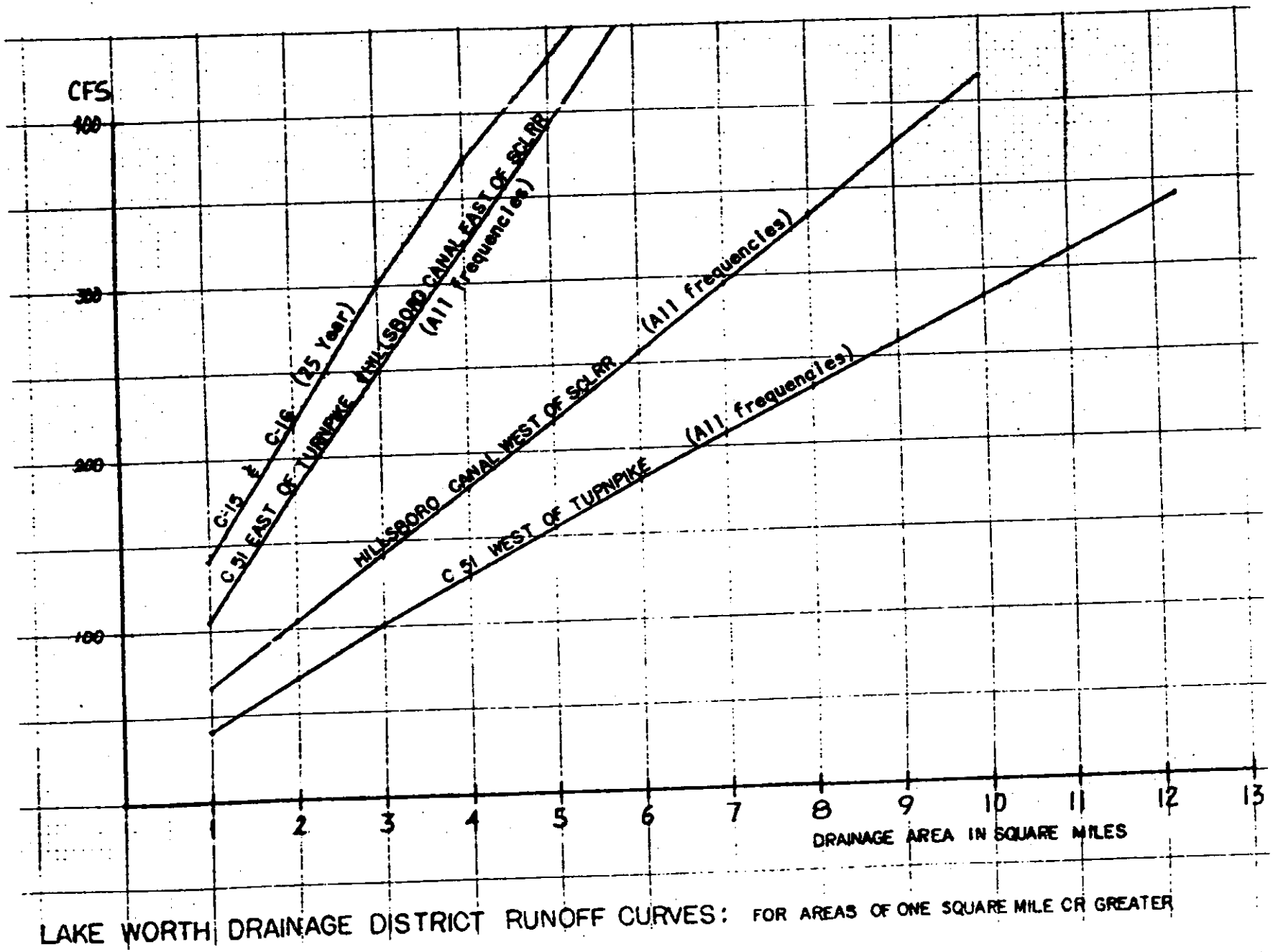

LAKE WORTH DRAINAGE DISTRICT RUNOFF CURVES : FOR AREAS BETWEEN 100 AND 640 ACRES
CFS
140
120
100
80
60
40
20
C-51 EAST OF TURNPIKE & MILLSBORO CANAL EAST OF SCLRR (All frequencies)
MILLSBORO CANAL WEST OF SCLRR (All frequencies)
C-51 WEST OF TURNPIKE (All frequencies)
100
200
300
400
500
600
640 AC

FIGURE 6



LAKE WORTH DRAINAGE DISTRICT RUNOFF CURVES: FOR AREAS OF ONE SQUARE MILE OR GREATER

FIGURE 7

Part B - Surface Water Management Design Criteria

I. General

The design of surface water management systems to meet local criteria and District criteria as specified in Rule 16K-4.035, "Basis of Review", requires the consideration of some basic hydrologic and hydraulic principles. More specific data and methodology will be presented herein on: rainfall depth, rainfall distribution, runoff estimation, ground storage, surface storage, structural discharge capacity, hydrographs and flood routing.

II. Design Rainfall

A. Depth

1. Selection of Design Event

The depth of rainfall in inches for a specific return frequency and storm duration is the most basic parameter needed in the design and analysis of a storm water management system. The design event (return frequency storm) is determined either from local criteria or from the "Basis of Review" document. For unregulated watercourses the chart on the following page is a summary of the criteria specified in the "Basis of Review" document.

2. Determination of Rainfall Amount

Once we have determined the design frequency and duration we can use Figures 8 through 17 for estimating the appropriate rainfall depth.

3. Use of Figures 8 through 17

Example 1:

Assume we know the following:

Frequency - 3-year
Duration - 1-hour
Location - West Palm Beach

From Figure 8 the 2-year, 1-hour depth is 2.6 inches and from Figure 9 the 5-year, 1-hour depth is 3.2 inches. Using linear interpolation we estimate the 3-year, 1-hour depth to be:

$$2.6 + \frac{3.2-2.6}{3} = \underline{\underline{2.8 \text{ inches Ans.}}}$$

SELECTION OF DESIGN EVENT BASED ON SIZE OF PROPERTY

SIZE (acres)	FREQUENCY	DURATION
$A \leq 100$	10 year	24 hours
$100 < A < 640$	10 year	5 days
$640 \leq A$	25 year	5 days

Ref: Rule 16K-4.035, Basis of Review of Applications for Construction of Works, Unregulated Watercourse

Example 2:

Assume we know the following:

Frequency - 10-year
Duration - 24-hour
Location - Jupiter

From Figure 12 we see that the 10-year, 24-hour depth is approximately 9.0 inches at Jupiter.

9.0 inches Ans.

Example 3:

Assume we know the following:

Frequency - 100-year
Duration - 5-day
Location - West Palm Beach

From Figure 15 the 100-year, 24-hour depth is 13.5 inches. From Figure 17 we see that the 5-day duration depth is approximately 56.8% greater than the 24-hour duration depth. Consequently the 100-year, 5-day depth is:

13.5 X 1.568 = 21.2 inches Ans.

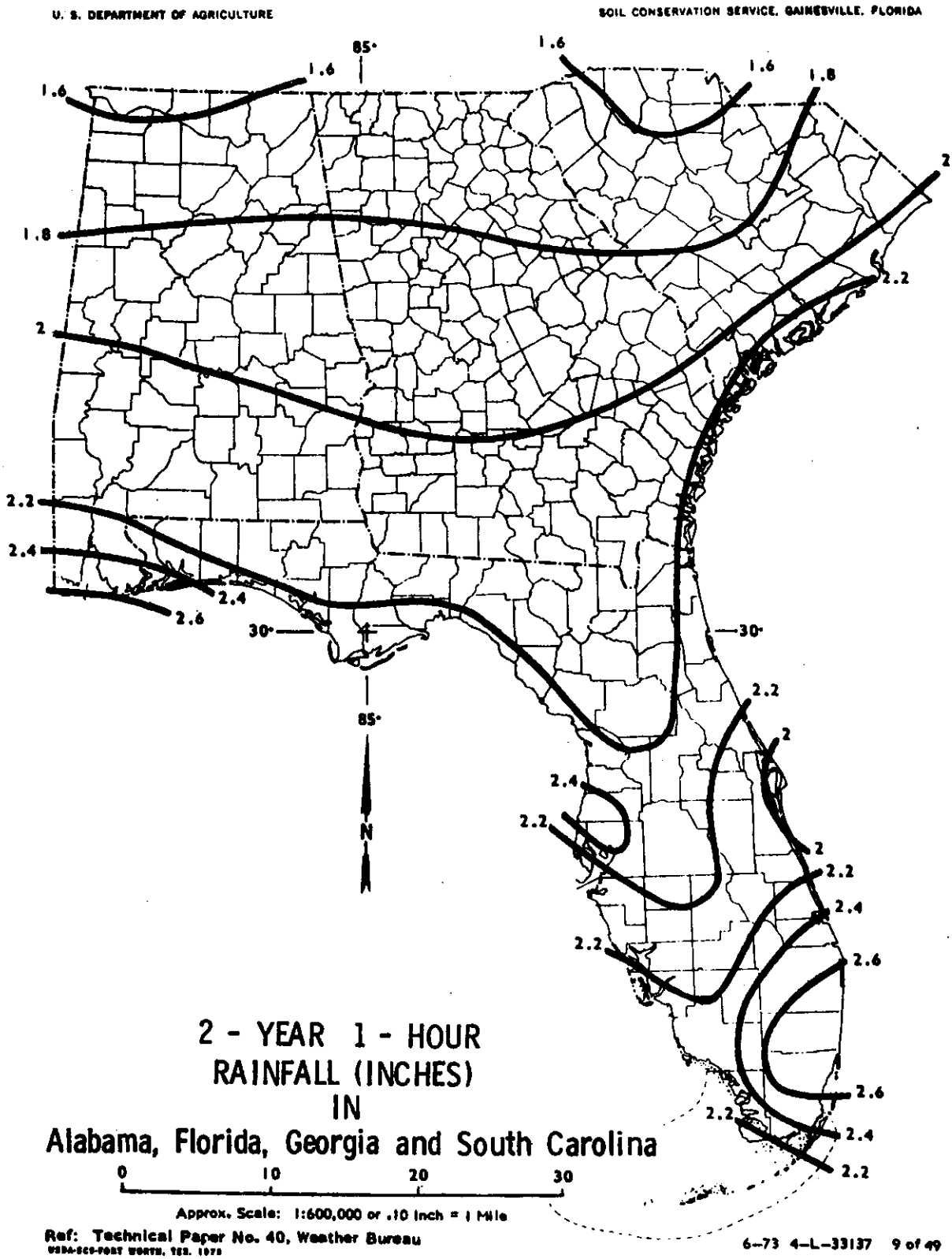

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
85°
30°
N
1.6
1.8
2
2.2
2.4
2.6
2 - YEAR 1 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0
10
20
30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
6-73 4-L-33137 9 of 49

FIGURE 8

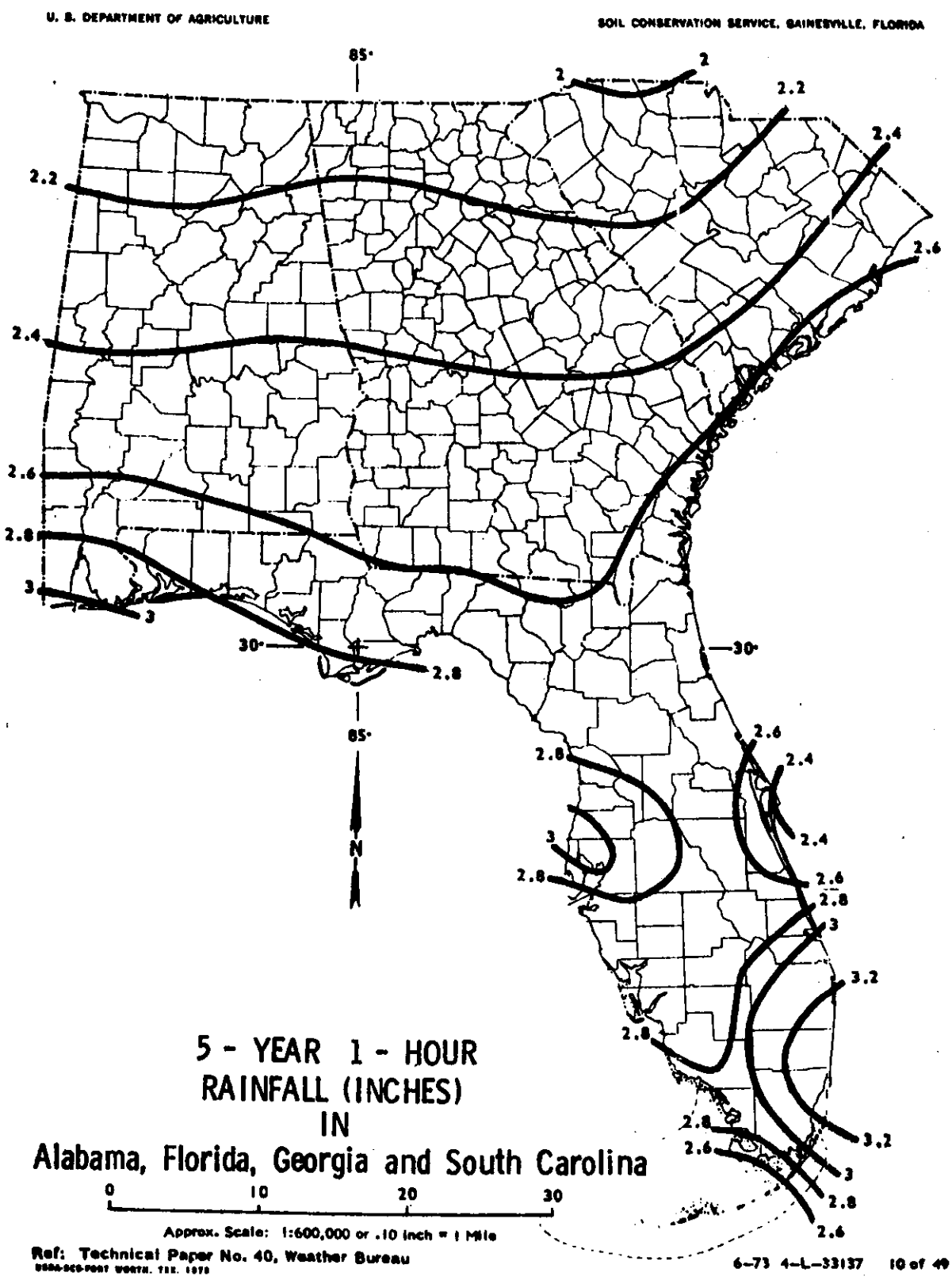

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
85°
30°
N
5 - YEAR 1 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0 10 20 30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
6-73 4-L-33137 10 of 49

FIGURE 9

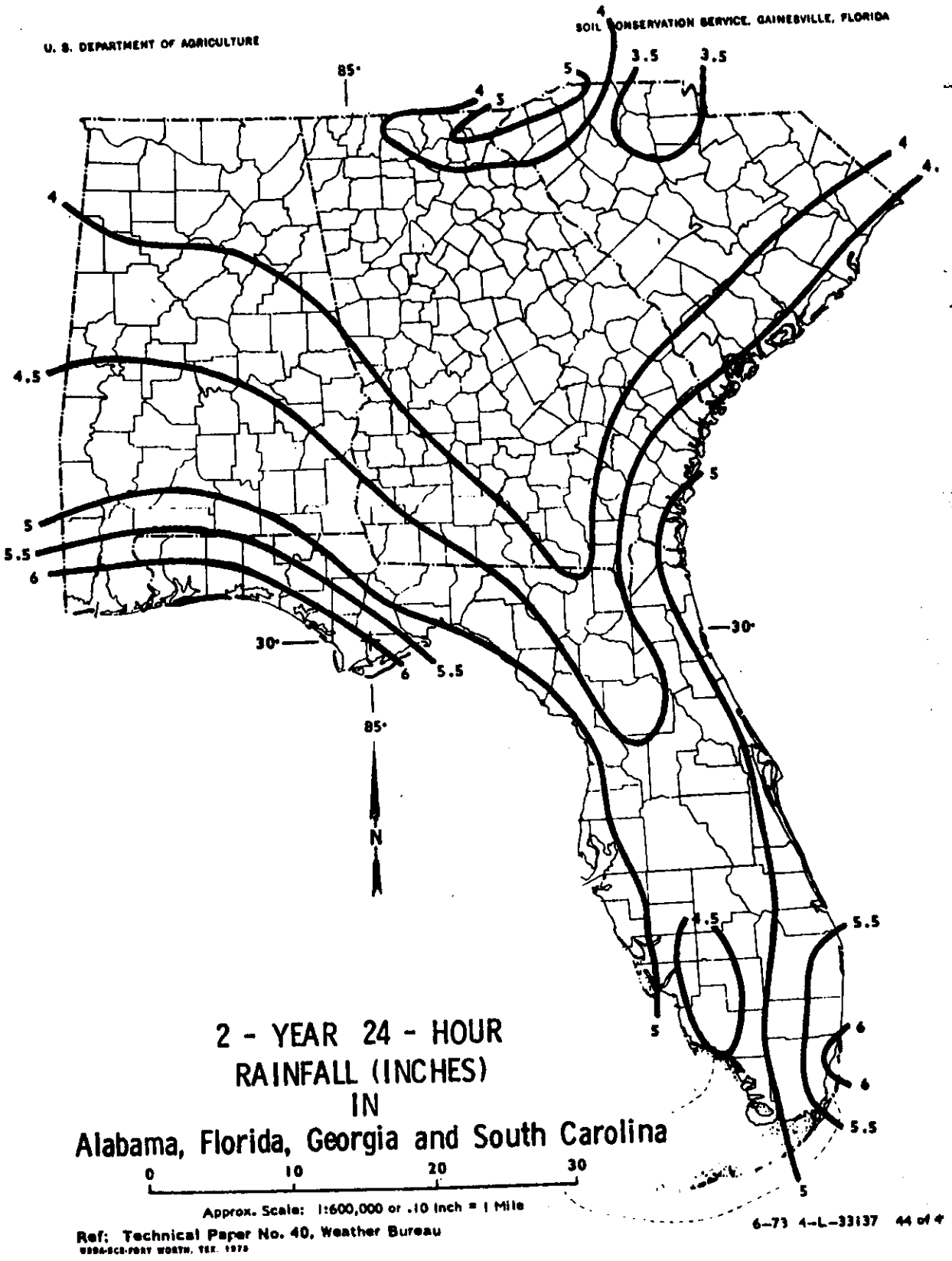
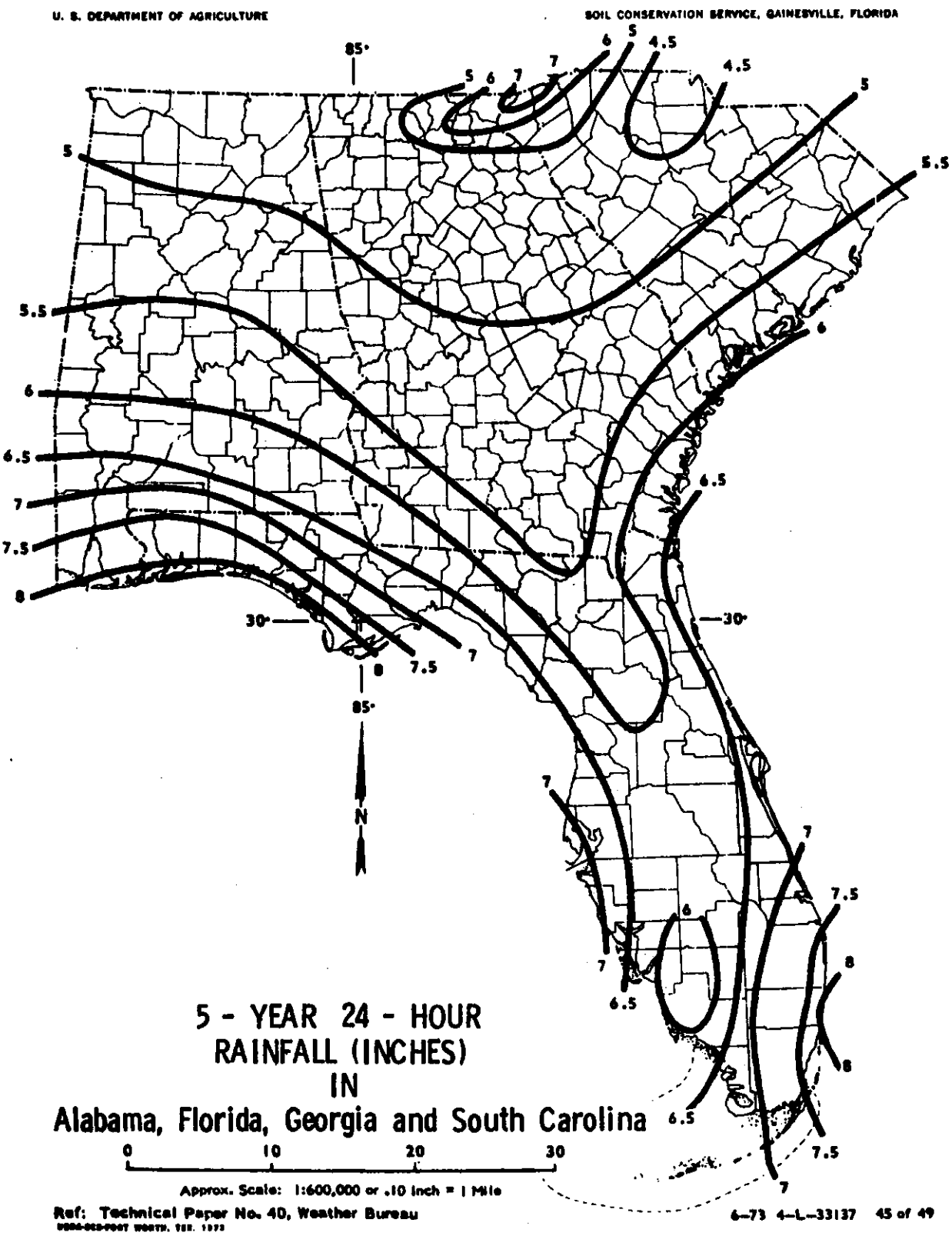

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
85°
30°
N
4
3.5
3.5
4.5
5
5.5
6
2 - YEAR 24 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0
10
20
30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
WDSA-SCS-FORT WORTH, TEX. 1973
6-73 4-L-33137 44 of 4

FIGURE 10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SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
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30°
N
5 - YEAR 24 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0 10 20 30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
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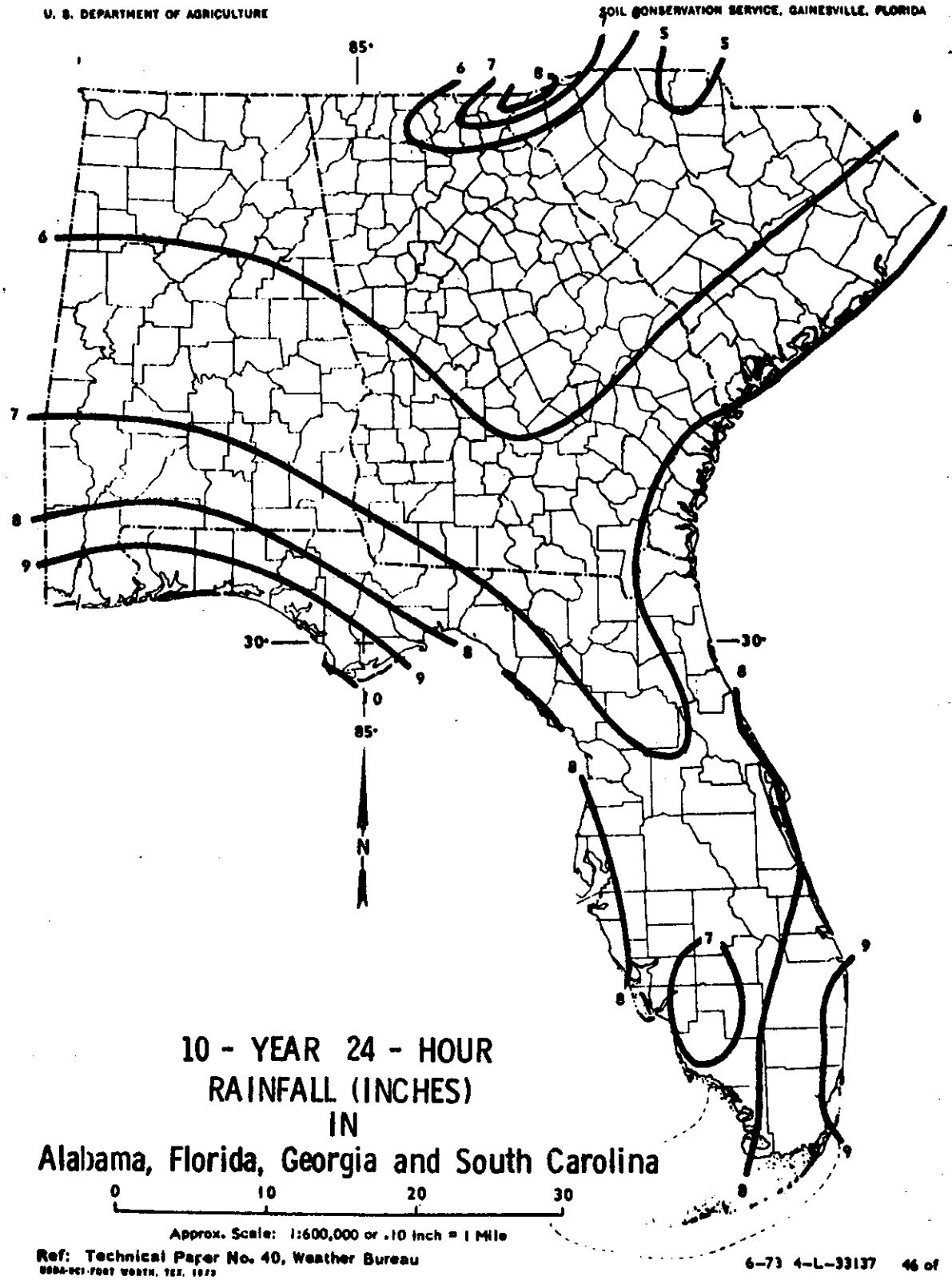
FIGURE 11


U. S. DEPARTMENT OF AGRICULTURE
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30°
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10 - YEAR 24 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0 10 20 30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
6-73 4-L-33137 46 of

FIGURE 12

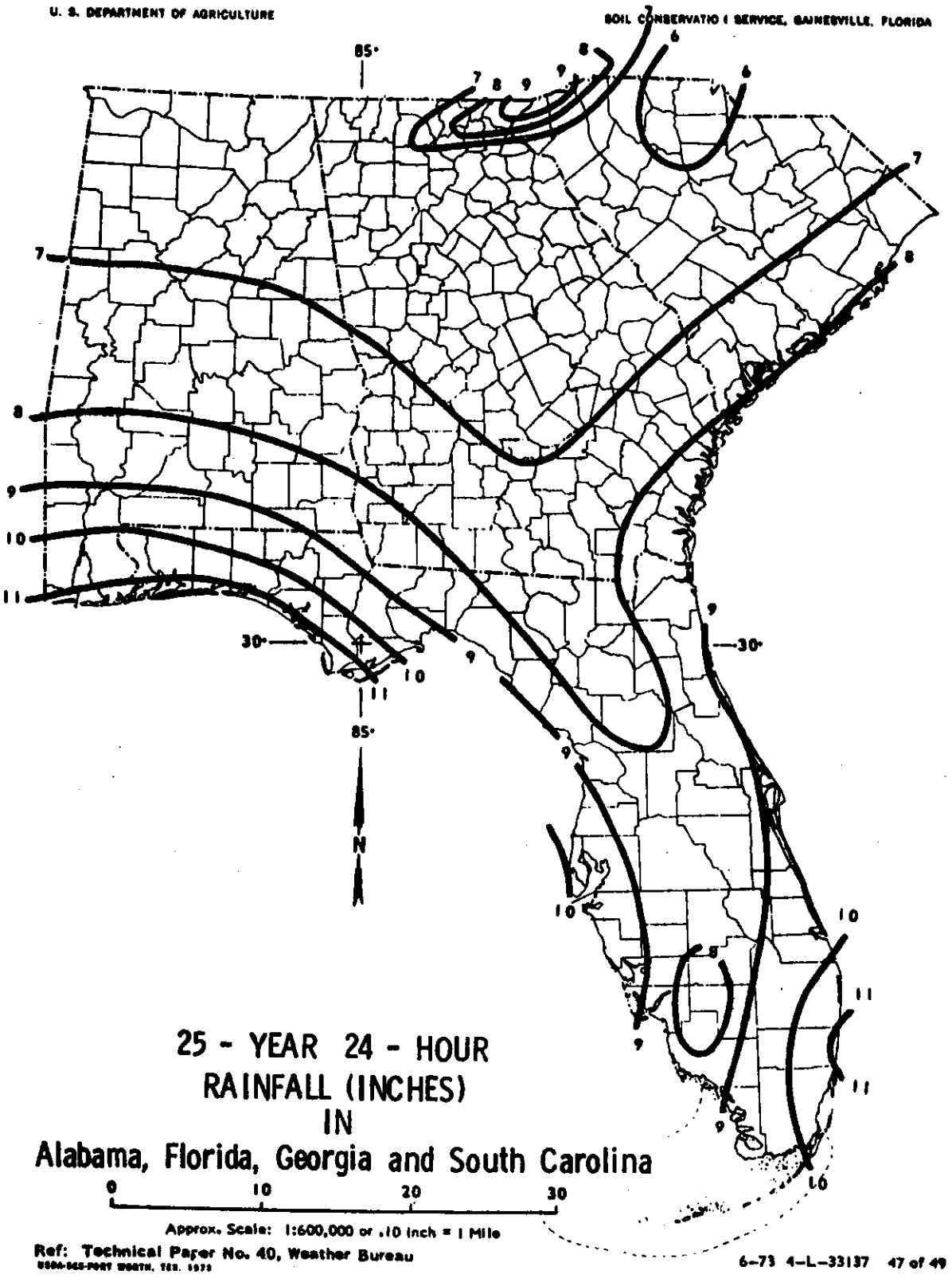
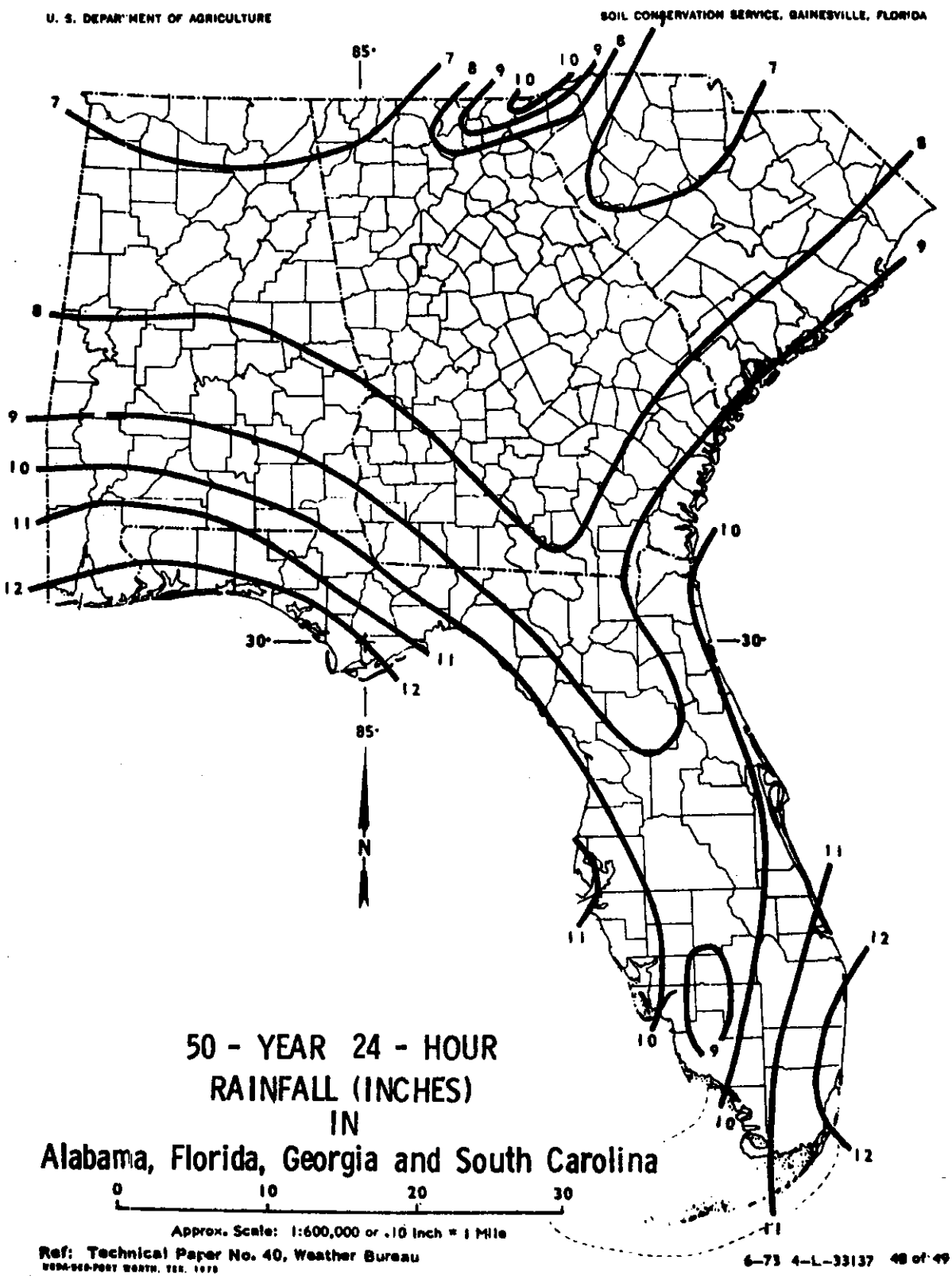

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
85°
30°
N
25 - YEAR 24 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0 10 20 30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
6-73 4-L-33137 47 of 49

FIGURE 13


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
85°
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50 - YEAR 24 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0 10 20 30
Approx. Scale: 1:600,000 or .10 Inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
6-73 4-L-33137 48 of 49

FIGURE 14

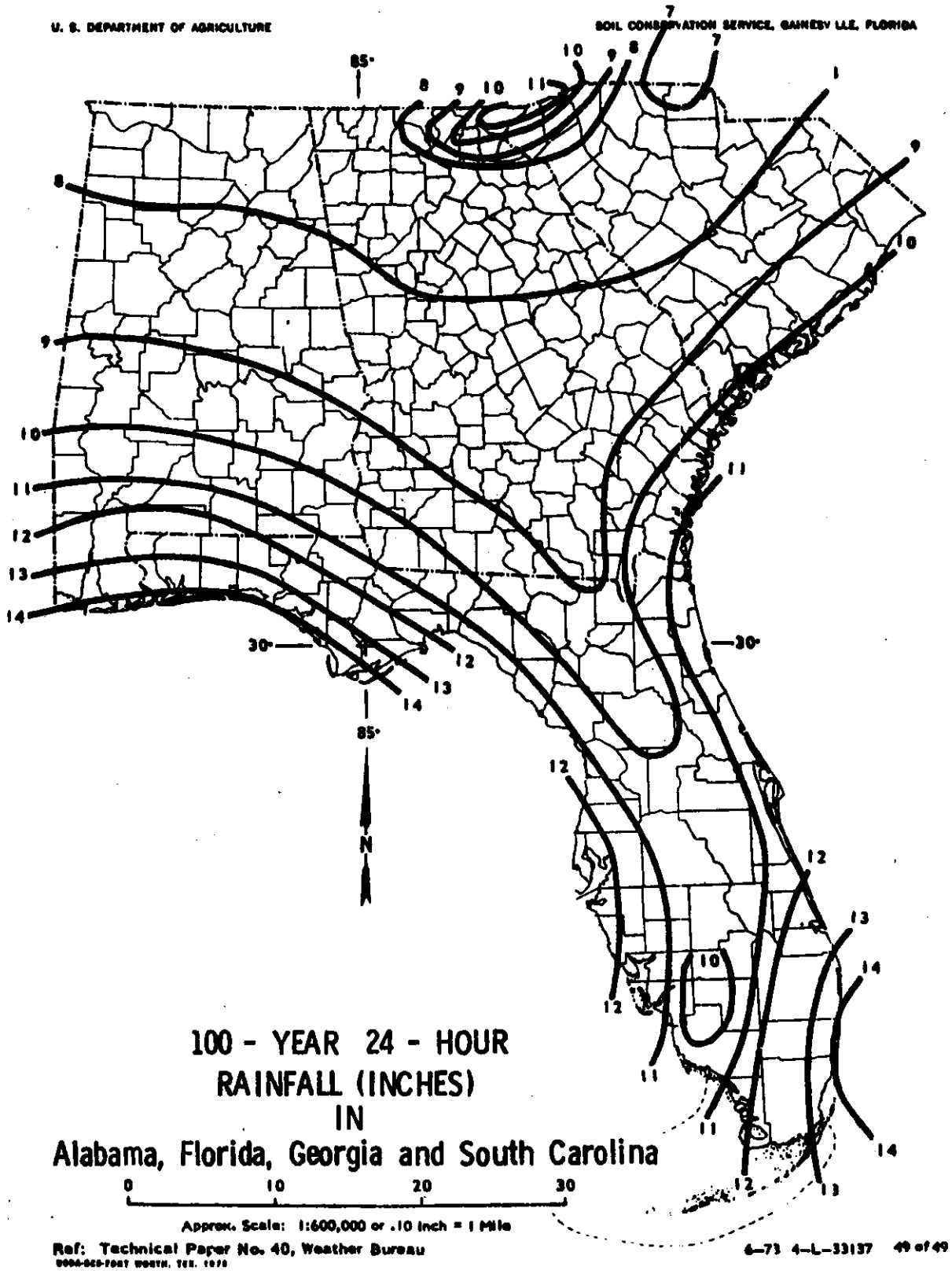

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE, GAINESVILLE, FLORIDA
85°
30°
N
100 - YEAR 24 - HOUR
RAINFALL (INCHES)
IN
Alabama, Florida, Georgia and South Carolina
0
10
20
30
Approx. Scale: 1:600,000 or .10 inch = 1 Mile
Ref: Technical Paper No. 40, Weather Bureau
6-73 4-L-33137 49 of 49

FIGURE 15

B. Distribution

1. SCS Type II 24-Hour

The distribution of rainfall versus time is an important consideration for determining the peak rates and stages which will occur during a design event. The table on the following page represents the SCS Type II 24-hour rainfall distribution in dimensionless form (P/P_{24}). The cumulative depth of rainfall versus time is represented as a ratio to the 24-hour total rainfall depth. An example of the use of this table for a 24-hour design rainfall depth of 10.0 inches is:

Time (hours)	Ratio (P/P_{24})	X	(P_{24}) 10.0 inches	=	Cumulative Rainfall (inches)	
0.0	.000	X	10.0	=	0.00	
4.0	.048	X	10.0	=	0.48	
8.0	.120	X	10.0	=	1.20	
10.0	.181	X	10.0	=	1.81	
11.0	.235	X	10.0	=	2.35	
11.5	.283	X	10.0	=	2.83	
12.0	.663	X	10.0	=	6.63	
13.0	.772	X	10.0	=	7.72	
16.0	.880	X	10.0	=	8.80	
20.0	.952	X	10.0	=	9.52	
24.0	1.000	X	10.0	=	10.00	24-hour Total RF

SCS RAINFALL DISTRIBUTIONS

The Type II distribution is representative for regions in which the high rates of runoff from small areas are usually generated from summer thunderstorms. The distribution is based on generalized rainfall depth-duration relationships obtained from Weather Bureau technical papers. The selection of the period of maximum intensity was based on design consideration rather than meteorological factors.

TYPE II

Time (hrs)	P/P_{24}	Time (hrs)	P/P_{24}
0.0	.000	12.5	.735
0.5	.005	13.0	.772
1.0	.011	13.5	.799
1.5	.017	14.0	.820
2.0	.022	14.5	.835
2.5	.029	15.0	.850
3.0	.035	15.5	.865
3.5	.042	16.0	.880
4.0	.048	16.5	.889
4.5	.056	17.0	.898
5.0	.064	17.5	.907
5.5	.072	18.0	.916
6.0	.080	18.5	.925
6.5	.090	19.0	.934
7.0	.100	19.5	.943
7.5	.110	20.0	.952
8.0	.120	20.5	.958
8.5	.134	21.0	.964
9.0	.147	21.5	.970
9.5	.163	22.0	.976
10.0	.181	22.5	.982
10.5	.204	23.0	.988
11.0	.235	23.5	.994
11.5	.283	24.0	1.000
12.0	.663		

Ref: A Method for Estimating Volume and Rate of Runoff in Small Watersheds, SCS-TP-149, April 1973.

2. SFWMD 24-Hour

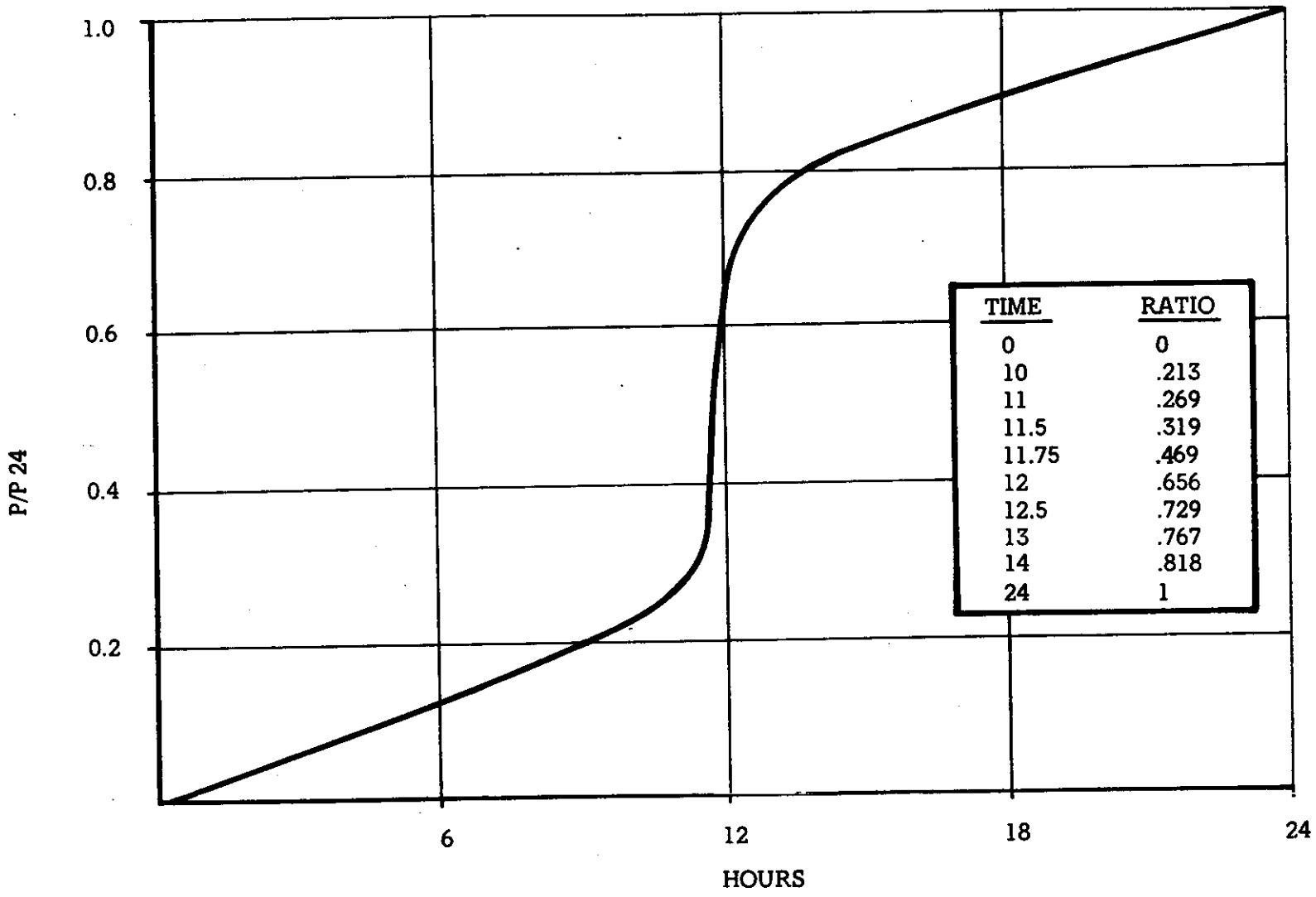
Figure 16 is a graphical representation of the 24-hour rainfall distribution presented in the "Basis of Review" document. The cumulative distribution of rainfall is given as a ratio to the total 24-hour rainfall depth. An example of the use of this figure for a 24-hour design rainfall depth of 10.0 inches is:

Time (hours)	Ratio (P/P_{24})	X	(P_{24}) 10.0 inches	=	Cumulative Rainfall (inches)	
0	.000	X	10.0	=	0.00	
10	.213	X	10.0	=	2.13	
11	.269	X	10.0	=	2.69	
11.5	.319	X	10.0	=	3.19	
11.75	.469	X	10.0	=	4.69	
12	.656	X	10.0	=	6.56	
12.5	.729	X	10.0	=	7.29	
13	.767	X	10.0	=	7.67	
14	.818	X	10.0	=	8.18	
24	1.000	X	10.0	=	10.00	24-hour Total RF

3. SFWMD 5-day

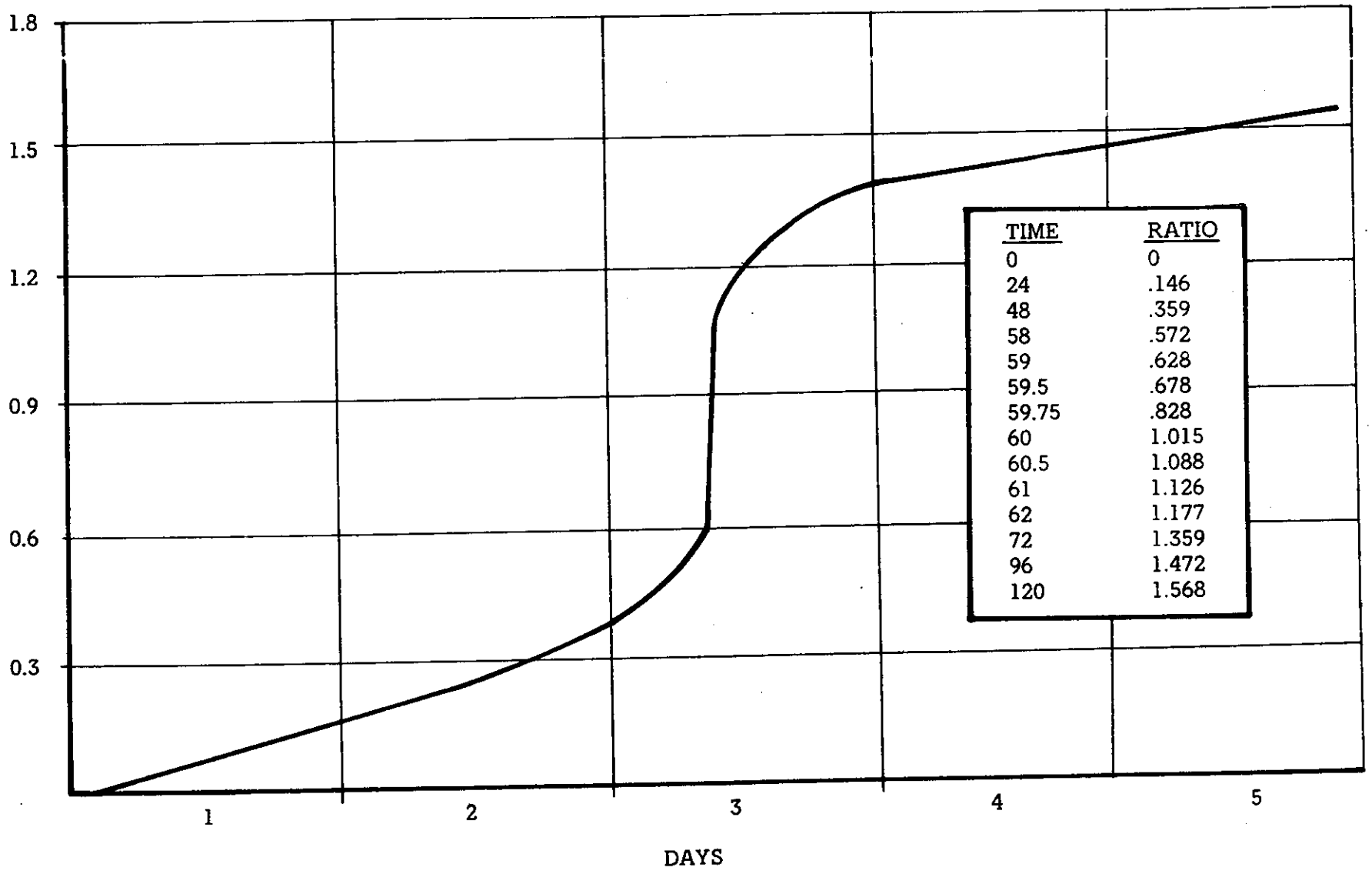
Figure 17 is a graphical representation of the 5-day rainfall distribution presented in the "Basis of Review" document. The cumulative distribution of rainfall is given as a ratio to the total 24-hour rainfall depth. An example of the use of this figure for a 24-hour design rainfall depth of 10.0 inches is:

Time (days)	Time (hours)	Ratio (P/P_{24})	X	(P_{24}) 10.0 inches	=	Cumulative Rainfall (inches)	
0	0	.000	X	10.0	=	0.00	
1	24	.146	X	10.0	=	1.46	
2	48	.359	X	10.0	=	3.59	
2 + 10 hours	58	.572	X	10.0	=	5.72	
2 + 11 hours	59	.628	X	10.0	=	6.28	
2 + 12 hours	60	1.015	X	10.0	=	10.15	
2 + 13 hours	61	1.126	X	10.0	=	11.26	
3	72	1.359	X	10.0	=	13.59	
4	96	1.472	X	10.0	=	14.72	
5	120	1.568	X	10.0	=	15.68	5-day Total RF



24 HOUR RAINFALL DISTRIBUTION

FIGURE 16



5 DAY RAINFALL DISTRIBUTION

FIGURE 17

III. Runoff Estimation

A method for estimation of runoff from rainfall information has been developed by the United States Department of Agriculture's Soil Conservation Service (SCS).

The runoff equation used by SCS was developed by Victor Mockus and others and presented in the U.S. Soil Conservation Service's National Engineering Handbook, Section 4, Hydrology. The relationship between accumulated rainfall and accumulated runoff was derived from experimental data for numerous soils, vegetative cover and land treatment measures.

The equation is:

$$Q = \frac{(P-Ia)^2}{(P-Ia) + S}$$

where:

Q = accumulated direct runoff (inches)

P = accumulated rainfall (inches)

Ia = initial abstraction including surface storage, interception, and infiltration prior to runoff (inches)

S = potential maximum retention (inches)

This equation is particularly easy to use with the cumulative rainfall distributions which we introduced in the previous section. For purposes of developing project specific runoff generation relationships District staff applies this formula using a weighted soil moisture storage value for the maximum retention parameter, S. For example, if a project had the ability to store 6.0 inches of rainfall in the soil profile and it was 50% impervious, then for purposes of calculating the cumulative runoff volumes you would use an S value of:

$$6.0 \text{ inches } X \text{ } (1-0.50) = \underline{3.0 \text{ inches}}$$

The relationship between Ia and S was developed from experimental watershed data. The empirical relationship used in the SCS runoff equation is:

$$Ia = 0.2S$$

Substituting 0.2S for Ia in the runoff equation, above, yields:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

To show the rainfall-runoff relationship graphically (see Figure 18), S values are transformed into curve numbers (CN) by the following equation:

$$CN = \frac{1000}{S+10}$$

Example:

Assume we have the following:

P_{24} = 10.0 inches rainfall
S_o = 10.0 inches storage in soil profile
I = 50% impervious
S = 10.0 (1-.50) = 5.0 inches
$CN = \frac{1000}{S+10} = 67$

Therefore,

$$Q = \frac{(P-0.2S)^2}{P+0.8S}$$

$$Q = \frac{(10.0-0.2(5.0))^2}{10.0+0.8(5.0)} = 5.8 \text{ inches runoff in 24 hours}$$

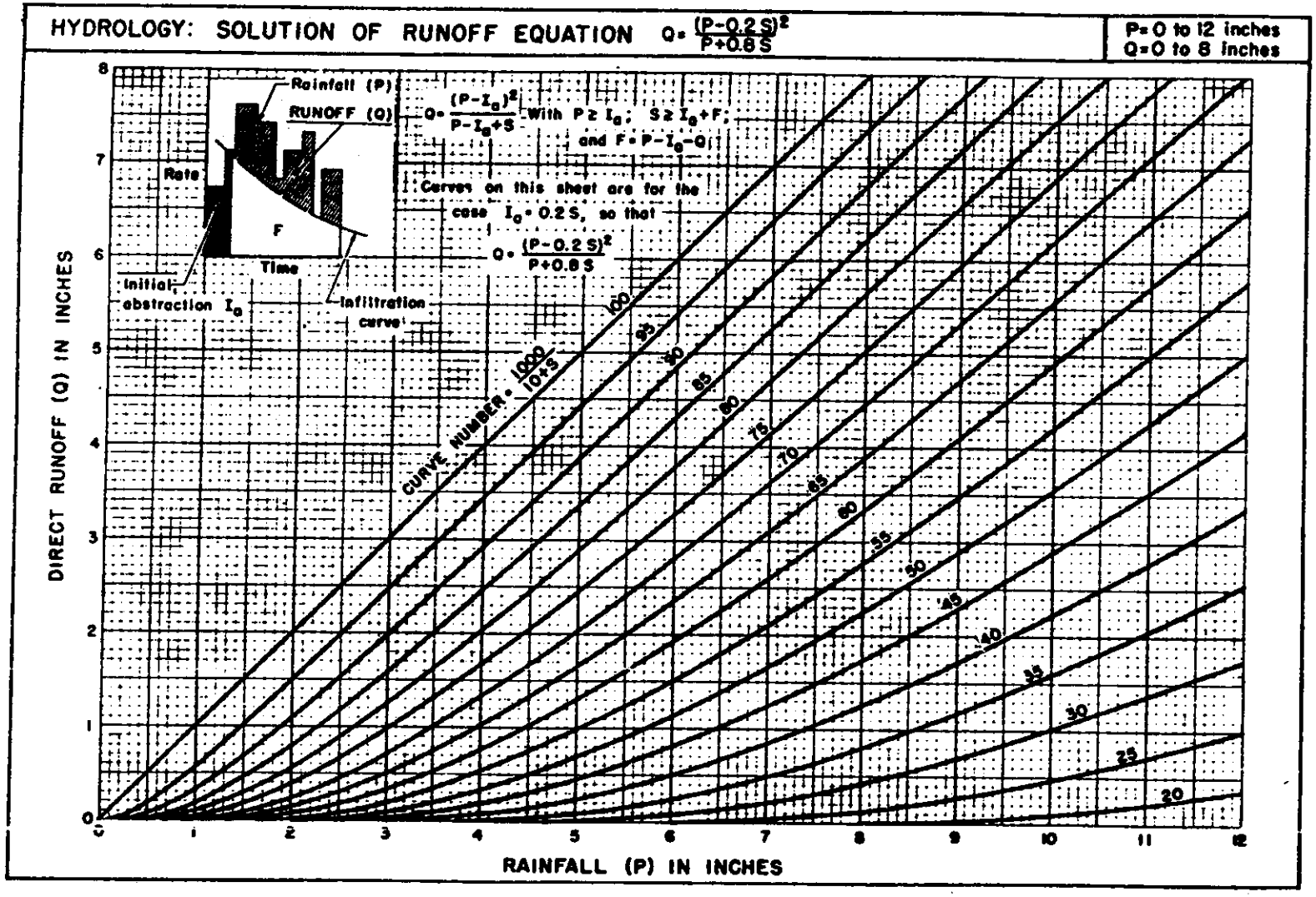
IV. Storage Calculation

A. Ground Storage

The moisture storage capability of the soil profile has been estimated by the Soil Conservation Service for the normal sandy soils found within the South Florida Water Management District boundaries. The total amount of water which can be stored in the soil profile expressed as a function of the depth to the water table for these soils is:

Depth To Water Table (Feet)	Cumulative Water Storage (Inches)	Compacted Water Storage (Inches)
1	0.60	0.45
2	2.50	1.88
3	6.60	4.95
4	10.90	8.18

The values in the third column represent the estimated amount of water which can be stored under pervious areas after development. These values represent the cumulative water storage values reduced by 25 percent to account for the reduction in void spaces due to the compaction which occurs incidental to earthwork operations. An example of the use of this information is:



Solution of the runoff equation, $Q = \frac{(r - 0.2s)^2}{P + 0.8S}$

FIGURE 18

Assume we have the following:

Average Finished Grade = 17.0 feet MSL
Maintained Water Level = 14.0 feet MSL
Percent of Project in Lakes = 15%
Percent of Project Impervious = 35%

We wish to determine the project specific S-value to use for determining the runoff volume which will be generated after development. We see that the depth to the water table will be 3 feet (17.0-14.0=3.0) consequently the total amount of water which can be stored under pervious surfaces will be 4.95 inches. If 15% of the project will be in lakes and 35% will be covered by impervious surfaces, then the remainder, or 50%, will be pervious areas and the appropriate weighted S-value will be:

4.95 inches X (1.0-0.15-0.35)=2.48 inches=S

Figure 19 is a graphical representation of the cumulative water storage capabilities of the soil profile for the developed and undisturbed conditions versus the depth to the water table for the typical sandy soils found within the South Florida Water Management District Boundaries.

B. Surface Storage

1. Storage in Lakes and Canals

For small projects the amount of water which can be stored within a developed project's lakes and canals can be assumed to store vertically without variation of surface area. For a project with 5 acres of lakes and canals and an average top of bank elevation 3 feet above the maintained water level within the project, we can estimate the "bank-full" storage capability as (5 acres X 3 feet) 15 acre-feet of water storage without overflowing the canal or lake banks. The actual storage volume will be somewhat different due to side slopes and the changing surface area versus elevation; however, it is not felt to be significant enough to substantially affect the calculated values for small projects. It should be noted that in certain projects that have a large number of lakes that compose the total lake acreage, thus creating a high ratio of shoreline to lake acreage, the side slopes may have to be considered when the volume of lake storage is computed.

2. Storage on the Land

The amount of water which can be stored above the land surface in the developed areas can be estimated as shown on Figure 20. The project used for Figure 20 has 360 acres of graded property below the house pad elevation of 17.5 feet MSL and above the top of bank of lake elevation of 14.5 feet MSL. The calculation is based upon the assumption that the total area with standing water varies linearly with the stage on-site. Based upon 360 acres of landscaped property with a 3 foot difference in grade, we see that the rate of submergence versus rising stage is 360 acres/3 feet or 120 acres of land submerged per foot of rise.

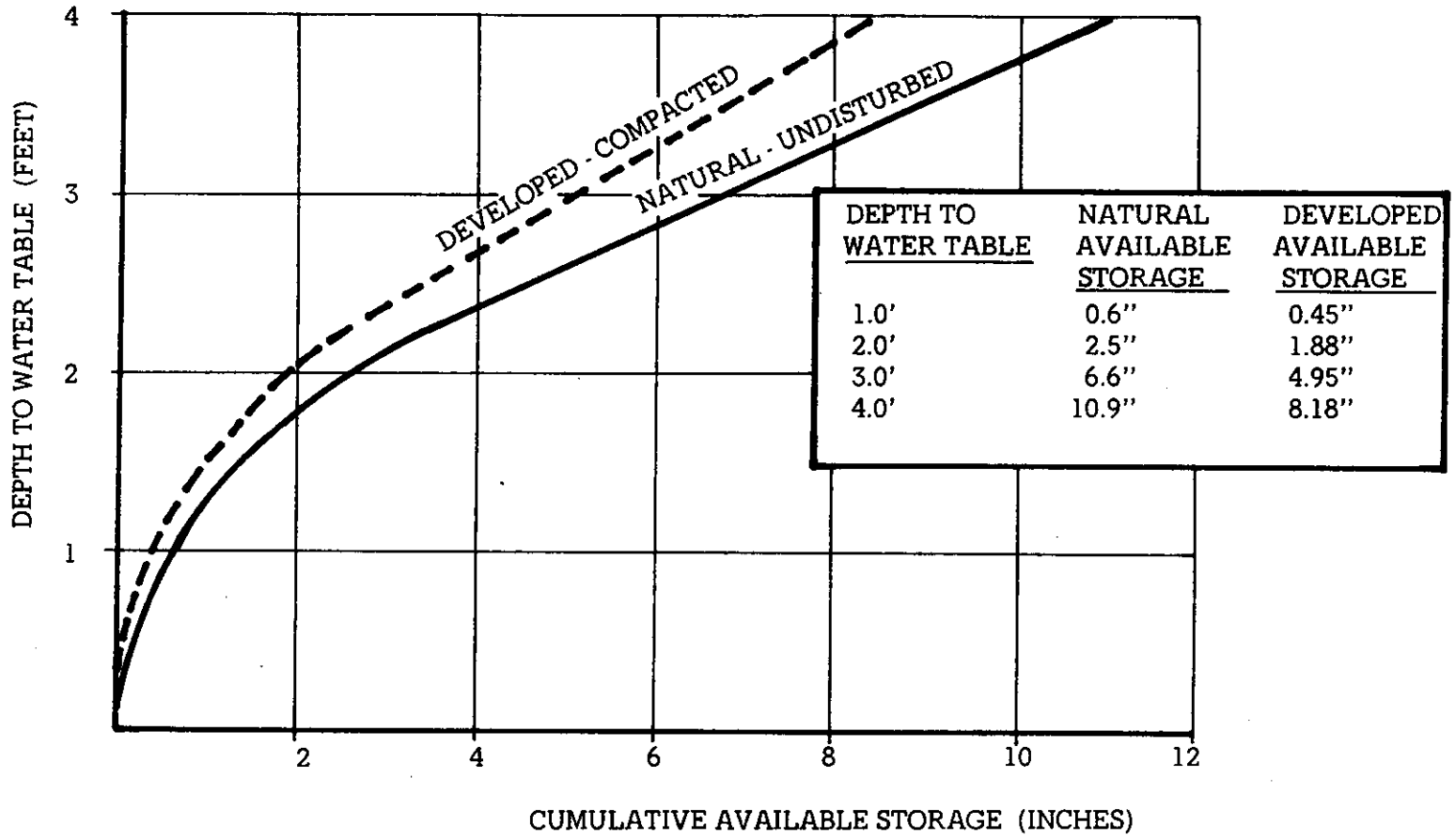


FIGURE 19

CUMULATIVE SOIL MOISTURE STORAGE

STAGE	STORAGE
14.5	0
16.0	0.75' X 180 = 135 AF
17.0	1.25' X 300 = 375 AF
17.5	1.50' X 360 = 540 AF

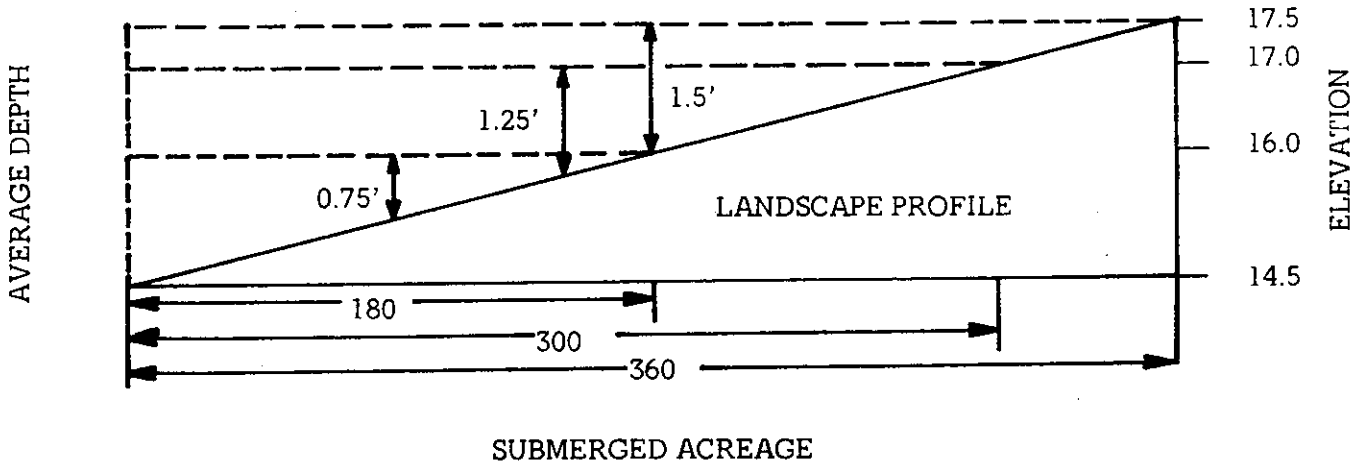


FIGURE 20

SURFACE STORAGE COMPUTATION SCHEME

As an example, we see from Figure 20 that at elevation 16.0 feet MSL, a total of 180 acres has some standing water on it and that the depth of standing water varies from 1.5 feet for property at 14.5 feet MSL to 0 feet depth for property at 16.0 feet MSL. Hence, the total volume of water stored on the land is equal to the total acreage with water on it times the average depth of standing water:

$$180 \text{ acres} \times \frac{1.5+0}{2} = \underline{\underline{135 \text{ acre-feet stored}}}$$

3. Stage-Storage Graph

Once we have performed the above calculation to determine the total volume of open surface storage available within the project as a function of the stage on-site, we can then represent the information visually by the construction of a Stage-Storage Curve as shown on Figure 21. On Figure 21 the total volume of water which can be stored within the developed project at a desired stage can be determined by moving across the graph horizontally to the right from the stage to the curve then from that point moving vertically downward to the bottom axis and reading the storage volume.

V. Discharge Considerations

A. Pumped Systems

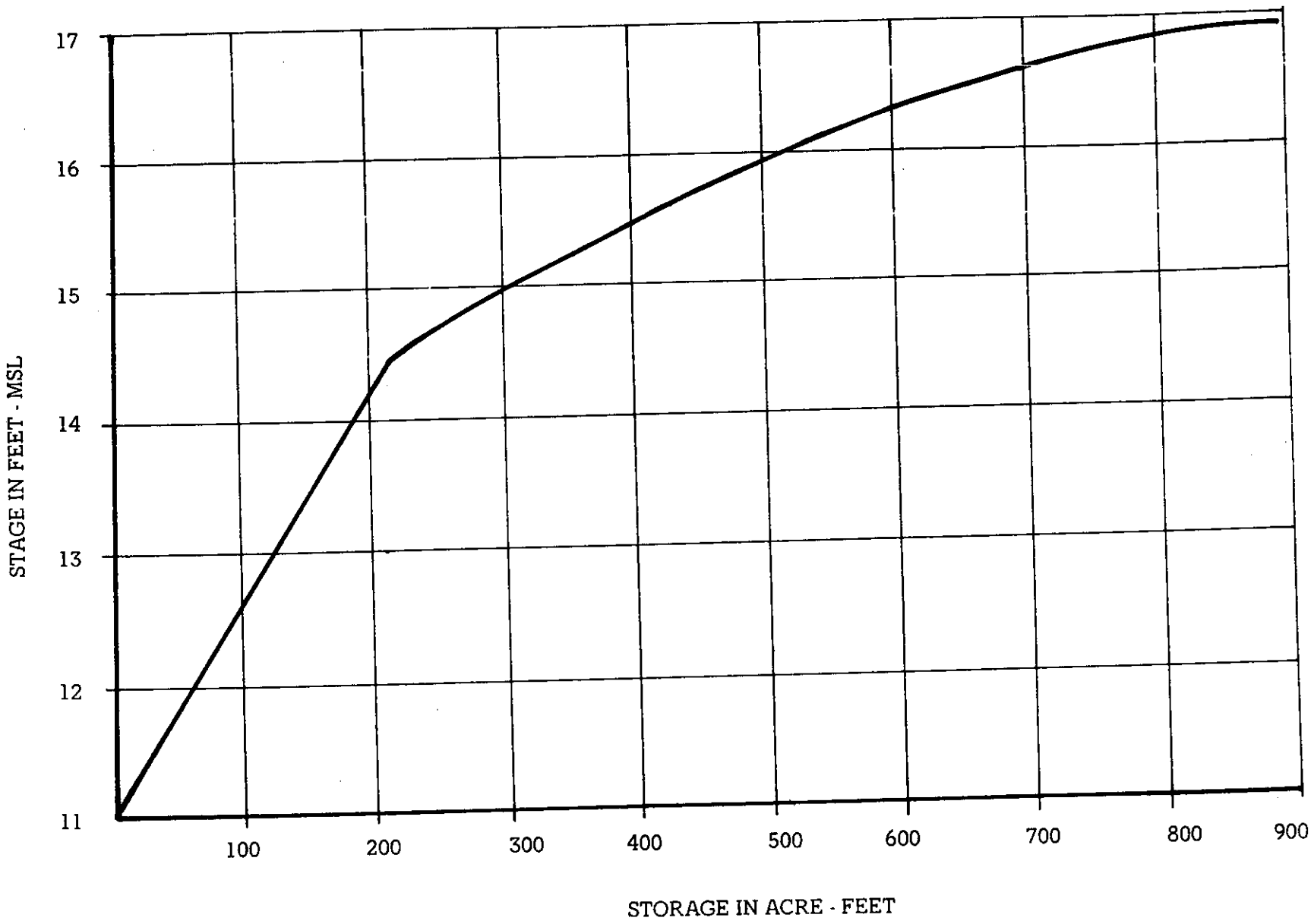
For the design and analysis of surface water management systems the use of pumps is easy to account for in determination of discharge rates and peak stages. The peak discharge rate from the project is obviously the capacity of the pump or pumps. To determine the total volume discharged up to any particular time you just multiply the capacity of the pump times the elapsed time since the pump started pumping.

B. Gravity Systems

The design and analysis of gravity systems is relatively complex and requires a very good working knowledge of hydraulics and the performance of various structure types under variable head conditions. We will not go into great detail herein due to the large number of combinations of gravity discharge structures which are available and used in system designs.

As an example of one of the problems which occurs frequently the design of a culvert with flashboard riser will be discussed since it is the most common structure used within the District.

Figure 22 shows the schematic of a culvert with flashboard riser and also illustrates graphically the discharge characteristics of both the culvert and the flashboard riser. If the flashboard riser were not attached to the culvert, then the culvert would have discharge any time the headwater (elevation in the on-site lake) elevation rose above 10.0 feet MSL, the tailwater (elevation in receiving water) elevation, and its discharge capacity as a function of the lake stage is represented by Curve A. However, the flashboard riser is attached to the



TYPICAL STAGE - STORAGE GRAPH

FIGURE 21

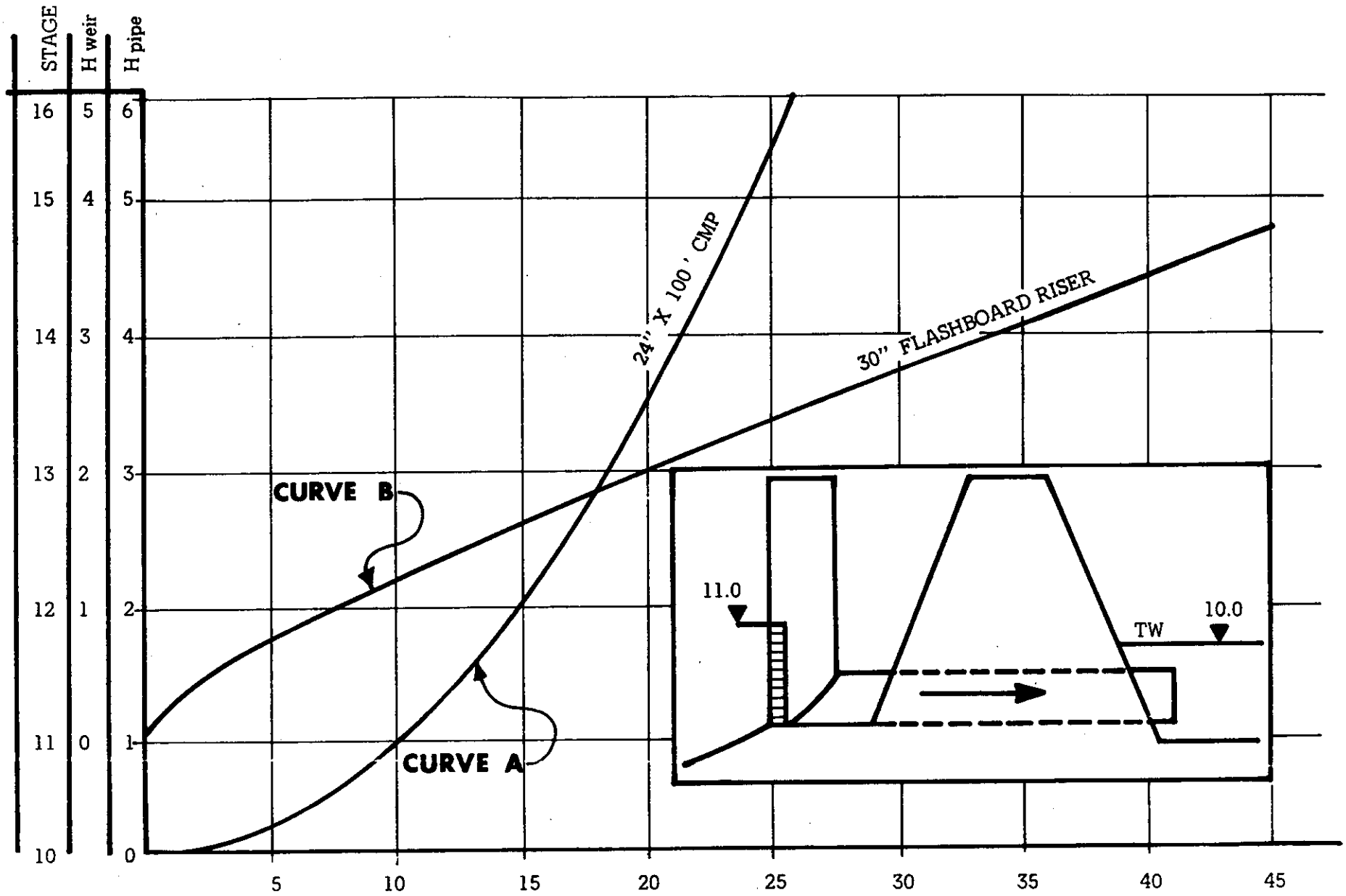


FIGURE 22

STAGE - DISCHARGE INTERSECTING CURVES GRAPH

upstream side of the culvert and acts as a sharp-crested weir which will not allow any discharges until the on-site lake level rises to elevation 11.0 feet MSL (the crest elevation of the top of the flashboards). When the lake stage rises above elevation 11.0 feet MSL the discharge capacity as a function of the lake stage is represented by Curve B.

The problem which we wish to point out in this example is the fact that the two discharge capacity curves cross when the on-site lake stage exceeds elevation 12.8 feet MSL. The question then is, which is the actual discharge rate of this structure as a function of the on-site lake stage? The answer is that whichever is the more restrictive, i.e. whichever structure passes less at a specific stage, is the controlling structure. From elevation 10.0 feet to 12.8 feet MSL the discharges are controlled by the flashboard riser and the structure is said to be in "weir control." From elevation 12.8 feet MSL and up the discharges are limited by the hydraulic capacity of the culvert and the structure is said to be in "pipe control." Consequently, the actual Stage-Discharge Curve for this particular structure arrangement is that shown on Figure 23.

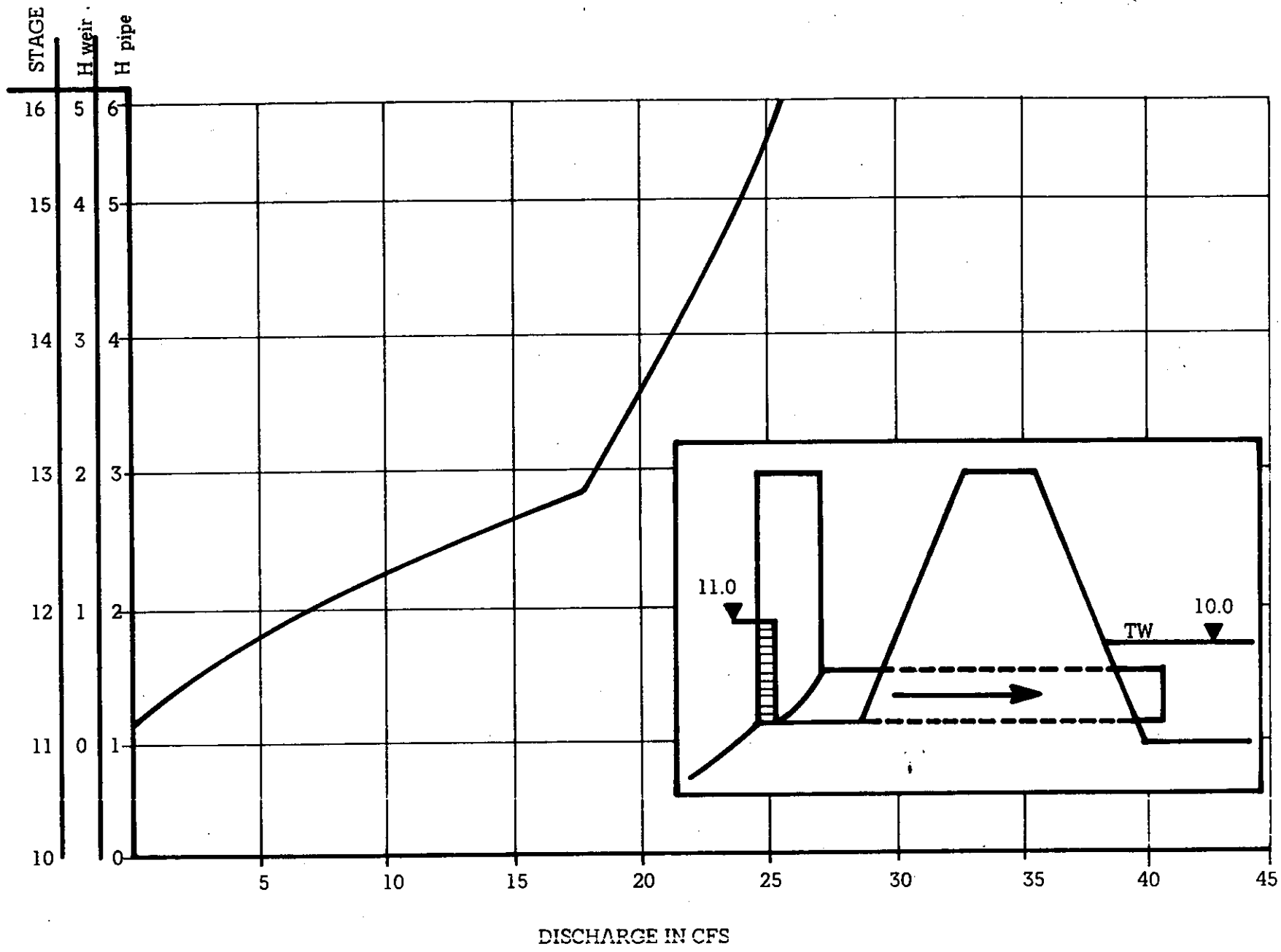


FIGURE 23

TYPICAL STAGE - DISCHARGE GRAPH

VI. Hydrographs and Flood Routing

A. Hydrographs

1. An inflow hydrograph is a graphical representation of the runoff generation rate versus time. It represents the rate at which runoff is flowing into the water management system. This influx of water into the system tends to make the water level (stage) on-site rise in accordance with the storage characteristics of the system as are normally represented by a Stage-Storage Curve.

2. An outflow hydrograph is a graphical representation of the discharge rate of the control structure(s) versus time. It represents the rate at which runoff is flowing out of the water management system. This outflux of water tends to reduce the stage on-site.

B. Flood Routing

1. Flood routing is a methodology for accounting for the inflow rates, discharge rates, storage volumes, and on-site stages at any point in time. Figure 24 is a graphical flood routing of a particular design event. In the example problem a numerical method for flood routing is presented.

2. A close look at the information on Figure 24 will provide a lot of information as to the performance of a surface water management system during a design event. The solid-line curve is the Inflow Hydrograph and represents the rate of runoff generation. The dotted-line curve is the Outflow Hydrograph and represents the discharge rate of the outfall structure(s). The area under the inflow hydrograph represents the Total Volume of Runoff. The area under the outflow hydrograph represents the Total Volume Discharged. The difference between the total volume of runoff and the total volume discharged is the Total Volume Stored.

   Whenever the inflow rate is greater than the outflow rate the on-site stage rises. Whenever the outflow rate is greater than the inflow rate the on-site stage drops. At the Point of Dynamic Equilibrium the inflow rate equals the outflow rate and the stage does not change. Prior to this point the inflow rate exceeded the outflow rate and the stage was continually rising. After this point the outflow rate exceeds the inflow rate and the stage drops. Consequently, the on-site stage has reached its peak value at this point. Since the discharge capacity is directly related to the on-site stage, the structure is also passing its peak discharge at this point.

   Since at the Point of Dynamic Equilibrium we know the peak stage on-site and the peak discharge for a particular design event it is this point which we are interested in knowing. Flood Routing is the way in which this point is found.

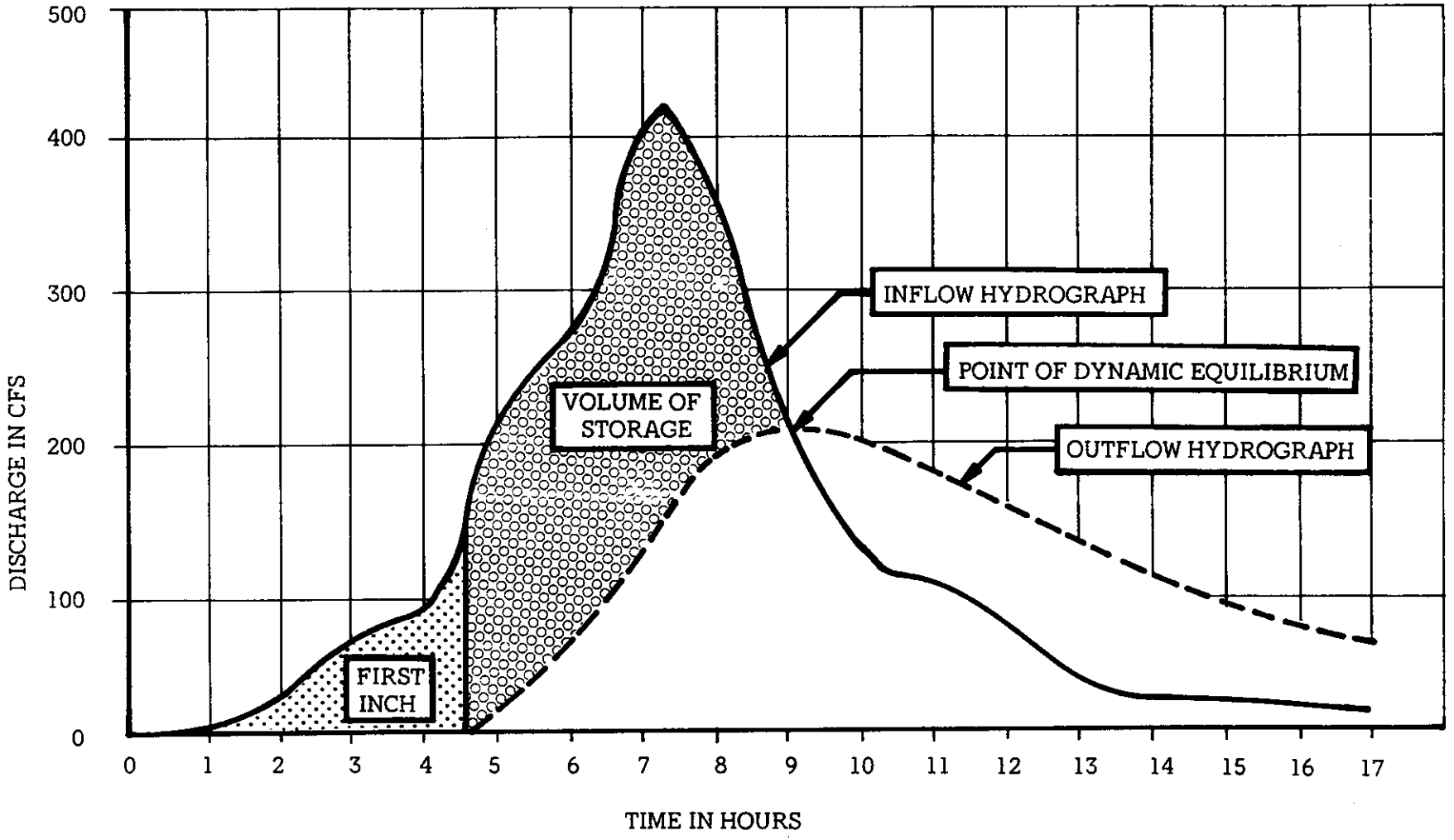


FIGURE 24

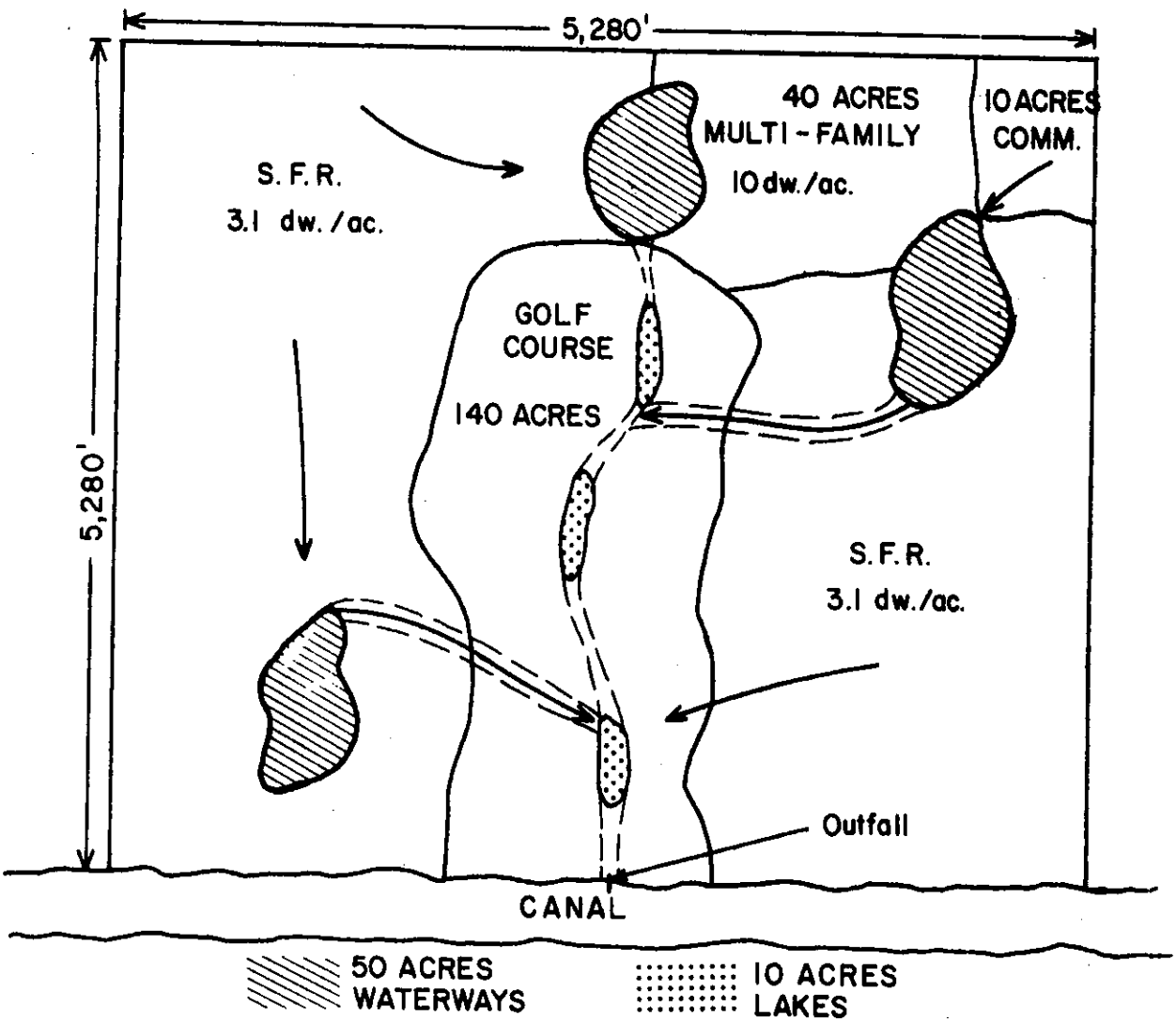
INFLOW AND OUTFLOW HYDROGRAPHS

Part C - Surface Water Management Example Problem

The example problem which follows incorporates all of the theories and principles of Part B of this volume to design a surface water management system which meets the criteria as delineated in Part A of this volume.

Any specific questions about any portion of this example problem can be answered personally through a visit with the staff.

EXAMPLE PROBLEM



Allowable 25 year discharge to canal

$Q = \left(\frac{78}{\sqrt{A}} + 54\right) A$ A = in square miles

Q = in cfs

Maintained canal stage 9.0
25 year design stage 11.9

Minimum road elevation 14.5
Minimum floor elevation 17.0

24 hour rainfalls
100 year 13"
25 year 10"
3 year 6"

FIGURE 25

Given:

EXAMPLE DESIGN PROBLEM

- Regulated Discharge -

640 acre development

140 acre golf course with 10 acres lakes

40 acre multi-family - 10 du/acre

10 acre commerical

400 acres SFR - 3.1 du/acre

50 acres waterways

1. Compute pervious/impervious

   a. Estimate road R/W @ 25% of (640-140) = 125 Ac.

      Impervious @ 30% of 125 Ac = 37.5 Ac.

   b. Lakes (impervious) = 10+50 = 60 Ac.

   c. Commerical 10 Ac. impervious

   d. SFR - 400 X 3.1 - 1240 lots @ 3000 SF/lot imp.

      $1240 \times \frac{3000}{43560} = 85.4$ Ac.

   e. Multi-family @ 5 X 1350 (bldg.) + 10 X 650 (park).

      = 13,250 SF/acre X 40 acres = 12.2 Ac.

   f. Total impervious = 37.5 + 60 + 10 + 85.4 + 12.2 = 205.1 Ac.

   g. Pervious = 640 - 205 = 435 Ac.

2 Compute ground water storage and SCS Curve No.

   a. Maintained water stage el. 11.0

   b. Minimum road el. 14.5

   c. Local well logs show the ground water table is at 3.5' over the entire project.

d. Say 3.5 ft. computed soil-storage is 75% of 8.8" = 6.6".

e. Ground storage = $435 \times \frac{6.6}{12} = 239$ AF.

f. Equivalent to $\frac{239}{640} \times 12 = 4.5"$ over total area.

S = Abstraction = 4.5" & CN = $\frac{1000}{S+10} = 69$.

3. Compute open surface stage-storage

a. Maintained stage el. 11.0.

b. Lakes store on vertical line el. 11.0 up.

c. Golf course on straight line el. 14.0 to 18.0.

d. Roads and lots on straight line less house pads el. 14.5 to 17.5.

Use 450 acres - 85.4 - 6.2 (MFR) - 2 (Comm.) = 360± Ac.

e. Calculations for developing curve

Stage (ft.)	Storage (AF) Lakes (60 Ac.)	G. Course (130 Ac.)	Rds & Lots (360 Ac.)	
11.0	0	0	0	0
14.0	60 X 3 = 180	0	0	180
14.5	60 X 3.5 = 210	1/8 X 130 X $\frac{0.5}{2}$ = 4	0	214
16.0	60 X 5 = 300	½ X 130 X $\frac{2.0}{2}$ = 65	½ X 360 X $\frac{1.5}{2}$ = 135	500
17.0	60 X 6 = 360	3/4 X 130 X $\frac{3.0}{2}$ =146	$\frac{2.5}{3}$ X360 X$\frac{2.5}{2}$ = 375	881

f. Stage - storage curve as developed given on Page 102.

4. Allowable discharge in C-14 as given in "The Basis of Staff Review-Appendix"

$$Q = \left(\frac{78}{\sqrt{A}} + 54\right) A = \left(\frac{78}{1} + 54\right) 1 = 132 \text{ cfs}$$

5. Weir crest elevations

Store first inch above el. 11.0 - flat @ el. 11.0.

Minimum weir crest @ el. 11.0 $+\left(\frac{640}{12}/60\right)$ = 11.0 + 0.9 = 11.9

6. Check minimum building floor elevations (100 year)

a. 24 hour rainfall 13" X 1.568 (Basis of Review) = 20.4" five day rainfall.

b. Assume no discharge as explained in "The Basis of Staff Review"

Rainfall = 640 X $\frac{20.4}{12}$ = 1087 AF

Ground storage = 240 AF

Surface storage = 847 AF

c. Entering into the stage-storage curve at 847 AF gives an elevation of 16.9 ft. Since the minimum floor was assumed to be at 17.0' msl, it is safe.

7. Compute the weir length

a. Since the minimum floor elevation is 17.0' msl, the stage for the 25 year - 5 day storm must not exceed this.

b. Assume a stage of 15.5', thus giving 15.5 - 11.9 = 3.6' of head over the weir with an allowable discharge of 132 cfs.

c. $Q = 3.3\ Lh^{1.5}$

$132 = 3.3L\ (3.6)^{1.5}$

L = length of weir = 5.86 say 6.0 ft.

d. Develop a stage-discharge curve as shown on page 103 for the 6' weir discharging into C-14 through a 54" CMP 50' long.

e. A bleeder must be incorporated into the weir design at the wet season maintained water level. Depending on the design of the weir a small v-notch, a small diameter pipe, a slot, or a small hole may be used for said bleeder.

8. Check discharge computed for design frequency storm vs. the allowable discharge.

a. For discharge into C-14 the "Basis of Staff Review" gives a design frequency of 25 years. Again a 5 day duration rainfall will be distributed according to the "Basis of Staff Review".

b. The 25 year - 24 hour rainfall as given in the "SCS - Rainfall Frequency Atlas" is 10.0".

c. Computation of the peak stage and peak discharge is shown in the flood routing on page 6. "S" still equals 4.5.

d. The peak discharge is 125.76 which is less than the allowable into C-14 and thus is alright.

DESIGN STORM = 25 yr. TOTAL ACREAGE = 640 acres 24 HOUR RAINFALL = 4.0" S = 4.5

Column 1 Time Increment (hrs.)	Column 2 Time Cumulative (hrs.)	Column 3 Rainfall Ratio	Column 4 Cumulative Rainfall (inches)	Column 5 Cumulative Runoff (inches)	Column 6 Cumulative Runoff (ac-ft)	Column 7 Discharge (cfs)	Column 8 Discharge (ac-ft)	Column 9 Total Discharge (ac-ft)	Column 10 Volume Stored (ac-ft)	Column 11 Stage
0.00	0.00									11.00
24.00	24.00	0.146	1.46	.06	3.31	0	0	0	3.31	11.06
24.00	48.00	0.359	3.59	1.01	53.68	0	0	0	53.68	11.89
10.00	58.00	0.572	5.72	2.49	132.95	9.38	7.76	7.76	125.19	13.09
1.00	59.00	0.628	6.28	2.93	156.25	32.12	2.65	10.41	145.84	13.43
0.50	59.50	0.678	6.78	3.33	177.65	44.23	1.83	12.24	165.41	13.76
0.25	59.75	0.828	8.28	4.58	244.51	68.00	1.40	13.64	230.87	14.59
0.25	60.00	1.015	10.15	6.22	331.88	98.67	2.04	15.68	316.20	15.04
0.50	60.50	1.088	10.88	6.88	366.85	114.82	4.74	20.43	346.43	15.19
0.50	61.00	1.126	11.26	7.22	385.21	121.01	5.00	25.42	359.79	15.26
1.00	62.00	1.177	11.77	7.69	410.00	125.76	10.39	35.82	374.18	15.34
10.00	72.00	1.359	13.59	9.37	499.63	124.21	102.64	138.46	361.17	15.27
24.00	96.00	1.472	14.72	10.43	556.02	102.34	202.97	341.43	214.59	14.50
24.00	120.00	1.568	15.68	11.33	604.28	58.87	116.75	458.18	146.10	13.44

9. Check roads vs. local road criteria

a. In this instance a 3 year storm will be assumed and because of the size of the project a 5 day duration rainfall will be used using the distribution system as given in the "Basis of Staff Review".

b. The 3 year - 24 hour rainfall is interpolated between the 2 year - 24 hour and the 5 year - 24 hour as given in the "SCS - Rainfall Frequency Atlas". The rainfall for a 3 year - 24 hour storm equals 6.0 inches.

c. Computation of the peak stage is shown in the flood routing on page 98. S = abstraction = 4.5 inches as previously determined in #2.

d. The peak stage for the 3 year - 5 day storm is 14.0* msl and the minimum road was at 14.5' msl, therefore the road is safe.

DESIGN STORM = 3 yr. TOTAL ACREAGE = 640 acres 24 HOUR RAINFALL = 6.0" S = 4.5

Column 1 Time Increment (hrs.)	Column 2 Time Cumulative (hrs.)	Column 3 Rainfall Ratio	Column 4 Cumulative Rainfall (inches)	Column 5 Cumulative Runoff (inches)	Column 6 Cumulative Runoff (ac-ft)	Column 7 Discharge (cfs)	Column 8 Discharge (ac-ft)	Column 9 Total Discharge (ac-ft)	Column 10 Volume Stored (ac-ft)	Column 11 Stage
0.00	0.00									11.00
24.00	24.00	0.146	0.88	0	.01	0	0	0	.01	11.00
24.00	48.00	0.359	2.15	0.27	14.58	0	0	0	14.58	11.24
10.00	58.00	0.572	3.43	0.91	48.62	0	0	0	48.62	11.81
1.00	59.00	0.628	3.77	1.12	59.54	.20	.02	.02	59.52	11.99
0.50	59.50	0.678	4.07	1.31	69.81	1.48	.06	.08	69.73	12.16
0.25	59.75	0.828	4.97	1.93	103.01	7.83	.16	.24	102.99	12.71
0.25	60.00	1.015	6.09	2.78	148.26	25.70	.53	.77	147.48	13.46
0.50	60.50	1.088	6.53	3.13	166.80	44.38	1.83	2.60	164.19	13.74
0.50	61.00	1.126	6.76	3.31	176.61	52.61	2.17	4.78	171.83	13.86
1.00	62.00	1.177	7.06	3.56	189.93	58.96	4.87	9.65	180.28	14.00
10.00	72.00	1.359	8.15	4.48	238.76	60.05	49.62	59.27	179.49	13.99
24.00	96.00	1.472	8.83	5.06	269.91	41.84	82.19	141.46	128.45	13.14
24.00	120.00	1.568	9.41	5.56	296.79	21.68	43.00	184.47	112.32	12.87

I. Calculation Steps for Flood Routing

Up Thru the 62.0 Hour Time Period

Step 1. Columns 1, 2, and 3 are taken directly from the "Basis of Staff Review".

Step 2. Column 4 = Column 3 X 24 hour rainfall

Step 3. Column 5 = $(\text{Column 4} - 0.2S)^2 / (\text{Column 4} + 0.8\ S)$

Step 4. Column 6 = Column 5 X (Total acreage ÷ 12)

Step 5. Column 6 - Column 9 (on the previous row) = Initial Storage

Step 6. Enter into stage-storage graph at initial storage and get an initial stage.

Step 7. If the initial stage is below the top of the weir;

a. Column 7 and 8 are zero

b. Column 9 = 0

c. Column 10 = Column 6

d. Enter the stage-storage curve at the storage value in Column 10 and get the stage and enter in to Column 11.

Step 8. If initial stage is above the top of the weir, disregard Step 7.

*Step 9. Compute Column 7

a. H = {Initial Stage + Column 11 (previous row)} ÷ 2 - top of weir ht. in msl.

b. Plug H into weir and pipe formulas being used or enter the corresponding stage into the stage discharge curve to determine discharge in cfs. Enter in Column 7.

$ Step 10. Column 8 = (Column 7 X Column 1 X 26,928) ÷ 325,850.

Step 11. Column 9 = Column 8 + Column 9 (previous row)

Step 12. Column 10 = Column 6 - Column 9

¢ Step 13. Enter into the stage-storage curve at the storage value from Column 10 and enter the stage into Column 11.

* If the stage given in Column 11 (previous row) is lower than the top of the weir use the top of weir height to compute the head.

$ Conversion Factors: 1) $26,928 = \left(\frac{60 \text{ sec}}{1 \text{ min}}\right)\left(\frac{60 \text{ sec}}{1 \text{ hour}}\right)\left(\frac{7.48 \text{ gal}}{1 \text{ cu. ft.}}\right)$

2) 325,850 gal./ac-ft

¢ Note that this is an iterative method and in some cases extra iterations may be necessary.

II. Calculation Steps

for

Flood Routing

for

the 62.0 thru 120.0 Hour Time Period

Steps 1 thru 4 are the same.

Step 5. Compute Column 7

a. H = Column 11 (previous row) - top of weir height

b. Plug H into weir formula and get initial discharge in cfs.

c. Acre-feet = (cfs X Column 1 X 26,928) ÷ 325,850.

d. Total discharge in acre-feet = Acre-feet computed in c. + Column 9 (previous row).

e. Volume stored = Column 6 - total discharge

f. Enter stage - storage curve at volume stored and get a stage

g. Recompute H, H = ½ X {Column 11 (previous row) + stage computed in f.} - top of weir

h. Column 7 is now determined by plugging new H into weir formula.

Step 6. Column 8 = (Column 7 X Column 1 X 26,928) ÷ 325,850

Step 7. Column 9 = Column 8 + Column 9 (previous row)

Step 8. Column 10 = Column 6 - Column 9

Step 9. Enter into the stage-storage curve at the storage value from Column 10 and enter the stage in Column 11.

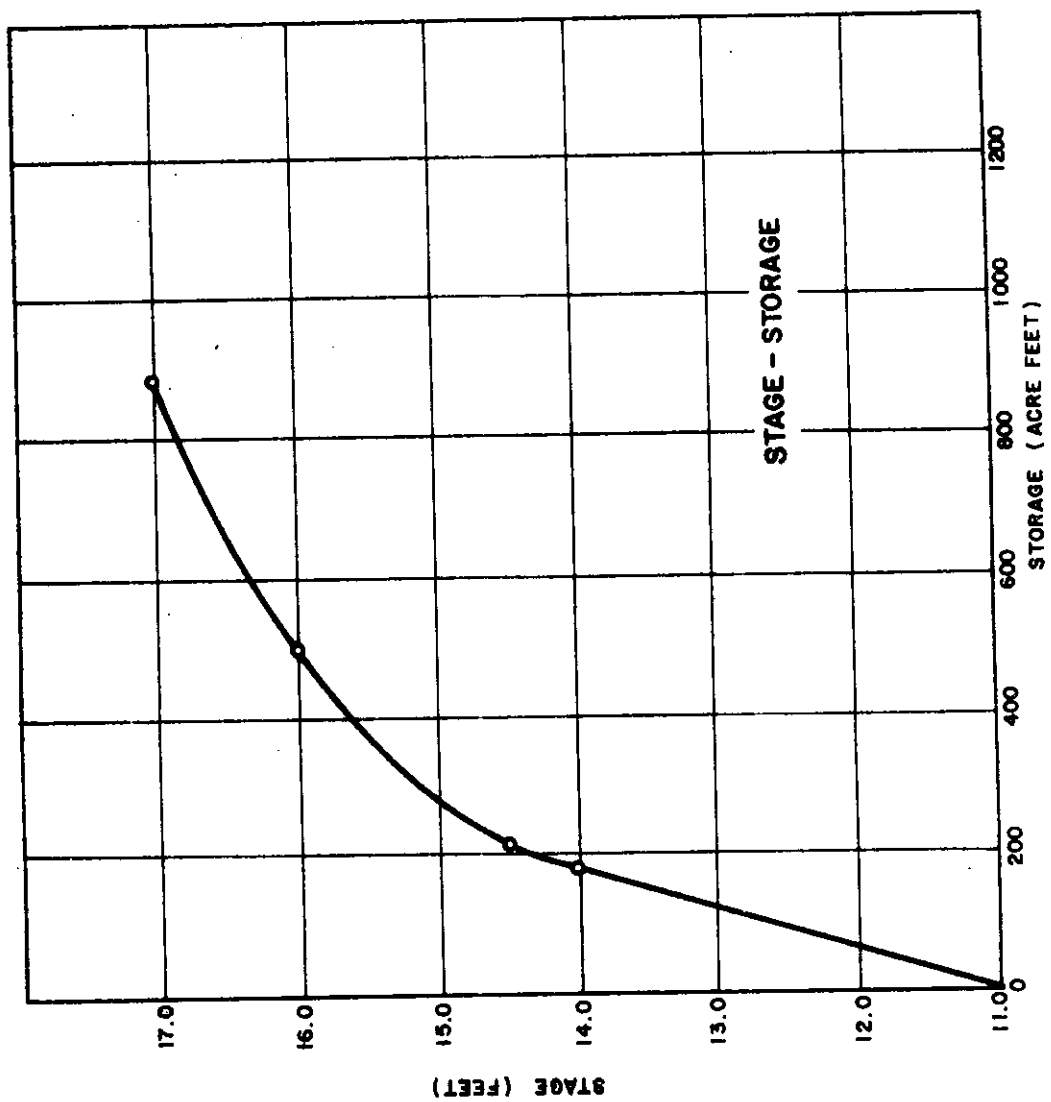

STAGE - STORAGE
STORAGE (ACRE FEET)
0
200
400
600
800
1000
1200
STAGE (FEET)
17.0
16.0
15.0
14.0
13.0
12.0
11.0

FIGURE 26

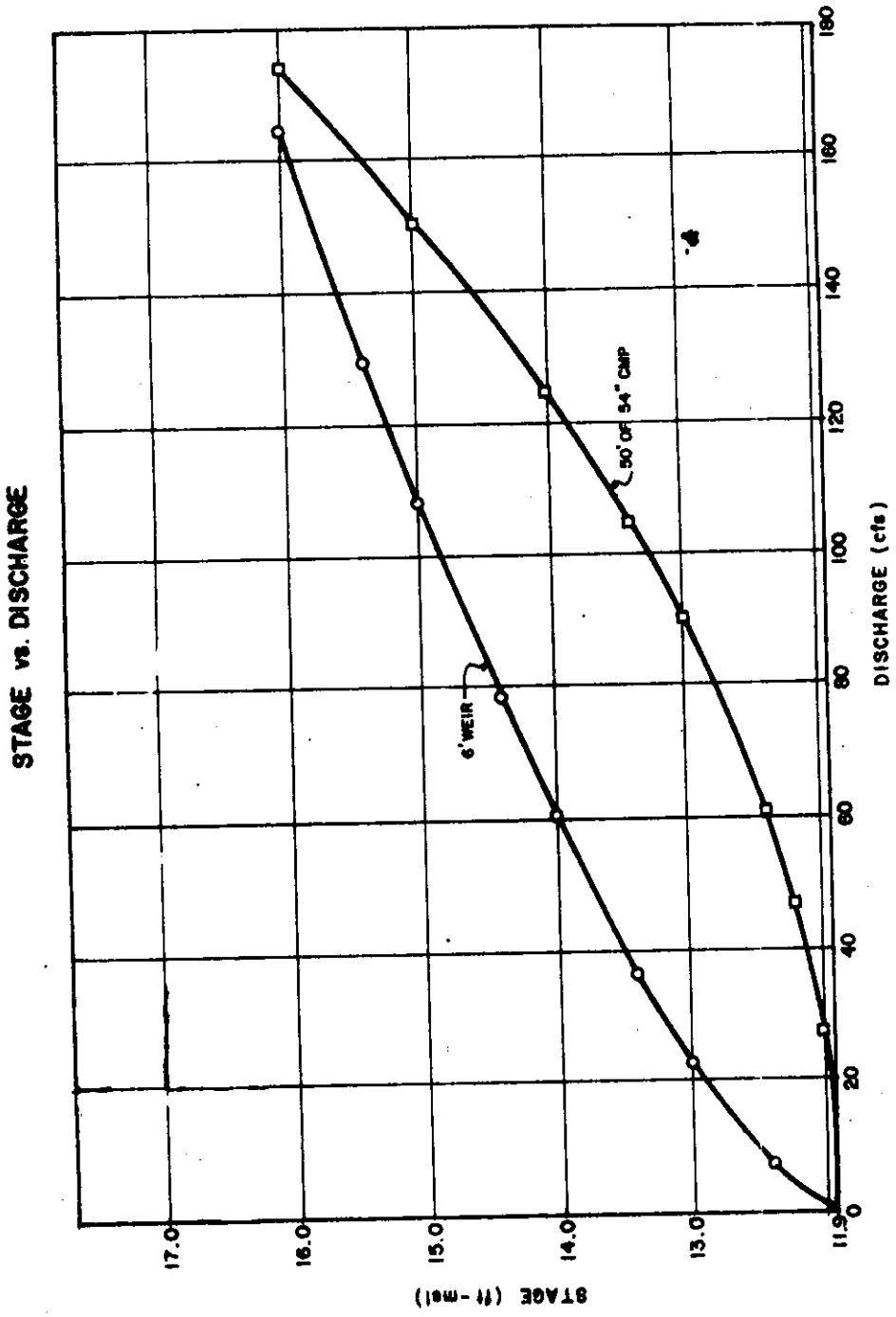

STAGE vs. DISCHARGE
STAGE (ft-msl)
DISCHARGE (cfs)
17.0
16.0
15.0
14.0
13.0
11.9
0
20
40
60
80
100
120
140
160
180
6' WEIR
50' OF 54" CMP

FIGURE 27