Flood Mitigation Methods for Existing Residential Buildings

and the Possible Use of Flood Panels

City of Naples 2/18/2025

Key Links

https://www.fema.gov/sites/default/files/2020-07/fema_p-936_floodproofing_non-residential_buiildings_110618pdf.pdf

https://www.fema.gov/sites/default/files/documents/fema_technical-bulletin-3_1-2021.pdf

https://www.fema.gov/sites/default/files/documents/fema_form-ff-206-fy22-153.pdf

What prompted urgency to address flood panels?

- Multiple hurricanes & storms have caused millions in property damage ($149,714,136 in claims paid from Ian)
- City wants to support property owners' efforts to mitigate future damage
- On Jan 2, 2025, staff was alerted by the Florida Department of Emergency Management (FDEM) that a residential building had been "dry floodproofed" in violation of the Florida Building Code and National Flood Insurance Program (NFIP)
- This violation affects all properties in the City as it can result in higher insurance premiums for all policies, including flood, and possibility ability to obtain any insurance at all.

Discussion & analysis

- After the FDEM alert, staff began internal investigation and analysis and a discussion back and forth with FDEM eventually resulting in FDEM agreeing with our position that it is possible to use these products and method in some cases following strict guidelines
- It was determined that the project was completed without following the city permitting process.
- A small number of vendors/contractors had been selling and installing floodproofing panels for residential building owners.
- These vendors/contractors, and their clients, were led to believe (by the salesman) that permits were not required.
- The Building Department was never consulted

Discussion & analysis

- Since NFIP regulations require communities to enforce their own rules, the city had to act upon discovering the unpermitted work.
- A sense of urgency was placed on staff after the Department issued “Stop Work Orders” on the identified properties
- We had to provide a remedy, requiring staff to study codes, regulations, and procedures to establish a clear path for implementing flood panels on existing buildings

Key Findings on Floodproofing

- According to the Florida Building Code (FBC), NFIP, and FEMA, **residential buildings cannot** use **Dry Floodproofing** to meet flood code compliance
- **Non-residential buildings** are permitted to use **Dry Floodproofing** for compliance if the proper procedures are followed (per **ASCE 24-14** and **FEMA P-936**)

The City's position

- The existing buildings in question did not install flood panels to meet flood code compliance
- Instead, the panels were installed to mitigate flood events
- This distinction was crucial, as the FBC, FEMA, and NFIP do not prohibit extra protective measures for buildings (as long as they are not meant to come into code compliance)
- The City's position has been validated by the Deputy State Floodplain Manager, Michael Burchette, for the use of dry floodproofing panels as a method of mitigation for our residents under certain conditions

FDEM Guidance on Jan 29, 2025:

“Upon further consideration and consultation, we have determined that it is not a violation of the NFIP minimum requirements to allow retrofit dry floodproofing of residential buildings under very specific circumstances which should be documented in the City’s permanent records:

- The proposed work, combined with any other work undertaken at the same time, is determined to not be substantial improvement of the existing building and is not proposed if a building is determined to have incurred substantial damage
- The proposed work is determined feasible and will not make the building unsafe, which should be based on an engineering evaluation of the structural integrity of the building with respect to resisting flood loads based on site-specific conditions and the proposed design
- The proposed work does not make a nonconforming building more nonconforming
- The proposed work does not violate any terms of the original permit that authorized construction in a flood hazard area
- The proposed work is authorized by a permit ”

Guidance to residential homeowners

- Building Department aims to provide clear and concise guidance for individuals interested in implementing flood panels on their residential buildings
- We support residents' desire to protect their buildings against flooding
- However, we must adhere to regulations and statutes requiring such projects to go through the permitting process

Permitting requirements

- Building and Fire Department have made the determination that the permit review process must focus on:
  1. **Structural Analysis (Building Load Capacity)**
  2. **Life Safety Plan**
  3. **Alterations to Post-FIRM buildings that may render a previously code compliant building non-compliant with regard to flood regulations.**

Permitting requirements: Structural Analysis (Building Load Capacity)

- The building must **withstand all flood loads imposed on the structure, including hydrostatic and hydrodynamic forces** during the design storm.
- Other flood loads include **wave, debris, flow velocity, scour and erosion, duration and rate of rise.**
- If the forces exceed the building's strength, it could **fail or collapse**.
- A **Florida-licensed design professional** must conduct this analysis.
- A **permit will NOT be issued** without a satisfactory report proving structural integrity that the building can withstand the loads

Permitting requirements: Life Safety Plan

- The Life Safety plan for the building once the panels are deployed must be provided
- The Florida Building Code (FBC) requires compliance with emergency opening sizes, distances between exits, and other safety standards.
- This plan must be reviewed and approved by the Building and Fire Departments before a permit is issued.
- An alteration to a building, even temporary in nature, cannot make the building less safe.
- The required level of egress must be maintained.

Initial Flood Insurance Rate Maps identified 7-2-1971 for City of Naples

BUILDING DESIGNATION	COMPLIANT MITIGATION MEASURE		
	Dry Floodproof Commercial Areas of Mixed-Use Buildings	**Dry Floodproof Residential Areas of Buildings**	**Dry Floodproof Below Grade Parking Areas**
New Construction/SI/SD	✓		Only Mixed-use Buildings
Legal Non-Conforming Construction (Not SI/SD)	✓	Possible[1]	Only Mixed-use Buildings
Existing Construction (Not SI/SD)	✓	✓	✓

[1] Allowable if it is above the required elevation at time of construction (i.e., BFE or locally adopted elevation that exceeds the BFE)

Flood Mitigation Equipment Approvals

- ANSI/FM 2510 American Standard for flood mitigation equipment
  - General and performance testing for:
    - Opening barriers
    - Perimeter barriers
    - Valves
    - Sealing devices
    - Pumps

Flood Mitigation Equipment Approvals

- General testing

- Hydrostatic test strength; tensile strength; compression set test; Extreme temperature when storing; aging test; salt spray test; impact and tear resistance, Component Durabiltiy – cycling test; and many others
- System leakage test – 0.08 gallons per hour per linear foot (length of seal plus 2x water depth)
  - 30’ (2-12’ lanai sliders plus front and side doors) +8 (4’ water depth) = 36.48 gallons in 12 hours from panels alone
  - Does not account for any other leaks through cracks, around pipes, etc

Flood Mitigation Equipment Approvals

- Performance testing
  - Deployment
  - Hydrostatic load – 1’ to max height, 22 hours
  - Wave induced load – 80% of height of panel
    - low waves - 2-3” - 1 hour (min)-7 hours (max)
    - Medium waves - 6-8” – 10 min (3 times)
    - High waves – 10-12” – 10 min
  - Over topping
  - Debris impact tests – 66.7% of height
    - 12” log, 610lb, at 7’/sec
    - 17” log, 790lb, at 7’/sec
  - Current tests

Advantages of Dry Floodproofing

- Can be used to protect against frequent flooding
- Where applicable, helps protect enclosed areas below BFE
- May allow for building utility systems to remain below BFE

Disadvantages of Dry Floodproofing

- Not applicable to flash floods or any flooding situation with limited or no warning
- Limited applicability based on a building structural system and walls capable of withstanding flood protection level
- Overlooking an entry point can negate an entire system
- Incomplete measures, poor installation, or poor maintenance can result in total system failure or significant seepage
- Potential failure of walls or floor slabs due to flood loads
- Standby power systems needed for sump pumps
- Can’t be tested before a flood occurs
- Complex and difficult to achieve success

Risks

1. Building floods
2. Building floods and a portion or whole building collapses
3. People become trapped in the building and cannot escape quickly at a time of panic or emergency
4. Fire rescue delayed entry in fire/ emergency resulting in loss of life and/or property
5. If installed in violation of codes, word spreads rapidly around state “the City of Naples allows this.”
6. Failure to enforce codes properly can result in higher premiums or loss of policy

Benefits

- Might stop flooding from a minor storm event, but not the 100-year, 1% flood.

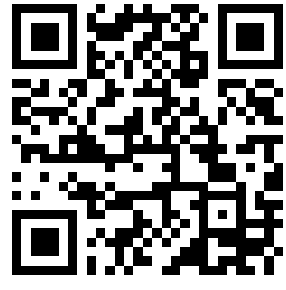
The City's Role

- **633.208 Minimum firesafety standards.**—(1) The Florida Fire Prevention Code adopted by the State Fire Marshal, which shall operate in conjunction with the Florida Building Code, shall be deemed adopted by each municipality, county, and special district with firesafety responsibilities. The minimum firesafety codes do not apply to buildings and structures subject to the uniform firesafety standards under s. 633.206 and buildings and structures subject to the minimum firesafety standards adopted pursuant to s. 394.879.

- **468.601 Purpose.**—The Legislature finds that, where building code administration and inspection personnel fail to adequately, competently, and professionally administer state or local building codes, physical and economic injury to the citizens of the state may result and, therefore, deems it necessary in the interest of public health and safety to regulate the practice of building code administration and inspection in this state.

The City's Role

- **553.72 Intent.**—(1) The purpose and intent of this act is to provide a mechanism for the uniform adoption, updating, amendment, interpretation, and enforcement of a single, unified state building code, to be called the Florida Building Code, which consists of a single set of documents that apply to the design, construction, erection, alteration, modification, repair, or demolition of public or private buildings, structures, or facilities in this state and to the enforcement of such requirements and which will allow effective and reasonable protection for public safety, health, and general welfare for all the people of Florida at the most reasonable cost to the consumer. The Florida Building Code shall be organized to provide consistency and simplicity of use. The Florida Building Code shall be applied, administered, and enforced uniformly and consistently from jurisdiction to jurisdiction. The Florida Building Code shall provide for flexibility to be exercised in a manner that meets minimum requirements, is affordable, does not inhibit competition, and promotes innovation and new technology. The Florida Building Code shall establish minimum standards primarily for public health and lifesafety, and secondarily for protection of property as appropriate.



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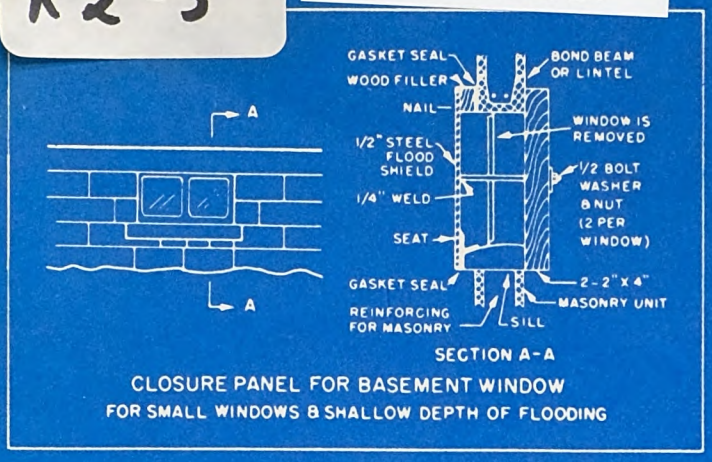
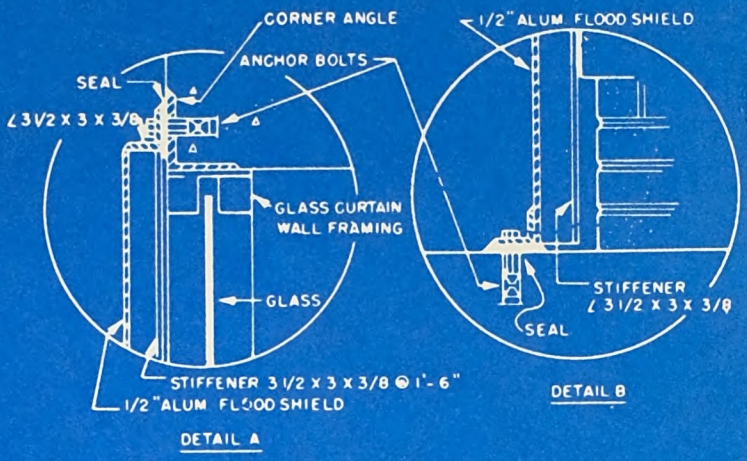
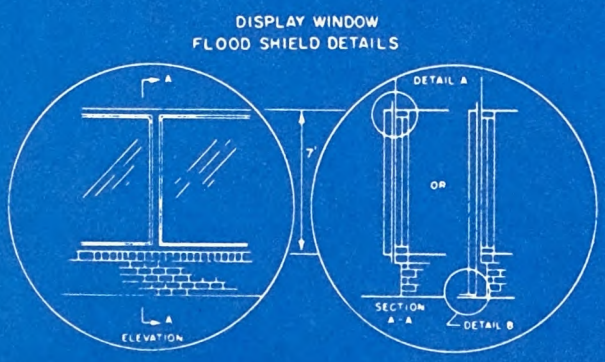
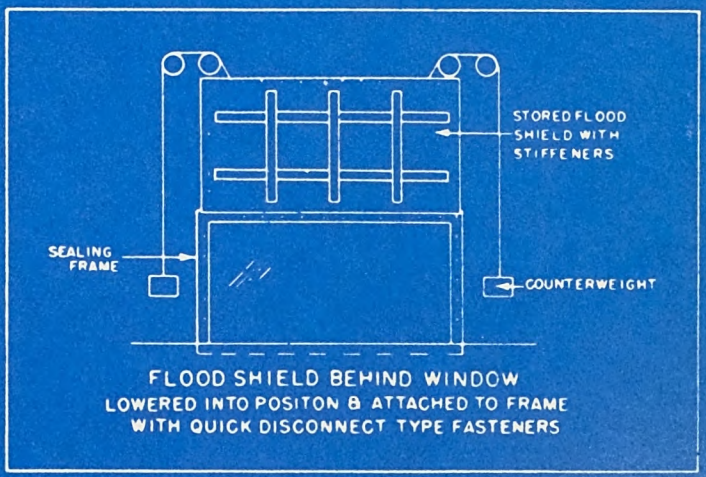




FLOOD-PROOFING REGULATIONS





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PREFACE

Existing building codes and regulations do not provide the special flood-proofing requirements and minimum standards of design and construction that should be met for buildings and structures susceptible to flood damages. A need for such standards has long been recognized at all levels of government and in the private sector. However, little, if any, work has been done to develop or assemble information on flood-proofing into a workable set of standards that could have national application. Under its Flood Plain Management Services Program, the Corps of Engineers, has therefore taken the first step towards meeting this need by developing minimum standards of design and construction for flood-proofing of buildings and structures.

This publication specifies the flood-proofing measures and techniques that should be followed to regulate private and public building construction in riverine flood hazard areas. It contains implications for changes in existing building and housing codes and provides for a diversity of flood-proofing methods and techniques. Chapters 2 through 13 have been prepared in a form that could be used to supplement existing building codes and regulations. If, on the other hand, a separate "flood-proofing code" for direct adoption by States and local governments is desired, the flood-proofing information contained herein is also sufficient for that purpose.

The Corps of Engineers is distributing this publication as a means of at least partly filling the present gap in building codes and regulations. Our purpose here is to develop a set of minimum flood-proofing building standards that will be workable, concise, understandable, and reasonable for national application. We also intend that the regulations herein be sufficiently flexible to benefit from expert criticism, further research, and the experience of implementation. Together with other flood plain management tools, use of these ideas will assist in reducing the threat to life, health, and property of users of flood hazard areas and help to achieve optimal flood plain use.

We have taken the first step, however, the initiative for adoption and implementation of these standards must come from State and local interests.

J. W. MORRIS
Major General, USA
Director of Civil Works

This publication was drafted for the Office, Chief of Engineers (OCE) by the U.S. Army Engineer District, Pittsburgh, Pa.

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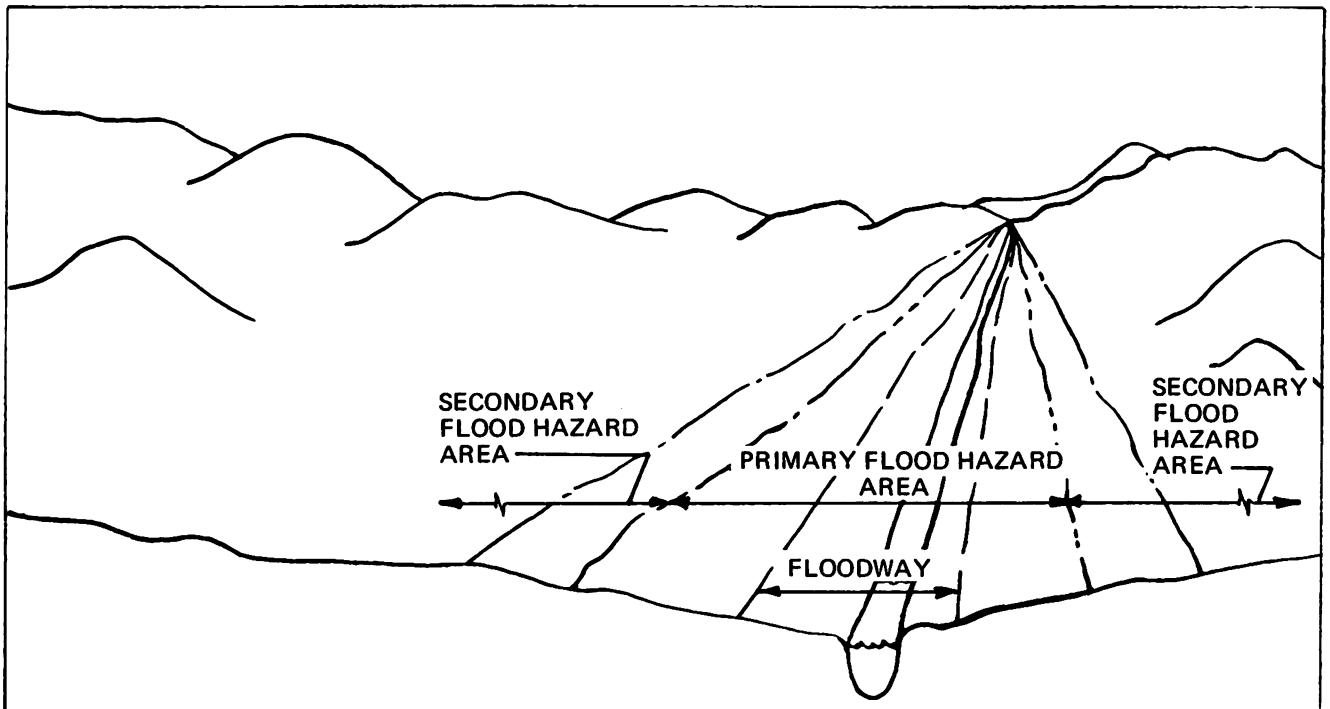

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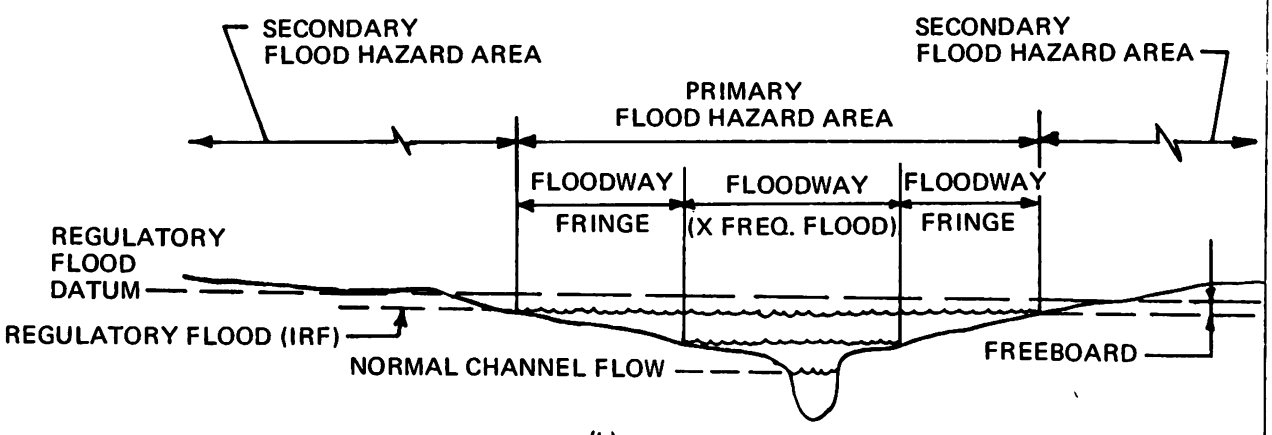

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Figure i

FLOOD HAZARD AREAS AND REGULATORY FLOOD DATUM

CHAPTER 1

INTRODUCTION

SECTION 100.0 FLOOD-PROOFING AND BUILDING CODES

Sec. 100.1 GENERAL: Many thousands of structures and potential building sites are located in the flood plains of our Nation and are susceptible to flooding. Flood control projects have partially protected some of these structures and building sites through reduction of the flood threat. However, the residual threat to partially protected sites and the total threat to unprotected sites remain as major problems. Evidence of this is given every year by the millions of words and hundreds of headlines that dramatically describe floods and their resulting damage and loss of life. When floods strike developed areas, whole cities may be disrupted and their productive capacities impaired. Strategic transportation lines are cut. Public service facilities are sapped, homes and crops are destroyed, and soils are eroded. Yet, in spite of this, flood vulnerable lands are the setting for continued urban growth in the United States.

Studies of flood plain use show that some encroachment is undertaken in ignorance of the hazard, that some occurs in anticipation of increased Federal protection, and that some takes place because by shifting the cost of the hazard to society it becomes profitable for private owners to do so. Even if full information on the flood hazard were available to all owners or users of flood plain property, there would still be conscious decisions for some reason or another to build in areas that are subject to flooding. In order to escape this dismal cycle of losses, partial protection, further induced development, and more unnecessary losses, old attitudes must be transformed into positive actions.

Primary among these actions is the revision of development policies and the enaction of a regulatory program to encourage and/or restrict the direction of growth or change necessary to achieve flood plain management objectives. Information programs are essential to this revision. They foster the development of more appropriate policies and involve the gathering and dissemination of data on past floods, on estimates of future floods, and information on alternate ways of dealing with flood losses in areas where intensive development has taken place or is anticipated. The latter has led to an expanded approach to flood damage reduction and prevention, recognizing the need to control or regulate the use of lands adjacent to watercourses and the need to provide guidance in the design of flood plain structures through the planned management and development of the flood hazard areas.

Regulation of the use of flood plain lands is a responsibility of State and local governments and can be accomplished by a variety of means, such as establishment of designated floodways and encroachment lines, zoning ordinances, subdivision regulations, and building codes. These land use controls, most often known as "Flood Plain Regulations", do not attempt to reduce or eliminate flooding but instead are intended to guide and regulate flood plain development to lessen the adverse affects of floods. Flood plain regulations are now being adopted by communities and used as the legal tools to control the extent and type of development permitted on flood plains.

Flood proofing standards applied through building codes and regulations to flood plain structures can permit economic development in the lower risk areas by holding flood damages and other adverse affects within acceptable limits. Flood-proofing requires adjustments both to structures and to building contents and involves keeping water out as well as reducing the effects of water entry. Such adjustments can be applied by the individual or as part of collective action either when buildings are under construction or during remodeling or expansion of existing structures. They may be permanent or temporary.

Flood proofing, like other methods of adjusting to floods has its limitations, however. For example, in addition to reducing loss potentials, a main purpose of flood proofing habitable structures is to provide for early return to normalcy after floods have receded rather than for continuity of occupance. Through a false sense of security,

occupants may choose to remain during a flood and risk being stranded or losing their lives. Only very substantial and self-contained structures should be occupied during a flood. Also, unless correctly used, flood proofing can tend to increase uneconomical use of flood plains. Applied to structurally unsound buildings it (e.g., with closures and seals) can result in more damage than would occur without flood proofing. Generally it is applied to individual structures, so unless flood proofing is also applied to means of access, it is only partially effective in an area context. Accordingly, access ways should be passable at least in floods up to the magnitude used in setting flood proofing elevations.

Building codes and regulations presently in use throughout the nation, whether prepared by nationally recognized groups or by State and local governments, are directed primarily to the fire hazard. They do not contain special requirements, limitations, or design and construction restrictions for facilities located in flood hazard areas and susceptible to flood damage. This omission has been verified by a careful review of several national buildings codes, state and city building codes, and publications directed to flood-proofing; by numerous discussions with designers, planners, and construction contractors, and, through study of existing conditions and general building practices in known flood hazard areas. It has also brought to light the scarcity of information on flood-proofing standards. Designers of flood plain structures have either ignored the flood hazard altogether or attempted to use a "common sense" approach. The latter has, in many cases, resulted in designs that have neither prevented nor even reduced flood damages.

The lack of detailed flood hazard information and general misconceptions of the flood hazard problem have been recognized at all levels of government. Positive action at the Federal level to correct these deficiencies was initiated in 1960 and reinforced at the Presidential level in August, 1966 by issuance of Executive Order 11296. With growing impetus, detailed flood hazard information is being furnished to State and local governments to aid them in flood plain planning and development programs. Study is now being directed to the subject of flood plain regulations, but the building code implications of flood-proofing, which also warrant consideration as a means of flood damage reduction or prevention, have not been accorded similar treatment. Consequently, the Corps of Engineers has undertaken the preparation of these regulations to provide the minimum design and construction standards that would, if properly utilized, assist in safeguarding users and property in flood hazard areas.

These recommended regulations are intended for direct use or for incorporation into existing building codes which properly enforced should effectively reduce flood damages to buildings and structures located in the flood plain. Compliance should be a mandatory requirement for approval of plans or issuance of permits for construction of all new buildings and structures, and for existing buildings that will be subjected to major alterations, additions, or reconstruction in the defined flood hazard areas.

These recommended regulations neither contain nor are referenced to other regulations pertinent to flood plain management that may be provided by separate statute or involve political decisions relative to land use, zoning, subdivision regulations, occupancy restrictions, creation of flood zones, flood warning, or floodway encroachment. The intent here is to establish the special design and construction provisions that should be required for buildings, structures, and support facilities that are or may be subjected to flooding, relying upon zoning regulations to establish the areas of application. Other aspects of flood plain regulations, such as Flood Plain Zoning and Subdivision Regulations, are treated in "Regulation of Flood Hazard Areas to Reduce Flood Losses", Water Resources Council, 1971-1972, Washington, D.C.

This publication deals with the treatment of hydrostatic and hydrodynamic forces and waterproofing associated with riverine flooding only. To the extent that coastline structures are subject to these semi-static conditions, these provisions will be applicable to coastal or tidal flooding situations; however, no consideration is given to the special problems of wave impact, corrosion and erosion associated with coastal flooding. Similarly the problems of impact from floating debris and velocity introduce dynamic considerations which are not treated in detail and mud slide and high density fluid problems that are prevalent in West Coast communities are omitted entirely.

The design and construction criteria contained herein for riverine flooding conditions should be of substantial benefit to many communities. Future development of more comprehensive coverage including the treatment of special dynamic problems should be implemented where warranted by others more directly involved with the particular flood damage situations.

CHAPTER 2

ADMINISTRATION

SECTION 200.0 PURPOSE

Sec. 200.1 APPLICATION: The provisions contained herein shall constitute the minimum building standards and requirements that are applicable to safeguard life or limb, health, property, and public welfare by regulating and controlling design, construction, and quality of materials of all buildings and structures which are or will be located in all lands shown within the Flood Hazard Area(s) indicated on the Official Flood Plain Zoning Map. Hereinafter these provisions will be referred to as the "Flood-Proofing Regulations" part of "The Building Code," or in short as "these Regulations."

Sec. 200.2 OFFICIAL FLOOD PLAIN ZONING MAP: The Official Flood Plain Zoning Map showing the extent and boundaries of the Primary and Secondary Flood Hazard Areas is hereby declared and established as a part of these Regulations.

Sec. 200.3 REGULATORY FLOOD DATUM: For the purpose of these Regulations, the Regulatory Flood Datum, or as hereinafter referred to as the "RFD", is hereby declared and established for use as the reference datum for determining the elevation above mean sea level to which flood-proofing protection shall be provided.

SECTION 201.0 SCOPE

Sec. 201.1 APPLICATION: These Regulations shall apply to the construction, alteration, and repair of any building or parts of a building or structure in the Flood Hazard Area(s) of the _____.
City, Town, Village, etc.
Additions, alterations, repairs, and changes of use or occupancy shall comply with all provisions for new buildings and structures as otherwise required in "The Building Code," except as specifically provided in these Regulations.

Sec. 201.2 NONCONFORMING USE: A structure or the use of a structure or premises which was lawful before the passage or amendment of the ordinance but which is not in conformity with the provisions of these Regulations may be continued subject to the following conditions:

(1) No such use shall be expanded, changed, enlarged or altered in a way which increases its nonconformity.

(2) No structural alteration, addition, or repair to any conforming structure over the life of the structure shall exceed _____per cent of its value at the time of its becoming a nonconforming use, unless the structure is permanently changed to a conforming use.

(3) If such use is discontinued for_____consecutive months, any future use of the building premises shall conform to these Regulations. The assessor shall notify the zoning administrator in writing of instances of nonconforming uses which have been discontinued for a period of _____months.

(4) If any nonconforming use or structure is destroyed by any means, including floods, to an extent of _____per cent or more of its_____value it shall not be reconstructed except in conformance with the provisions of these Regulations; provided, the Board of Adjustment may permit reconstruction if the use or structure is located outside the floodway and is adequately and safely flood-proofed, elevated, or otherwise protected in conformance with these Regulations.

(5) Uses or adjuncts thereof which are or become nuisances shall not be entitled to continue as nonconforming uses.

(6) Except as provided in "The Building Code," any use which has been permitted as a special exception shall not be deemed a nonconforming use but shall be considered a conforming use.

(7) Any alteration, addition, or repair to any nonconforming structure which would result in substantially increasing its flood damage or flood hazard potential shall be protected as required by these Regulations.

(8) The Building Official shall maintain a list of nonconforming uses including the date of becoming nonconforming, assessed value at the time of its becoming a nonconforming use, and the nature and extend of nonconformity. This list shall be brought up-to-date annually.

(9) The Building Official shall prepare a list of those nonconforming uses which have been flood-proofed or otherwise protected in conformance with these Regulations. He shall present such list to the Board of Adjustment which may issue a certificate to the owner stating that such uses, as a result of these corrective measures, are in conformance with these Regulations.

SECTION 202.0 ALTERNATE MATERIALS AND METHODS OF CONSTRUCTION

Sec. 202.1 APPLICATION: These Regulations are not intended to prevent the use of any materials or methods of construction not specifically prescribed herein or by "The Building Code"; provided, any such alternate has been approved and its use authorized by the Building Official prior to its incorporation or use in the construction.

Sec. 202.2 APPROVAL: The Building Official may approve any such alternate provided he finds the proposed design is satisfactory and complies with the provisions of "The Building Code" and that the material, method, or work offered is, for the purpose intended, at least equivalent of that prescribed in "The Building Code" in quality, strength, effectiveness, fire resistance, durability, and safety. The Building Official shall require that sufficient evidence or proof be submitted to substantiate any claim that may be made regarding its use. If, in the opinion of the Building Official, the evidence and/or proof is not sufficient to justify approval, the owner or his agent may refer the entire matter to the Board of Appeals.

SECTION 203.0 TESTS

Sec. 203.1 PROOF OF COMPLIANCE: Whenever there is insufficient evidence or proof of compliance with the provisions of these Regulations, or evidence that any material or any construction does not conform to the requirements of these Regulations, or in order to substantiate claims for alternate materials or methods of construction, the Building Official may require tests or test reports as proof of compliance. Tests, if required, are to be made at the expense of the owner or his agent, by an approved testing laboratory or other approved agency, and in accordance with approved rules or accepted standards as prescribed in "The Building Code".

Sec. 203.2 ABSENCE OF APPROVED RULES: In the absence of approved rules or other accepted standards, the Building Official shall determine the test procedure or, at his election, shall accept duly authenticated reports from recognized testing authorities or agencies in respect to the quality and manner of use of new materials.

Sec. 203.3 RECORDS: Copies of such tests reports, certifications, or the results of such tests shall be kept on file in the office of the Building Official for a period of not less than _____years after the approval and acceptance of the completed structure for beneficial occupancy.

SECTION 204.0 ORGANIZATION AND ENFORCEMENT

Sec. 204.1 RULES AND REGULATIONS: The Building Official is hereby authorized and directed to enforce the provisions of these Regulations as part of "The Building Code". For such purpose he shall have the powers of a police officer.

Sec. 204.2 DEPUTIES: The Building Official may appoint such number of officers, inspectors, and assistants as required. He may deputize such employees as needed to perform the functions of the Building Department.

Sec. 204.3 OFFICIAL RECORDS: The Building Official shall establish and maintain an official record of all business and activities of the department relating to these Regulations, and all such records shall be open to public inspection. He shall keep a permanent, accurate account of all fees and other monies collected and received under these Regulations. The Building Official shall, at least once a year, submit a report to the proper city official covering the work of the Department during the preceding period. Said report shall include detailed information regarding the administration and enforcement of these Regulations.

Sec. 204.4 RIGHT OF ENTRY: Whenever it may be necessary to make an inspection to enforce the provisions of these Regulations, the Building Official or his authorized representative may enter such building or premises at all reasonable times to inspect all parts that are or may be subject to flooding or where the potential for flood damage exists.

Sec. 204.5 STOP WORK ORDER: Whenever any building work is found to be done contrary to these Regulations, the Building Official shall order the work stopped by notice in writing to the person doing the work.

Sec. 204.6 BOARD OF APPEALS: In order to determine the suitability of alternate materials and methods of construction and to provide reasonable interpretations of the provisions herein, there shall be and is hereby created a Board of Appeals of _____ members. Each member of the Board shall be a licensed professional architect or engineer, or a builder or superintendent of building construction, with at least ten years experience, for five years of which he shall have been in responsible charge of work. At no time shall there be more than two members from the same profession. At least one of the members shall be a licensed structural or civil engineer with architectural engineering experience. The Board shall adopt reasonable rules for its investigations and shall render written decisions to the Building Official.

Sec 204.7 VALIDITY: It shall be unlawful for any person, firm or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert, or demolish, any building or structure in the Flood Hazard Area(s), or cause the same to be done, contrary to or in violation of any of the provisions of these Regulations and/or "The Building Code."

Sec. 204.8 VIOLATIONS AND PENALTIES: Any person, firm, or corporation violating any of these provisions shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine or by inprisonment as provided in the laws of the municipality for such misdemeanor, or as specified in "The Building Code."

SECTION 205.0 PERMITS

Sec. 205.1 STATEMENT OF INTENTION TO IMPROVE: The Owner or any registered architect or licensed professional engineer authorized to represent the Owner shall, before preparing final plans for any improvement in the Primary Flood Hazard Area(s), file with the Building Official a Statement of Intention to Improve, including a brief description of the type of improvement being considered and giving its precise location, on a form provided by

the Building Official. The Building Official shall note on two copies the elevation of the RFD at the location of the proposed improvement. One copy of the Statement of Intention to Improve shall be retained by the Building Official until a permit for improvement on the site is approved or one year has elapsed; a second copy shall be returned to the Owner for his use in final siting and design of his improvement. Assignments of the RFD elevations at all locations shall be made from profiles and/or cross sections provided by the *(Army Corps of Engineers, SCS, USGS)*. This information shall be open to public examination at all reasonable times.

Sec. 205.2 PERMITS REQUIRED: No person, firm, or corporation shall erect, construct, enlarge, alter, repair, move, remove, convert, or demolish any building or structure or any part thereof, or make any other improvement within the Primary Flood Hazard Area(s), or cause same to be done, without first obtaining a separate building flood proofing permit for any such improvement from the Building Official. Ordinary minor repairs may be made with the approval of the Building Official without a permit, provided that such repairs shall not violate any provision of these Regulations or of "The Building Code."

Sec. 205.3 APPLICATIONS: To obtain a permit, the applicant shall first file an application therefore which shall consist of:

(1) A description of the work to be covered by the permit including a list of all spaces affected by these Regulations giving flood-proofing class, elevation of RFD, floor elevation(s), proposed uses and contents, and references to drawings and specifications which explain the flood-proofing measures that apply to each space. The description shall include an estimate of the total value of the improvement. This description shall be made on a form provided by the Building Official (Fig. 1).

(2) _____ sets of complete plans and specifications, in addition to plans and specifications required by "The Building Code", except that plans and specifications for any and all proposed improvements in the Primary Flood Hazard Area(s) shall be prepared by an engineer or architect licensed by the State to practice as such. All drawings and specifications shall bear the name of the author thereof in his true name, followed by such title as he may be lawfully authorized to use. All plans and sections shall be noted with the proposed flood-proofing class of each space below the RFD including detail drawings of walls and wall openings.

(3) _____ copies of the Owner's Contingency Plan, which shall describe in detail all procedures for temporary placement and removal or contingent protection proposed for items in spaces affected by these Regulations including:

(a) Plans and schedules for items to be removed and locations of places above the RFD to which they will be removed if these contents violate restrictions associated with the flood-proofing class of the space in which they are placed temporarily, including specific organizational responsibilities for accomplishing this removal.

(b) Procedures, materials and equipment for protecting items required to have protection by their flood-proofing class but for which this protection is proposed to be provided contingently, including specific organizational responsibilities for accomplishing this protection.

Waivers of restrictions implicity requested by submission of the Owner's Contingency Plan may be granted by the Building Official as provided by 1101.2.

(4) Any other information as reasonably may be required by the Building Official, including computations, stress diagrams, and other data sufficient to show the correctness of the plans.

Sec. 205.4 ACTION ON PERMIT APPLICATION: The complete application filed by an applicant for a flood proofing permit, including all of the above listed items, shall be checked by the Building Official. Such plans may be

Supplementary Application

BUILDING OR STRUCTURE IN FLOOD HAZARD AREA
(To Accompany Application for Building Permit)

City or Town_____ County_____
Location_____
Intended Use_____ Value Of Improvement $ _____
Type of Construction_____ No. of Stories_____
Owner_____ Address_____
Exist.Ground Elev._____MSL; Fin.Ground Elev._____MSL; Reg.Flood Datum Elev.at Site_____MSL; RFD Velocity_____Ft/Sec
_____Floor Elev._____MSL: Proposed Use_____; _____Floor Elev._____MSL: Proposed Use_____
_____Floor Elev._____MSL: Proposed Use_____; _____Floor Elev._____MSL; Proposed Use_____

Maximum Loading on Walls:
Non Flood Load_____PSF
Hydrostatic Load_____PSF
Hydrodynamic Load_____PSF
Impact Load_____PSF
Total Flood Load_____PSF

Hydrostatic (Uplift) Pressure on Floor Slabs(Maximum)____PSF
Foundation Type(s)_____
Lowest Footer Elev. (Bottom)_____MSL
Sewage Disposal:___Septic Tank,___Pub.Syst.,___Other(Explain)
Potable Water:___Individual Well,___Pub.Syst.,___Other(Explain)

Exterior Wall Construction Type(s):
Above_____Floor_____
Above_____Floor_____
Above_____Floor_____
Above_____Floor_____

Floor Construction Type(s):
_____Floor_____
_____Floor_____
_____Floor_____
_____Floor_____

Types of Waterproofing_____
Type(s) of Joints: Walls_____Floors_____; Waterstops/Seals(Types): Walls_____Floor_____
Sump Location_____ Sump Type _____
All Tanks and/or Bouyant Equipment Are_____Are Not_____Anchored To Prevent Flotation
Alternate Power Source Is_____Is Not_____Provided For Emergency Operation Of Sump Pump
Sanitary, Drainage & Water Supply Facilities Are_____Are Not_____Protected From Contamination & Back Flow by Flood Water
Retaining Wall(s) Are_____Are Not_____Used To Protect Building/Structure
Intentional Flooding Is_____ Is Not _____Planned For This Building/Structure
Temporary And/Or Emergency Flood Proofing Is_____Is Not_____Planned For This Building/Structure
Building Structure Is_____Is Not_____Protected Against Erosion By Flood Flows
Site Is_____Is Not_____Protected Against Erosion By Flood Flows
Classification Of Building/Structure: FP_____, Primary _____ Secondary _____ Flood Hazard Area.

SPACES: List below all spaces of the building or structure below the Regulatory Flood Datum including their name, room number, and proposed flood-proofing classification (i.e. W1, W2 etc.). List all contents of each space (see Chapter 10 of the Flood-Proofing Regulations). Mark all items which are to be either protected contingently or removed to safe refuge upon receipt of a flood warning with an asterisk (*); all such items must be mentioned in the Owner's Contingency Plan. Attach additional sheets if necessary.

The applicant hereby certifies that the above information is correct and that the plans submitted herewith conform to those submitted for occupancy permit application. The applicant agrees to comply with the provisions of the Zoning Ordinance, the Building Code and all other laws and ordinances affecting the construction and occupancy of this proposed building.

Signature Of Architect/Engineer_____ Address_____

The undersigned will supervise the construction of the work above.

Signature_____

SEAL

Title_____

Date_____

Address_____

(Signature)_____

Clerk_____

APPROVED FOR COMPLIANCE WITH BUILDING CODE

Date_____

Figure 1

reviewed by other Departments of the _____ (City) to check compliance with the laws and ordinances under their jurisdiction. The Building Official shall determine that the RFD elevation noted in the application is correct is accordance with the Statement of Intention to Improve and that all requirements for the flood-proofing classes selected by the Owner are met. If the Building Official determines that for any space affected by these Regulations, any requirement for the particular flood-proofing class, or any other requirement of these Regulations has not been met, he shall so indicate on the drawings and a permit shall not be granted. If the Building Official is satisfied that the work described in all parts of the application conform to the requirements of these Regulations and "The Building Code" and other pertinent laws and ordinances, and that the fees specified in "The Building Code" have been paid, he shall issue a permit therefore to the applicant. When the Building Official issues the permit, he shall endorse in writing or stamp on _____ sets of written descriptions, plans and specifications, and the Owner's Contingency Plan "APPROVED" _____ (Name and Date) . _____ sets of the complete application as approved shall be retained by the Building Official for a period of not less than two years after the approval or issuance of a certificate of occupancy for the completed improvement. _____ sets of the complete application as approved shall be returned to the applicant, of which one set shall be kept at the building site and available for review by the Building Official at all reasonable times.

Sec. 205.5 ISSUANCE OF PERMIT: The Building Official shall not issue a permit for the partial execution of any improvement until the complete application for the entire improvement has been submitted and approved. The issuance or granting of a permit or approval of an application shall not be construed to be a permit for, or approval of, any violation of these Regulations or of "The Building Code." The issuance of a permit based upon an approved application shall not prevent the Building Official from thereafter requiring correction in such application or any part thereof or from preventing work related to the execution of any improvement from being carried on thereunder when in violation of these Regulations, "The Building Code" or of any other ordinance of the _____ (City) .

Sec. 205.6 EXPIRATION: Every permit issued by the Building Official shall expire by limitation and shall become null and void if the work authorized by such permit is not commenced within 60 days after issuance date of such permit, or if the work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 120 days. Before such work is re-commenced a new permit shall first be obtained, and the fee therefore shall be one-half the amount required for the original permit for such work; and provided, further, that such suspension or abandonment has not exceeded one year, after which, a new application for permit must be submitted and the permit fee shall be based on the total value of all construction work for which the permit is issued.

Sec. 205.7 REVOCATION OF PERMIT: The Building Official may revoke a permit or approval issued under these Regulations in case of any false statement or misrepresentation of fact in the application or on the plans, whenever the permit is issued in error, or whenever the permit is issued in violation of any ordinance or regulation, "The Building Code," or these Regulations.

Sec. 205.8 PERMIT FEES: Building permit fees shall be paid to the Building Official as required and set forth in "The Building Code," and in accordance with the determination of value or valuation under any provision of these Regulations that shall be made by the Building Official.

Sec. 205.9 POSTING OF PERMIT: The building permit shall be posted at the site of operations in a conspicuous place open to public inspection during the entire time of prosecution of the work and until completion of the same.

SECTION 206.0 INSPECTIONS

Sec. 206.1 INSPECTIONS REQUIRED: All construction or work for which a permit is required shall be subject to inspection by the Building Official.

Sec. 206.2 PERIODIC INSPECTIONS: Buildings or structures and parts thereof that contain or utilize contingent or emergency (temporary) type flood-proofing elements or devices shall be subject to inspection by the Building Official at intervals of three (3) years or less. The Owner or his agency shall be notified at least 10 days in advance of inspection date and shall be present at the inspection. He shall be responsible for demonstrating the availability, installation, and proper functioning, anchorage and support of all closure assemblies and other contingent or emergency (temporary) flood-proofing items. All necessary correction of deficiencies shall be performed within 90 calendar days of the inspection date and at the Owner's expense. Failure to perform the required remedial work within the prescribed time shall be a violation of these Regulations and the applicable part(s) of "The Building Code."

SECTION 207.0 CERTIFICATE OF USE AND OCCUPANCY

Sec. 207.1 NEW BUILDINGS AND STRUCTURES: No building or structure hereafter constructed in the Flood Hazard Area(s), or any portion thereof, shall be used or occupied until the Building Official shall have issued a certificate of use and occupancy.

Sec. 207.2 BUILDINGS OR STRUCTURES HEREAFTER ALTERED: No building or structure in the Flood Hazard Area(s) hereafter enlarged, extended or altered, or any portion thereof, shall be used or occupied; and no change in use or occupancy shall be made, until the Building Official shall have issued the certificate of use and occupancy, except that; the Building Official may permit lawful use or occupancy to continue upon the submission of evidence that the flood hazard or flood vulnerability of any occupied portions of the structure and its contents will not be increased during the execution of the improvements.

Sec. 207.3 EXISTING BUILDINGS AND STRUCTURES: The Building Official shall issue a certificate of use and occupancy for an existing building or structure located in the Flood Hazard Area(s) upon receipt of a written request from the Owner, provided:

(1) There are no violations of law or orders of the Building Official pending.

(2) It is established after inspection and investigation that the alleged use or occupancy of the building or structure has heretofore existed.

(3) There is a positive showing that the continued use or occupancy of a lawfully existing building or structure in the Flood Hazard Areas(s), and without requiring alterations, rehabilitation or reconstruction, does not endanger public safety and welfare.

The Building Official shall refuse to issue a certificate of use or occupancy for any existing building or structure in the Flood Hazard Area(s) whenever it is found that the building or structure, or any portion thereof or appurtenant thereto, is in an unsafe condition and/or would be potentially unsafe when subjected to floods up to the RFD. He shall, in writing, so notify the Owner, lessee, tenant, occupant and/or agent thereof describing said condition and ordering the abatement thereof within a reasonable length of time. Failure to comply with the order of the Building Official shall be a violation of these Regulations and the applicable part (s) of "The Building Code."

Sec. 207.4 **CONTENTS OF CERTIFICATE:** When a building or structure is entitled thereto, the Building Official shall issue a certificate of use and occupancy that shall certify compliance with the provisions of these Regulations and "The Building Code." Issuance of a certificate does not assign liability to the community.

SECTION 208.0 PUBLIC NOTICE OF FLOOD HAZARD

Sec. 208.1 **PROCEDURE:** On or about the anniversary date of the flood of record, the Building Official shall alert the public of the existing flood hazard of the _____. He shall publish or cause to be published
(City)
a public notice which shall indicate the elevation of the flood of record together with depths and approximate area(s) of inundation (if known). Said public notice will also contain similar information about the RFD that is established for purposes of these Regulations.

Sec. 208.2 **OTHER INFORMATION:** The public notice shall emphasize the necessity for maintenance and repair of all contigent flood-proofing measures and the probability of occurrence of a flood that would reach elevations higher than the RFD. It shall advise owners and/or occupants to operate all mechanically and manually operated closure assemblies for doors, windows and utilities openings, emergency electrical generating units, sump pumps etc. and, to check the availability and condition of all temporary closure panels, gaskets and anchorage devices, etc. All organizational, volunteer or assistance groups having responsibilities to act at times of flood emergencies shall be advised to review its state of readiness for effective mobilization and implementation of the flood emergency plan.

SECTION 209.0 PROVISION OF SAFE REFUGE

Sec. 209.1 **NEW BUILDING AND STRUCTURES:** Every building or structure hereafter erected, that is located in the Primary Flood Hazard Area(s) where the ground surface is _____ feet or more below the RFD, or where flood water velocities may exceed five (5) feet per second, shall be provided with an inclosed refuge space above the RFD of sufficient area to provide for the occupancy load with a minimum of 12 square feet per person. It shall be provided with one or more exits through the exterior walls above the RFD to an exterior platform and stairway not less than three (3) feet wide.

Sec. 209.2 **BUILDINGS OR STRUCTURES HEREAFTER ALTERED:** Existing buildings and structures in the Primary Flood Hazard Area(s) that are subject to flood conditions described in 209.1, and which are hereafter enlarged, extended or altered, or where change of use or occupancy shall be made, shall conform to all provisions for new buildings and structures required by 209.1.

Sec. 209.3 **USE OF SPACE BELOW THE REGULATORY FLOOD DATUM:** No flood level or portion of the building or structure that is below the RFD regardless of structure or space classification shall be used for human occupancy, or for storage of any property, materials, or equipment that might constitute a safety hazard when contacted by flood waters.

SECTION 210.0 CLASSIFICATION AND POSTING OF BUILDINGS AND STRUCTURES

Sec. 210.1 **GENERAL:** For administrative purposes of coordination of zoning regulations, inspection of structures, and conduct of emergency public safety operations, all buildings or structures in the Flood Hazard Area(s), whether existing or hereafter erected, shall be classified and posted in accordance with this Section. Classification of buildings and structures (FP1, FP2, etc.) is shown in Table 1 and is based upon the flood-proofing classifications of the constituent spaces (W1, W2, etc.) of the structure below the RFD (see Chapter 4) and the means by which these classifications are achieved. Posting would be accomplished by placards mounted on internal walls at building

entrances. For public safety operations, an identification symbol, eg. FP1, would be placed on the outside of the building above the RFD so as to be readily visible.

Table 1

CLASSIFICATION OF BUILDINGS AND STRUCTURES							
Building or Structure Class-ification	SPACE CLASSIFICATION						
	W1		W2		W3	W4	W5
	Completely Dry		Essentially Dry		Flooded with Potable Water	Flooded with Flood Water	Non-Flood-Proofed
	Without *HI	With *HI	Without *HI	With *HI			
FP1	X		X				
FP2	X	X	X	X			
FP3	X		X		X	X	
FP4	X	X	X	X	X	X	
FP5							X

*Human Intervention

SEC. 210.2 COMPLETELY FLOOD-PROOFED STRUCTURES (FP1, FP2):

Sec. 210.2.1 FP1—Any building or structure located in a Flood Hazard Area with no space below the RFD or in which all enclosed spaces below the RFD are classified W1 or W2 without employing any contingent closure, removal, protection, or other measure which requires human intervention for effectiveness in a flood event to obtain those classifications shall be known as a Completely Flood-Proofed Structure and classified FP1. It shall be posted by the Owner with a Type 1 placard, which shall be fastened securely to the structure in a readily visible place.

Sec. 210.2.2 FP2—Any Building or structure located in a Flood Hazard Area with any space below the RFD and in which all such spaces are classified W1 or W2, but for which at least one or more of the spaces employs any contingent closure, removal, protection, or other measure which requires human intervention for effectiveness in a flood event to obtain those classifications shall be classified FP2. It shall be posted by the Owner with a Type 2 placard, which shall be fastened securely to the structure in a readily visible place above the RFD.

SEC. 210.3 PARTIALLY FLOOD-PROOFED STRUCTURES (FP3, FP4):

Sec. 210.3.1 FP3—Any building or structure located in a Flood Hazard Area which contains a combination of spaces below the RFD that are classified W1 or W2 which is achieved without human intervention, and one or more spaces that will be flooded internally (W3 and/or W4), shall be known as a partially flood-proofed structure and be classified FP3. It shall be posted by the Owner with a Type 3 placard which shall be fastened securely to the structure in a readily visible place above the RFD.

Sec. 210.3.2 FP4—Any building or structure located in the Flood Hazard Area which contains a combination of spaces below the RFD that are classified W1 or W2 which is achieved with human intervention, and/or one or more spaces that will be flooded internally (W3 and/or W4), shall be classified FP4. It shall be posted by the Owner with a Type 4 placard which shall be fastened securely to the structure in a readily visible place above the RFD.

Sec. 210.4 NON-FLOOD-PROOFED STRUCTURES (FP5): Any existing building or structure located in a Flood Hazard Area which contains one or more spaces below the RFD that are not flood-proofed (W5) shall be known as a Non-Flood-Proofed Structure and classified FP5. It shall be posted by the Owner with a Type 5 placard which shall be securely fastened to the structure in a readily visible place.

Sec. 210.5 SAFE REFUGE AREAS: Buildings or structures located in the Primary Flood Hazard Area that are provided with area(s) of safe refuge shall have said area(s) posted by the Owner with a Type 6 placard, which shall be securely fastened to the structure in a readily visible place.

Sec. 210.6 PLACARDS: All placards shall be furnished by the Building Official and installed by the owner and shall be replaced immediately if removed, or defaced.

Sec. 210.7 PLACARD TYPES: Placards shall be white rigid plastic or other non-water susceptible material,_____ inches long and _____ inches wide, and shall have printed thereon in black letters the information shown in Figure 2.

Sec. 210.8 VIOLATIONS: Failure to comply with the requirements of this section shall be a violation of these Regulations and the applicable part(s) of "The Building Code."

PLACARD TYPES

COMPLETELY FLOOD-PROOFED STRUCTURE

This building/structure is completely flood-proofed to withstand flooding to the RFD.

REGULATORY FLOOD DATUM_____FEET MSL

Areas below RFD are authorized for _____ use
(Group Type)

as approved by _____ Date _____
(Building Official, Dept. of Public Safety, etc.)

FLOOR ELEVATION AT THIS POINT-_____FT MSL

Type 1

FLOOD-RESISTIVE STRUCTURE

This building/structure contains areas below the RFD which require implementation of an approved contingency plan to achieve their required degree of protection

REGULATORY FLOOD DATUM_____FEET MSL

Areas below RFD are authorized for _____ use
(Group Type)

as approved by _____ Date _____
(Building Official, Dept. of Public Safety, etc.)

FLOOR ELEVATION AT THIS POINT_____FT. MSL

Type 2

PARTIALLY FLOOD-PROOFED STRUCTURE

Structural integrity during floods to the RFD will be achieved by internal flooding of_____spaces
(Some, All)
when flood waters reach_____feet MSL.

REGULATORY FLOOD DATUM_____FEET MSL

Areas below RFD are approved for _____ use
(Group Type)

as approved by _____ Date _____
(Building Official, Dept. of Public Safety, etc.)

FLOOR ELEVATION AT THIS POINT- FT. MSL

Type 3

PARTIALLY FLOOD-PROOFED STRUCTURE

Structural integrity during floods to the RFD will be achieved by internal flooding of_____spaces when flood waters reach_____feet MSL. Some areas require implementation of an approved contingency plan to achieve their required degree of protection.

REGULATORY FLOOD DATUM_____FEET MSL

Areas below RFD are approved for _____ use

as approved by _____ Date _____

FLOOR ELEVATION AT THIS POINT_____FT. MSL

Type 4

NON-FLOOD-PROOFED STRUCTURE

This building/structure is not flood-proofed.

REGULATORY FLOOD DATUM FEET MSL

Areas below RFD are authorized for _____ use
(Group Type)

as approved by _____ Date _____
(Building Official, Dept. of Public Safety, etc.)

FLOOR ELEVATION AT THIS POINT-_____FT. MSL

Type 5

AREA OF SAFE REFUGE

This space is authorized as an area of safe refuge above the RFD and will accommodate____persons.

REGULATORY FLOOD DATUM_____FEET MSL

Approved by _____ Date _____
(Building Official, Dept. of Public Safety, etc.)

FLOOR ELEVATION AT THIS POINT- FT. MSL

Type 6

Figure 2

CHAPTER 3

DEFINITIONS OF TERMS

SECTION 300.0 SCOPE

Sec. 300.1 PURPOSE: For the purpose of these Regulations, certain abbreviations, words, and their derivatives, shall be construed as set forth in this Chapter.

SECTION 301.0 DEFINITIONS

Sec. 301.1 GENERAL: The terms defined in this Chapter have been grouped in accordance with their main uses under the headings; Administrative, Physical, and Regulatory.

Sec. 301.2 ADMINISTRATIVE:

Sec. 301.2.1 ACCESSORY USE OR STRUCTURE – a use or structure on the same lot with, and of a nature customarily incidental and subordinate to, the principal use or structure.

Sec. 301.2.2 BUILDING OFFICIAL – the officer charged with the administration and enforcement of the Building Code and these Flood-proofing Regulations or his regularly authorized deputy.

Sec. 301.2.3 ENCROACHMENT LINES – the lateral limits or line drawn along each side and generally parallel to a watercourse or body of water, to preserve the flood carrying capacity of the stream or other body of water and its flood plain, and to assure attainment of the basic objective of improvement plans that may be considered or proposed. Their location, if along a stream, should be such that the floodway between them will effectively carry and discharge a large flood, i.e. not less than the Intermediate Regional Flood.

Sec. 301.2.4 FLOOD HAZARD AREAS: [1]

Sec. 301.2.4.1 PRIMARY – the lands adjoining the channel of a river, stream or watercourse, would be covered by flood water during a Regulatory Flood.

Sec. 301.2.4.2 SECONDARY – the land area beyond the runout line of the Regulatory Flood that could be affected by higher floods and by underground water travel, back flooding of sewerage, drainage, domestic water supply, and public utility systems, or cause other flood related problems during a Regulatory Flood.

Sec. 301.2.5 FLOODWAY[1] – the channel of the stream or body of water and those portions of the flood plains which are reasonably required to carry and discharge flood water or flood flow of a designated magnitude.

Sec. 301.2.6 FLOOD PLAIN MANAGEMENT – a term applied to the full range of public policy and action for insuring wise use of the flood plains. It includes everything from collection and dissemination of flood control information to actual acquisition of flood plain lands, including the enactment and administration of flood plain regulations including building codes and the building of flood modifying structures.

Sec. 301.2.7 FLOODWAY FRINGE[1] – the area of the flood plain not lying within a floodway which may hereafter be covered by flood waters up to the Regulatory Flood.

1/ See illustration on Page vi – Figure i.

Sec. 301.2.8 FREEBOARD[1] – a factor of safety usually expressed in feet above a design flood level for flood protective or control works. Freeboard tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions such as wave action, bridge opening and floodway obstructions, and the hydrological effects of urbanization of the watershed.

Sec. 301.2.9 HABITABLE ROOM – a space used for living, sleeping, eating or cooking, or combination thereof, but not including bathrooms, toilet compartments, closets, halls, storage rooms, laundry and utility rooms, basement recreation rooms and similar spaces.

Sec. 301.2.10 NONCONFORMING USE – a building or structure, or the use thereof, which was lawful before the passage or amendment of the (ordinance, resolution, act) but which is not in conformance with the provisions of these Regulations.

Sec. 301.2.11 OWNER – owner shall mean any person who has dominion over, control of, or title to an artificial or natural obstruction.

Sec. 301.2.12 REGULATORY FLOOD[1] – a flood which is representative of large floods known to have occurred generally in the area or reasonably characteristic of what can be expected to occur on a particular stream or other body of water. This flood is generally being recognized and accepted nationally by Federal and non-Federal interests as one with an average frequency of occurrence on the order of once in 100 years (see Intermediate Regional Flood).

Sec. 301.2.13 REGULATORY FLOOD DATUM (RFD)[1] – established plane of reference from which elevation and depth of flooding may be determined for specific locations of the flood plain. It is the Regulatory Flood plus a freeboard factor of safety established for each particular area which tends to compensate for the many unknown and uncalculable factors that could contribute to greater flood heights than that computed for a Regulatory Flood. (see Regulatory Flood and Freeboard definitions for clarification of cumulative definition of Regulatory Flood Datum).

Sec. 301.2.14 SUBDIVISION – the partitioning or dividing of a parcel or tract of land.

Sec. 301.3 PHYSICAL:

Sec. 301.3.1 ARTIFICIAL OBSTRUCTION – artificial obstruction shall mean any obstruction which is not a natural obstruction.

Sec. 301.3.2 CHANNEL[1] – a natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water. Channel flow thus is that water which is flowing within the limits of the defined channel.

Sec. 301.3.3 FILL – the placing, storing, or dumping of any material, such as (by way of illustration but not of limitation) earth, clay, sand, concrete, rubble, or waste of any kind, upon the surface of the ground which results in increasing the natural ground surface elevation.

Sec. 301.3.4 FLOOD – an overflow of lands adjacent to a river, stream, ocean, lake, etc., not normally covered by water. Otherwise it is normally considered as any temporary rise in stream flow or stage that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, backwater effects in sewers and local drainage channels, creation of unsanitary conditions, soil erosion, deposition of materials during flood recessions, rise of ground water coincident with increased streamflow, contamination of domestic water supplies, and other problems.

1/ See illustration on Page vi – Figure i.

Sec. 301.3.5 FLOOD CREST – the maximum stage or elevation reached by the waters of a flood at a given location.

Sec. 301.3.6 FLOOD PLAIN – the area, usually low lands, adjoining the channel of a river, stream or watercourse or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

Sec. 301.3.7 FLOOD PROFILE – a graph or a longitudinal profile showing the relationship of the water surface elevation of a flood to location along a stream or river.

Sec. 301.3.8 FLOOD-PROOFING – a combination of structural changes and/or adjustments incorporated in the design and/or construction and alteration of individual buildings, structures or properties subject to flooding primarily for the reduction or elimination of flood damages.

Sec. 301.3.8.1 Permanent flood-proofing – permanent protection would be provided against the flood which do not depend upon any judgment, flood forecast, or action to put flood protection measures into effect.

Sec. 301.3.8.2 Contingent (or partial) flood-proofing – contingent measures would not be effective unless, upon receipt of a warning or forecast, some minimal action would be required to make the flood-proofing measures operational.

Sec. 301.3.8.3 Emergency (or temporary) flood-proofing – emergency measures would be, upon receipt of a warning or forecast, either improvised just prior to or during an actual flood or carried out according to an established emergency plan of action.

Sec. 301.3.9 INTERMEDIATE REGIONAL FLOOD (IRF) – a flood having an average frequency of occurrence in the order of once in 100 years although the flood may occur in any year (a one per cent chance of being exceeded in any year). It is based on statistical analyses of streamflow records available for the watershed and analyses of rainfall and runoff characteristics in the "general region of the watershed."

Sec. 301.3.10 NATURAL OBSTRUCTION – natural obstruction shall mean any rock, tree, gravel, or analogous natural matter that is an obstruction and has been located within the floodway by a nonhuman cause.

Sec. 301.3.11 REACH – a hydraulic engineering term to describe longitudinal segments of a stream or river. A reach will generally include the segment of the flood plain where flood heights are primarily controlled by man-made or natural flood plain obstructions or restrictions. In an urban area, the segment of a stream or river between two (2) physically identifiable points on the stream centerline would most likely be designated as a reach.

Sec. 301.3.12 STRUCTURE – anything constructed or erected on the ground, or attached to the ground, including, but not limited to the following: docks, dams, fences, mobile homes, sheds and buildings.

Sec. 301.3.13 UNDERCLEARANCE – the lowest point of a bridge or other structure over or across a river, stream, or watercourse that limits the opening through which water flows. This is referred to as "low steel" in some regions.

Sec. 301.3.14 WATERCOURSE – any natural or man-made depression with a bed and well-defined banks two feet or more below the surrounding land serving to give direction to a current of water at least nine months of the year or having a drainage area of one square mile or more.

Sec. 301.4 REGULATORY:

Sec. 301.4.1 BUILDING CODE – the regulations adopted by a local governing body setting forth standards for the construction, addition, modification and repair of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public.

Sec. 301.4.2 FLOOD PLAIN REGULATIONS – a general term applied to the full range of codes, ordinances and other regulations relating to the use of land and construction within flood plain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws and open area (space) regulations.

Sec. 301.4.3 SUBDIVISION REGULATIONS – regulations and standards established by a local unit of government with authority granted under a state enabling law, for the subdivision of land in order to secure coordinated land development, including adequate building sites and land for vital community services and facilities such as streets, utilities, schools and parks.

CHAPTER 4

FLOOD-PROOFING CLASSIFICATION OF SPACES BELOW THE REGULATORY FLOOD DATUM

SECTION 400.0 SCOPE

Sec. 400.1 GENERAL: The flood-proofing classification of a space is determined by the degree of protection required under these Regulations to permit its intended use. (Classification of entire buildings or structures for administrative and posting purposes, which is based jointly on the flood-proofing classes of its constituent spaces and the means by which their classifications are obtained, is explained in 210.0). The flood-proofing class of a space for which temporary placement or contingent protection measures are approved assumes that these measures are in effect during a flood and defines the resulting relationship of protection to use.

Sec. 400.2 ASSIGNMENT OF FLOOD-PROOFING CLASSES: Assignment is made by the Owner at the time of application for a permit and is subject to the approval of the Building Official as indicated in 205.0. Every space of an improvement in a Flood Hazard Area which impinges in whole or part upon the RFD shall have a flood-proofing class assigned to it, and all requirements associated with a flood-proofing class shall be met by the space to which they apply in addition to all other requirements of these Regulations and the Building Code.

SECTION 401.0 DESCRIPTIONS OF FLOOD-PROOFING CLASSES

Sec. 401.1 CLASSIFICATIONS: The following descriptions of the five flood-proofing classes are approximate and general; more precise specification of the requirements associated with each class is given in Table 2 of the following section.

Sec. 401.2 COMPLETELY DRY SPACES (W1): These spaces shall remain completely dry during flooding to the RFD; walls shall be impermeable to passage of water and water vapor. Permitted contents and interior finish materials are virtually unrestricted, except for high hazard type uses or human habitation as provided in 209.3. Structural components shall have capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

Sec. 401.3 ESSENTIALLY DRY SPACES (W2): These spaces shall remain essentially dry during flooding to the RFD; walls shall be substantially impermeable to water, but may pass some water vapor or seep slightly. Contents and interior finish materials are restricted when hazardous or vulnerable under these conditions. Structural components shall have capability of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

Sec. 401.4 SPACES INTENTIONALLY FLOODED WITH POTABLE WATER (W3): These spaces will be flooded internally with potable water provided by the Owner in order to maintain the building's structural integrity by equalizing pressures on structural components during flooding to the RFD; walls shall be sufficiently impermeable to prevent the passage, infiltration or seepage of contaminated flood waters. Contents and interior finish materials are restricted when hazardous or vulnerable under intentional flooding conditions.

Sec. 401.5 SPACES FLOODED WITH FLOOD WATER (W4): These spaces will be flooded with flood water (contaminated) by automatic means, or are otherwise partially exposed to the unmitigated effects of the flood. Although there are minimal structural requirements to be met for walls and other structural components, contents and interior finish materials are restricted to types which are neither hazardous nor vulnerable to loss under these flooding conditions. (Most spaces in existing buildings would have this classification if provided with a suitable automatic flooding system. Carports, loading platforms, open crawl spaces, porches and patios would generally fall into this classification.

Sec. 401.6 NON-FLOOD-PROOFED SPACES (W5): A non-flood-proofed space in an existing building or structure is defined as a space which fails to meet the requirements of any of the above described classifications.

SECTION 402.0 THE SPACE CLASSIFICATION CHART

Sec. 402.1 GENERAL: Table 2 indicates the various degrees of protection required to permit uses of spaces for each flood-proofing class. Although spaces must meet the requirements shown for each element of flood-proofing, the chart in itself shall not be construed as being exhaustive with respect to all requirements imposed by these Regulations. In disputes arising over the interpretation of this chart, the written provisions of these Regulations shall be considered as definitive.

Table 2

SPACE CLASSIFICATION CHART

FLOOD-PROOFING CLASSIFICATION OF SPACES									
	MINIMUM REQUIREMENTS								
Flood-Proofing Classes	Water-Proofing	Struc-tural Loads	Closure of Openings	Internal Flooding & Drainage	Flooring	Walls and Ceilings	Contents	Electrical	Mechanical
W1 Completely Dry	Type A	Class 1	Type 1	See Chapter 8	Class 1	Class 1	Class 1	See Chapter 12	See Chapter 13
W2 Essentially Dry	Type B	Class 1	Type 1		Class 2	Class 2	Class 2		
W3 Flooded with Pota-ble Water	Type A	Class 2	Type 3		Class 3	Class 3	Class 3		
W4 Flooded with Flood Water	Type C	Class 3	Type 4		Class 4	Class 4	Class 4		
W5 Non-Flood-Proofing	–	–	Type 5		Class 5	Class 5	Class 5		

Sec. 402.2 SEPARATION OF SPACES WITH DIFFERENT FLOOD-PROOFING CLASSIFICATIONS: Any two adjacent spaces below the RFD having different flood-proofing classes shall be separated by a barrier meeting the requirements for the space with the lower-numbered classification. In addition, any opening below the RFD between two adjoining spaces shall be provided with a closure meeting the requirements for the space with the lower-numbered classification.

CHAPTER 5

WATERPROOFING

SECTION 500.0 SCOPE

Sec. 500.1 PURPOSE: This chapter shall govern the design, use, and methods of construction and materials with respect to obtaining, for a given space, the degree of protection against water, water vapor, and water-borne contamination determined by the vulnerability or hazard potential of the contents and interior finish materials to meet its flood-proofing classification.

Sec. 500.2 PERFORMANCE STANDARDS: Three types of waterproofing are defined herein as to the degree to which they satisfy a standard of dryness. If any material or method of construction meets the functional performance standard defining a type of waterproofing construction it shall be considered as satisfying the requirements of this chapter. For the purpose of these Regulations, the detailed specification of Type A waterproofing construction, as contained in this chapter, shall be interpreted as a guide to measures which are reasonable prerequisites for attaining this standard of dryness.

SECTION 501.0 TYPE A CONSTRUCTIONS

Sec. 501.1 PERMEABILITY: Type A waterproofing constructions are completely impermeable to the passage of external water and water vapor under hydrostatic pressure of flooding to the RFD. Type A waterproofing construction shall consist of either a continuous membrane satisfying 501.2, integrally waterproofed concrete satisfying 501.3, or a continuous interior lining satisfying 501.4.

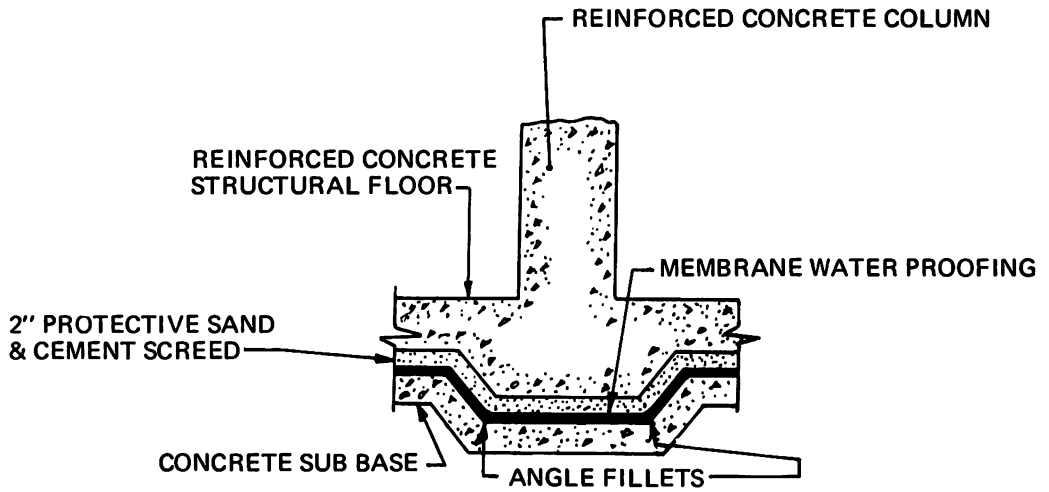
Sec. 501.2 TYPE A MEMBRANE CONSTRUCTION: Type A membrane water-proofing forms a continuous external impervious lining to protect a structure with a concrete floor slab and concrete or reinforced concrete masonry unit walls. It shall comply with the following requirements for structural prerequisites, materials, and installation.

Sec. 501.2.1 STRUCTURAL PREREQUISITES:

Sec. 501.2.1.1 CONTINUITY OF STRUCTURE: Structural slabs below grade shall be continuous under perimeter walls to prevent differential settlement and shall be designed to act monolithically with the walls; reinforced concrete masonry unit walls shall be connected rigidly to slabs with reinforcing steel. Where conventional footings are necessary to achieve bearing below the frost line, the structural slab shall be formed monolithically with the walls or anchored into the walls by means of a keyway and reinforcing steel so as to act monolithically with the wall.

Sec. 501.2.1.2 PROJECTION OF SLAB: Where a slab is continuous under perimeter walls, it shall project not less than six (6) inches beyond the outside of the wall in order to provide space for joining horizontal and vertical membranes.

Sec. 501.2.1.3 COLUMNS: Where columns occur, there shall be no vertical discontinuity or abrupt change in slab cross-sections. Where slab thicknesses change, they shall do so gradually, and the effects of pressure distribution on the thinner portions of the slab cross-section shall be considered.



TYPE "A" MEMBRANE WATER PROOFING IN FLOOR SLABS

Figure 3

Sec. 501.2.1.4 PROTECTION: All membranes shall be installed on exterior surfaces of perimeter walls. For floor slabs, the membrane shall be installed between the structural slab and wearing surface or otherwise placed on a non-structural concrete sub-base at least two (2) inches in thickness to protect the membrane and insure its flatness; in the latter case (Fig. 3) a two (2) inch thick sand-cement screed shall be placed over the membrane before laying reinforcing steel for the structural slab. If a floor membrane is sandwiched between two structural slabs, the membrane shall be positioned at a location that will not subject it to excessive overstress conditions.

Sec. 501.2.1.5 PILE FOUNDATIONS: When spaces are supported on pile foundations, there shall be complete separation between pile caps and floor slab; the membrane shall be continuous and loads shall be transferred to the piles through basement walls acting as deep beams or through isolated foundations. The pile caps shall be interconnected with stabilizing beams and a reinforced concrete slab not less than four (4) inches thick shall be provided over the entire area between the beams (and monolithic with them) in order to receive the membrane.

Sec. 501.2.2 MATERIALS: For the purpose of these Regulations, a membrane shall be any layered sheet construction of tar/asphalt bitumen and felts, at least 3-ply in thickness neoprene coated nylon fabric; other approved sheet material; or multiple applied hydrolithic coatings of asphaltic bitumens. All applicable ASTM standards shall apply to Type A membranes and their component parts.

Sec. 501.2.2.1 PERMEABILITY: Type A membrane shall permit passage of no more than three (3) pounds of water per 1,000 square feet in 24 hours at 40 psi.

Sec. 501.2.2.2 PLASTIC WATERPROOFING MATERIALS: Various plastic materials, including among others, polyethylene, PVC, polyurethane, and polyisobutylene, shall be permitted in sufficient thicknesses in sheets or coatings. In certain cases the Building Official may require less protection beneath the plastic than the concrete sub-base required in 501.2.1.4.

Sec. 501.2.3 INSTALLATION:

Sec. 501.2.3.1 APPLICATION: All Type A membrane waterproofing shall be applied by a certified roofing or waterproofing contractor.

Sec. 501.2.3.2 TURNS: Turns at corners, both vertical and horizontal, shall be made with chamfers or fillets of not less than two (2) inches dimension on any side.

Sec. 501.2.3.3 SEAMS: Membrane seams or overlaps, if any, shall be thoroughly interleaved and protected in accordance with accepted practice, but in no case shall seams or overlaps be less than two (2) inches in any direction.

Sec. 501.2.3.4 PIPES: Points where pipes or ducts penetrate water-proofed construction shall be designed to be watertight in accordance with accepted engineering practice.

Sec. 501.2.3.5 JOINTS: Membranes shall be continuous across expansion, control, and construction joints, which shall have waterstops of rubber, copper, plastic, or other suitable materials.

Sec. 501.2.3.6 PROTECTION: Membranes on walls shall extend at least three (3) inches above the RFD of the protected space and shall be attached with a reglet or covered with protective masonry at its upper termination. To protect all wall membranes during backfill operations, protection of not less than ½-inch thickness of cement parging, plastic sheets, or other rigid non-cellulose material, installed in a workmanlike manner, shall be provided; however, in large projects or where the protection required above may not be adequate, the Building Official may require protection by some other means.

Sec. 501.2.3.7 EXCAVATION: Excavation preceding construction shall extend a minimum distance of 24 inches beyond the exterior wall lines to facilitate construction operations. In build-up areas where this requirement cannot be met, excavation limits will be as designated by the Building Official.

Sec. 501.3 TYPE A INTEGRALLY WATERPROOFED CONCRETE CONSTRUCTION: Type A integrally waterproofed concrete construction shall comply with the following requirements for structural prerequisites, materials, and installation.

Sec. 501.3.1 STRUCTURAL PREREQUISITES:

Sec. 501.3.1.1 CONTINUITY OF STRUCTURE: Structural slabs shall be continuous under perimeter walls. Slabs shall be designed to act monolithically with perimeter walls, or otherwise shall carry them non-rigidly in a recess with mastic V fillings and waterstops. (Fig. 4) Where conventional footings are necessary to achieve bearing below the frost line, the structural slab shall be formed monolithically with the walls or anchored into the walls by means of a keyway and reinforcing steel.

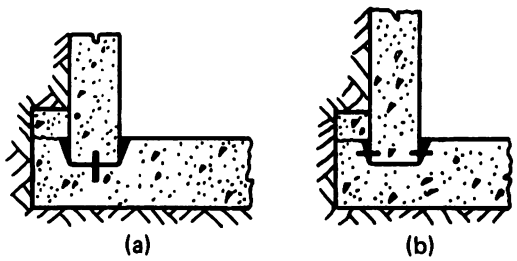
Sec. 501.3.1.2 DEFLECTIONS: To prevent increases of permeability in tension zones, the maximum deflection of any structural slab or perimeter wall shall not exceed 1/500 of its shorter span.

Sec. 501.3.1.3 COLUMNS: Where columns occur there shall be no vertical discontinuity or abrupt change in slab cross-section. Where slab cross-sections change, they shall do so gradually, and the effects of pressure distribution on the thinner portions of the slab cross-section shall be considered.

Sec. 501.3.2 MATERIALS:

Sec. 501.3.2.1 STRENGTH: All Type A integrally waterproofed concrete shall have a seven-day compressive strength of at least 3,000 psi and a 28-day compressive strength of 4000 psi.

Sec. 501.3.2.2 WATERPROOFING ADMIXTURES: If an approved water-proofing admixture is used, the cement content required to achieve the strength specifications may not be reduced by more than 10%. Approved admixtures shall not reduce the compressive strength of the concrete and shall act as a densifier and/or to increase workability.



NON-RIGID PERIMETER WALL AND FLOOR SLAB CONNECTIONS

Figure 4

Sec. 501.3.2.3 JOINTS: Expansion joints shall be keyed and provided with waterstops. Construction joints shall be provided with waterstops and shall be thoroughly roughened and cleaned before continuation of concrete placement.

Sec. 501.3.2.4 PROTECTION OF FRESH CONCRETE: When potentially aggressive ground water conditions exist, the Building Official may require the protection of fresh concrete from contact with ground water for a minimum of 14 calendar days. Protection shall be accomplished either by the removal of ground water or by the application of a temporary membrane or surface coating (e.g. bitumen or tar emulsion) which, however, need not meet standards for permanent protection.

Sec. 501.4 TYPE A INTERIOR LININGS: A Type A interior lining forms a continuous internal impervious barrier to protect a structure with a concrete floor slab and concrete or reinforced concrete masonry unit walls. All Type A interior linings shall conform to the following requirements for structural prerequisites, materials, and installation.

Sec. 501.4.1 STRUCTURAL PREREQUISITES:

Sec. 501.4.1.1 CONTINUITY OF STRUCTURE: Structural slabs below grade shall be continuous under perimeter walls to prevent differential settlement and shall be designed to act monolithically with the walls; reinforced concrete masonry unit walls shall be connected rigidly to slabs with reinforcing steel. Where conventional footings are necessary to achieve bearing below the frost line, the structural slab shall be formed monolithically with the walls or anchored into the walls by means of a keyway and reinforcing steel so as to act monolithically with the wall.

Sec. 501.4.1.2 COLUMNS: Where columns occur, there shall be no vertical discontinuity or abrupt change in slab cross-sections. Where slab thicknesses change, they shall do so gradually, and the effects of pressure distribution on the thinner portions of the slab cross-section shall be considered.

Sec. 501.4.1.3 DEFLECTIONS: To prevent cracking of the interior lining, the maximum deflection of any structural slab or perimeter wall to which the lining is applied shall not exceed 1/500 of its shorter span.

Sec. 501.4.2 MATERIALS: For the purpose of these Regulations, an interior lining shall be any continuous coating, parging, or rendering of a cementitious or other approved waterproofing material or compound with adequate structural strength and impermeability to serve its intended purpose. All relevant ASTM standards shall apply to Type A interior lining materials.

Sec. 501.4.2.1 PERMEABILITY: Type A interior linings shall permit the passage of no more than three (3) pounds of water per 1,000 square feet in 24 hours at 40 psi.

Sec. 501.4.3 INSTALLATION:

Sec. 501.4.3.1 APPLICATION: All Type A interior lining waterproofing shall be applied by a certified roofing or waterproofing contractor.

Sec. 501.4.3.2 TURNS: Turns at corners, both vertical and horizontal, shall be made with fillets of not less than two (2) inches dimension on any side.

Sec. 501.4.3.3 PIPES: Points where pipes or ducts penetrate water-proofed construction shall be designed to be watertight in accordance with accepted engineering practice.

Sec. 501.4.3.4 JOINTS: Interior linings shall be continuous across expansion, control, and construction joints, which shall have waterstops of rubber, copper, plastic, or other suitable material.

Sec. 501.4.3.5 VERTICAL EXTENT: Interior linings on walls shall extend at least 3 inches above the RFD of the protected space.

Sec. 501.5 EXISTING SPACES: Spaces in existing buildings or structures which become subject to these Regulations may be approved as having Type A waterproofing upon submission by the Owner of plans and specifications for these spaces prepared by a licensed architect or engineer; however, the Building Official shall make a thorough inspection of actual site conditions and may require that tests be made to demonstrate the adequacy of the work before granting this approval.

SECTION 502.0 TYPE B CONSTRUCTIONS

Sec. 502.1 PERMEABILITY: Type B waterproofing constructions shall be substantially impermeable but may pass water vapor and seep slightly during flooding to the RFD. Large cracks, openings, or other channels that could permit unobstructed passage of water shall not be permitted. In no case shall there be permitted the accumulation of more than four (4) inches of water depth in such a space during a 24 hour period if there were no devices provided for its removal. However, sump pumps shall be required to control this seepage.

Sec. 502.2 UPGRADING EXISTING SPACES: Spaces with Type B water-proofing construction may be upgraded to Type A through the installation of a continuous exterior or interior lining or a combination of both which the Building Official may approve as meeting the requirements for permeability of Type A waterproofing.

Sec. 502.2.1 INSPECTIONS: The Building Official shall make inspections prior to and upon completion of this work before approving the completed work as meeting Type A waterproofing requirements. The Building Official may require that tests be made to demonstrate the adequacy of the work before granting this approval.

SECTION 503.0 TYPE C CONSTRUCTIONS

Sec. 503.1 NON-WATER-PROOFED: Type C waterproofing constructions are any which do not satisfy the requirements for Type A or B in 501.0 and 502.0, respectively.

Sec. 503.2 UPGRADING OF SPACES: Non-waterproofed spaces may be upgraded to Type A or B waterproofing when the Building Official shall approve such work as meeting the standards for Type A or B in 501.0 and 502.0, respectively.

Sec. Sec. 503.2.1 INSPECTIONS: The Building Official shall make inspections prior to, during, and upon completion of this work before approving the improvement as Type A or B waterproofing, and may require tests be made to demonstrate the adequacy of the work before granting this approval.

CHAPTER 6

STRUCTURAL REQUIREMENTS

SECTION 600.0 SCOPE

Sec. 600.1 GENERAL: All buildings and structures, covered by these Regulations and all parts thereof, shall be capable of resisting all loads required by "The Building Code" and, in addition, all loads prescribed in this chapter, without exceeding the prescribed allowable stresses.

SECTION 601.0 CLASSES OF LOADS

Sec. 601.1 Class 1 loads – reflect the probable effects of flooding on structures which are waterproof (W1 or W2). These loads shall be calculated in complete accordance with this Chapter and shall include all water, impact, and soil loads specified herein.

Sec. 601.2 Class 2 loads – reflect the probable effects of flooding on structures which include internal flooding as a means of structural protection and which shall be so flooded in accordance with Chapter 8. These loads shall be calculated in accordance with this Chapter except that only hydrodynamic and impact loads must be considered when the interior and exterior water levels are equal.

Sec. 601.3 Class 3 loads – apply to buildings or structures which are to be flooded with flood water either internally by automatic means or externally in partially exposed areas. For such internal flooding, Class 3 loads shall coincide with those of Class 2. For partially exposed spaces, however, any dependent or supporting structural components shall be designed for Class 1 or 2 loads if they are also structural components of any adjacent enclosed space, whichever is required; isolated or free-standing columns or walls shall meet all criteria of 612.2.3.

SECTION 602.0 WATER LOADS

Sec. 602.1 TYPES: Water loads, as defined herein, are loads or pressures on surfaces of the buildings and structures caused and induced by the presence of flood waters. These loads are of two basic types: hydrostatic and hydrodynamic.

Sec. 602.2 HYDROSTATIC LOADS: Hydrostatic loads are those caused by water either above or below the ground surface, free or confined, which is either stagnant or moves at very low velocities, or up to five (5) feet per second. These loads are equal to the product of the water pressure times the surface area on which the pressure acts. The pressure at any point is equal to the product of the unit weight of water (62.5 pounds per cubic foot) multiplied by the height of water above the point or by the height to which confined water would rise if free to do so. Hydrostatic pressures at any point are equal in all directions and always act perpendicular to the surface on which they are applied. For the purpose of these Regulations, hydrostatic loads are subdivided into the following types:

Sec. 602.2.1 VERTICAL LOADS: These are loads acting vertically downward on horizontal or inclined surfaces of buildings or structures, such as roofs, decks or floors, and walls, caused by the weight of flood waters above them.

Sec. 602.2.2 LATERAL LOADS: Lateral hydrostatic loads are those which act in a horizontal direction, against vertical or inclined surfaces, both above and below the ground surface and tend to cause lateral displacement and overturning of the building, structure, or parts thereof.

Sec. 602.2.3 UPLIFT: Uplift loads are those which act in a vertically upward direction on the underside of horizontal or sloping surfaces of buildings or structures, such as basement slabs, footings, floors, decks, roofs and overhangs. Hydrostatic loads acting on inclined, rounded or irregular surfaces may be resolved into vertical or uplift loads and lateral loads based on the geometry of the surfaces and the distribution of hydrostatic pressures.

Sec. 602.3 HYDRODYNAMIC LOADS: Hydrodynamic loads, for the purpose of these Regulations, are those induced on buildings or structures by the flow of flood water moving at moderate or high velocity around the buildings or structures or parts thereof, above ground level. Such loads may occur below the ground level when openings or conduits exist which allow free flow of flood waters. Hydrodynamic loads are basically of the lateral type and relate to direct impact loads by the moving mass of water, and to drag forces as the water flows around the obstruction. Where application of hydrodynamic loads is required, the loads shall be computed or estimated by recognized and authoritative methods. Methods for evaluating water velocities and related dynamic effects are beyond the scope of these Regulations, but shall be subject to review and approval by the Building Official.

Sec. 602.3.1 CONVERSION TO EQUIVALENT HYDROSTATIC LOADS: For the purpose of these Regulations, and for cases when water velocities do not exceed 10 feet per second, dynamic effects of the moving water may be converted into equivalent hydrostatic loads by increasing the depth of water to the RFD by an amount dh, on the headwater side and above the ground level only, equal to:

$$dh = \frac{a\,V^2}{2g}\text{, where}$$

V is the average veolocity of the water in feet per second;
g is the acceleration of gravity, 32.2 feet per second per second;
a is the coefficient of drag or shape factor. (The value of a, unless otherwise evaluated, shall not be less than 1.25)

The equivalent surcharge depth dh shall be added to the depth measured between the design level and the RFD and the resultant pressures applied to, and uniformly distributed across, the vertical projected area of the building or structure which is perpendicular to the flow. Surfaces parallel to the flow or surfaces wetted by the tailwater shall be considered subject to hydrostatic pressures for depths to the RFD only.

Sec. 602.4 INTENSITY OF LOADS:

Sec. 602.4.1 VERTICAL LOADS: Full intensity of hydrostatic pressures caused by a depth of water between the design level and the RFD applied on all surfaces involved.

Sec. 602.4.2 LATERAL LOADS: Full intensity of hydrostatic pressures caused by a depth of water between the design elevation(s) and the RFD applied over all surfaces involved, both above and below ground level, except that for surfaces exposed to free water, the design depth shall be increased by one foot.

Sec. 602.4.3 UPLIFT: Full intensity of hydrostatic pressures caused by a depth of water between the design level and the RFD acting on all surfaces involved, unless provisions are made to reduce uplift intensities as permitted in 611.0.

Sec. 602.4.4 HYDRODYNAMIC LOADS: Hydrodynamic loads, regardless of method of evaluation, shall be applied at full intensity over all above ground surfaces between the ground level and the RFD.

Sec. 602.5 APPLICABILITY: For the purpose of these Regulations, hydrostatic loads shall be used in the design of buildings and structures exposed to water loads from stagnant flood waters, for conditions when water velocities do not

exceed five (5) feet per second, and for buildings and structures or parts thereof not exposed or subject to flowing water. For buildings and structures, or parts thereof, which are exposed and subject to flowing water having velocities greater than five (5) feet per second, hydrostatic and hydrodynamic loads shall apply.

SECTION 603.0 IMPACT LOADS

Sec. 603.1 TYPES: For the purpose of these Regulations, impact loads are those which result from floating debris, ice and any floatable object or mass carried by flood waters striking against buildings and structures or parts thereof. These loads are of three basic types: normal, special and extreme.

Sec. 603.1.1 NORMAL IMPACT LOADS: Normal impact loads are those which relate to isolated occurrences of logs, ice blocks or floatable objects of normally encountered sizes striking buildings or parts thereof.

Sec. 603.1.2 SPECIAL IMPACT LOADS: Special impact loads are those which relate to large conglomerates of floatable objects, such as broken up ice floats and accumulation of floating debris, either striking or resting against a building, structure, or parts thereof.

Sec. 603.1.3 EXTREME IMPACT LOADS: Extreme impact loads are those which relate to large floatable objects and masses such as runaway barges or collapsed buildings and structures, striking the building, structure or component under consideration.

Sec. 603.2 APPLICABILITY: Impact loads shall be considered in the design of buildings, structures and parts thereof as stipulated below:

Sec. 603.2.1 NORMAL IMPACT LOADS: A concentrated load acting horizontally at the RFD or at any point below it, equal to the impact force, produced by a 1,000-pound mass traveling at the velocity of the flood water and acting on a one (1) square foot surface of the structure.

Sec. 603.2.2 SPECIAL IMPACT LOADS: Where special impact loads are likely to occur, such loads shall be considered in the design of buildings, structures, or parts thereof. Unless a rational and detailed analysis is made and submitted for approval by the Building Official, the intensity of load shall be taken as 100 pounds per foot acting horizontally over a one-foot wide horizontal strip at the RFD or at any level below it. Where natural or artificial barriers exist which would effectively prevent these special impact loads from occurring, the loads may be ignored in the design.

Sec. 603.2.3 EXTREME IMPACT LOADS: It is considered impractical to design buildings having adequate strength for resisting extreme impact loads. Accordingly, except for special cases when exposure to these loads is highly probable and the resulting damages are extremely severe, no allowances for these loads need be made in the design.

SECTION 604.0 SOIL LOADS

Sec. 604.1 APPLICABILITY: Full consideration shall be given in the design of buildings, structures and parts thereof, to the loads or pressures resulting from the presence of soils against or over the structure. Loads or pressures shall be computed in accordance with accepted engineering practice, giving full consideration to the effects that the presence of flood water, above or within the soil, has on loads and pressures. When expansive soils are present, the Building Official may require that special provisions be made in foundation and wall design and construction to safeguard against damage due to this expansiveness. He may require a special investigation and report to provide these design and construction criteria.

SECTION 605.0 HURRICANE AND TIDAL WAVE LOADS

Sec. 605.1 **APPLICABILITY**: Coverage of loads caused by flooding related to hurricanes, tidal waves and other similar natural events is beyond the scope of these Regulations and no specific or detailed treatment is provided. Concepts and requirements of these Regulations may be used as a guide in developing suitable provisions for flood-proofing of buildings exposed to flooding from these sources.

SECTION 606.0 LOADING CONDITIONS

Sec. 606.1 **APPLICABILITY**: Buildings and structures, covered by these Regulations, and all parts thereof, shall be designed for all loads and loading conditions required by "The Building Code" for the prevalent state of loading when the structure is not subject to flood loads. In a separate analysis, the effects of flood related loads and loading conditions shall be calculated. Maximum values of loads and member stresses shall then be computed under the combined effects of the normal loads required by "The Building Code" and those of flood related loads. The buildings, structures, and all structural members or components thereof shall be capable of resisting these maximum loads and stresses without exceeding the prescribed allowable stresses.

SECTION 607.0 COMBINED LOADS

Sec. 607.1 **APPLICABILITY**: All loads stipulated in "The Building Code" and all flood related loads shall be applied on the structure and on structural components, alone and in combination, in such a manner that the combined effect will result in maximum loads and stresses on the structure and members. Loads required by "The Building Code" shall be used in combination with flood related loads defined in this chapter to the extent and subject to the exceptions stated below.

(1) **Dead Load.** Use at full intensity.

(2) **Live Load.** Use at reduced intensity as provided in "The Building Code" for design of columns, piers, walls, foundations, trusses, beams, and flat slabs. Live loads on floors at or below the RFD and particularly on basement slabs, shall not be used if their omission results in greater loading or stresses on such floors. Similarly, for storage tanks, pools, bins, silos and other similar structures designed to contain and store materials, which may be full or empty when a flood occurs, both conditions shall be investigated in combination with flood related loads of the containing structure being full or empty.

(3) **Snow Load.** Use at full intensity.

(4) **Wind Load.** Use at full intensity as required in "The Building Code" on areas of the building and structure above the RFD.

(5) **Earthquake Load.** Combined earthquake and flood related loads need not be considered.

SECTION 608.0 ALLOWABLE STRESSES

Sec. 608.1 **APPLICABILITY**: Allowable stresses for all materials shall be as stipulated in "The Building Code". Except as otherwise permitted by "The Building Code", only basic allowable stresses shall be used under flood related loads or combined loads, and those allowable stresses shall in no way be increased or permitted to be used in an "overstress" condition.

SECTION 609.0 ALLOWABLE SOIL PRESSURES

Sec. 609.1 APPLICABILITY: Under flood conditions, the bearing capacity of submerged soils is affected and reduced by the buoyancy effect of the water on the soil. For foundations of buildings and structures covered by these Regulations, the bearing capacity of soils shall be evaluated by a recognized acceptable method. Expansive soils should be investigated with special care. Soils which lose all bearing capacity when saturated, or become "liquefied", shall not be used for supporting foundations. If a detailed soils analysis and investigation is not made, and if bearing capacities of the soils are not evaluated as required above, allowable soil pressures permitted in "The Building Code" may be used, provided those values are reduced ___%. (This reduction should be determined for each locality and soil type by the Building Official).

SECTION 610.0 STABILITY

Sec. 610.1 OVERTURNING: All buildings and structures covered by these Regulations and all parts or elements thereof shall be proportioned to provide a minimum factor of safety of 1.50 against failure by sliding or overturning when subjected to flood related loads or combined loads defined under 607.0. The required stability shall be provided by the normal resistive loads allowed by "The Building Code", such as frictional resistance between the foundations and the soil, passive earth pressure, batter and vertical piles and permanent anchors which may be provided. For the purpose of providing stability, only the dead load shall be considered effective. No use shall be made of any resistance, either as weight or frictional or passive, from soils which could be removed or displaced by excavation, scour or other causes. Similarly, no use shall be made of frictional resistance between the foundation and the underlying soil in the case of structures supported on piles.

Sec. 610.2 FLOTATION: The building or structure, and all appurtenances or components thereof not rigidly anchored to the structure, shall have enough weight (deadload) to resist the full or reduced hydrostatic pressures and uplift from flood water at the RFD with a factor of safety of 1.33. For provisions governing reduced uplift intensities, see 611.0. In cases when it is not practical to provide the required factor of safety against flotation by weight alone, the difference shall be made up by providing dependable and permanent anchors that meet the approval of the Building Official. Elements which depend on anchorage to other portions of the structure shall be anchored to a portion or portions of the structure which has the required factor of safety against flotation from all contributing elements subject to uplift. Apportionment of uplift and resisting forces shall be made by a recognized method of structural analysis in accordance with accepted engineering practice.

Sec. 610.3 ANCHORAGE: Any building and structure as a whole, which lacks adequate weight and mass to provide the required factors of safety against overturning, sliding, and flotation, shall be dependably and permanently anchored to the ground and preferably to underlying sound rock formations. In addition, all elements of a building or structure, such as walls, floor slabs, girders, beams, columns and other members, shall be dependably connected or anchored to form an adequate structural system to support the individual members and all the applied loads. Provision of adequate anchorage is also essential and required for all tanks and vessels, sealed conduits and pipes, lined pits and sumps and all similar structures which have negligible weight of their own.

SECTION 611.0 REDUCTION OF UPLIFT PRESSURES

Sec. 611.1 GENERAL: Uplift forces, in conjunction with lateral hydrostatic forces, constitute the most adverse flood related loading on buildings and structures and elements thereof. Their combined effect determines to a major extent the requirements for weight and anchorage of a structure as a whole to assure its stability against flotation, sliding and overturning. When uplift forces are applied to structural elements of a building or structure, such as footings,

walls, and particularly basement slabs, they generally constitute the critical loading on such elements. In the interest of providing economical solutions to the basic problem of structurally flood-proofing buildings and structures, it is permissible under these Regulations to make provisions for effectively reducing uplift forces acting under the structure. The plans and design data submitted to the Building Official for approval as required by 205.0, shall show complete and detailed procedures, assumptions, analyses and design information, and specific provisions to be incorporated in the work for accomplishing the proposed reduction in uplift. Data and design procedures shall be based on recognized and acceptable methods of foundation drainage and waterproofing. Such provisions shall include, but are not limited to, the following items, used alone or in combination, as conditions will dictate.

Sec. 611.2 IMPERVIOUS CUTOFFS: Impervious cutoffs are barriers installed below the ground line and externally to the perimeter of the building or structure for the purpose of decreasing seepage quantities and/or reducing exit gradients. Such cutoffs must, in all cases where flood waters will rise above the ground level, be connected by suitable impervious blankets or membranes to the walls of the building or structure. Cutoffs may consist of interlocking steel sheeting, compacted barrier of impervious soil, grouted or injected cutoffs, impervious wall of interconnected concrete piles or panels, and similar seepage barriers, used alone or in combination.

Sec. 611.3 FOUNDATION DRAINAGE: Where impervious cutoffs are provided or where suitable foundation conditions exist, effective drainage and relief of uplift pressures under buildings and structures can be achieved. These foundation materials must be free-draining and have the desired degree of permeability. For the purpose of these Regulations, foundation drainage is intended to consist of the provision of drainage blankets, trenches, and, in all cases, drain tiles or perforated drain pipes adjacent to footings and under floor slabs. Other methods of foundation drainage, such as by means of sumps, well points, or deep wells can be used for special applications. Drain pipes shall discharge into a sump or suitable collection structure, where the water is collected and ejected by sump pumps.

Sec. 611.4 SUMPS AND PUMPS: Spacing, sizing and determination of depth of sumps shall be consistent with and correlated to the intended drainage system, the estimated amount of seepage and drainage yield.

SECTION 612.0 REQUIREMENTS FOR OTHER FLOOD-PROOFING METHODS

Sec. 612.1 METHODS: A building shall be considered as being completely flood-proofed if the lowest elevation of all space(s) within the building perimeter is above the RFD as achieved by:

(1) building on natural terrain beyond the RFD limit line on natural undisturbed ground,
(2) building on fill,
(3) building on stilts,
(4) protection by dikes, levees and/or flood walls.

These methods may be used alone or in combination to achieve the required degree of flood-proofing. Data and design procedures shall, in all cases, be based on recognized and acceptable methods of the applicable disciplines involved, and the following additional requirements.

Sec. 612.2 FLOOD-PROOFING BY ELEVATING THE BUILDING:

Sec. 612.2.1 NATURAL TERRAIN: In addition to the requirements of "The Building Code", the building shall be located not less than_____feet back from the line of incidence of the RFD on the ground, foundation design shall take into consideration the effects of soil saturation on the performance of the foundation, the effects of flood waters on slope stability shall be investigated, normal access to the building shall be by direct connections with areas above the RFD and all utility service lines shall be designed and constructed as required to protect the building and/or its components from damage or failure during a flooding event to the RFD.

Sec. 612.2.2 BUILDING ON FILL: The building and all parts thereof may be constructed above the RFD on an earth fill. Prior to placement of any fill or embankment materials, the area upon which fill is to be placed, including a five-foot strip measured horizontally beyond and contiguous to the toe line of the fill, shall be cleared of standing trees and snags, stumps, brush, down timber, logs and other growth, and all objects including structures on and above the ground surface or partially buried. The area shall be stripped of topsoil and all other material which is considered unsuitable by the Building Official as foundation material. All combustible and noncombustible materials and debris from the clearing, grubbing and stripping operations shall be removed from the proposed fill area and disposed of at locations above the RFD and/or in the manner approved by the Building Official. Fill material shall be of a selected type, preferably granular and free-graining, placed in compacted layers. Fill selection and placement shall recognize the effects of saturation from flood waters on slope stability, uniform and differential settlement, and scour potential. The minimum elevation of the top of slope for the fill section shall be at the RFD. Minimum distance from any point of the building perimeter to the top of the fill slope shall be either 25 feet or twice the depth of fill at that point, whichever is the greater distance. This requirement does not apply to roadways, driveways, playgrounds, and other related features which are not integral and functional parts of the building proper. Fill slopes for granular materials shall be no steeper than one vertical on one and one-half horizontal, unless substantiating data justifying steeper slopes are submitted to the Building Official and approved. For slopes exposed to flood velocities of less than five (5) feet per second, grass or vine cover, weeds, bushes and similar vegetation undergrowth will be considered to provide adequate scour protection. For higher velocities, stone or rock slope protection shall be provided.

Sec. 612.2.3 BUILDING ON "STILTS": The building may be constructed above the RFD by supporting it on "stilts" or other columnar type members, such as columns, piers, and in certain cases, walls. Clear spacing of support members, measured perpendicular to the general direction of flood flow shall not be less than eight (8) feet apart at the closest point. The "stilts" shall, as far as practicable, be compact and free from unnecessary appendages which would tend to trap or restrict free passage of debris during a flood. Solid walls, or walled in columns are permissible if oriented with the longest dimension of the member parallel to the flow. "Stilts" shall be capable of resisting all applied loads as required by "The Building Code" and all applicable flood related loads as required herein. Bracing, where used to provide lateral stability, shall be of a type that causes the least obstruction to the flow and the least potential for trapping floating debris. Foundation supports for the "stilts" may be of any approved type capable of resisting all applied loads, such as spread footings, mats, piles and similar types. In all cases, the effect of submergence of the soil and additional flood water related loads shall be recognized. The potential of surface scour around the stilts shall be recognized and protective measures provided, as required.

Sec. 612.3 PROTECTION BY DIKES, LEVEES, AND FLOODWALLS: The building shall be considered a floodproofed type when it is protected from flood waters to the RFD by means of dikes, levees, or floodwalls, either used alone or in combination, as necessary. This protection may extend all around the building where all surrounding ground is low, or on one or more sides where high ground (above the RFD) exists on the remaining sides. Regardless of type and method of construction, dikes, levees, and floodwalls shall be designed and constructed in accordance with recognized and accepted engineering practice and methods. They shall have adequate strength and stability to resist all applied loads and shall provide an effective watertight barrier up to the RFD.

Sec. 612.3.1 DIKES AND LEVEES: Dikes and levees shall be constructed of suitable selected materials, placed and compacted in layers to a section that has the required stability and impermeability. Prior to start of placement operations, the area on which the dike or levee is to be constructed shall be prepared as required by 612.2.2. In cases where underlying materials are highly pervious, it may be necessary to provide impervious cutoffs. A filter blanket, drainage ditch and/or trench shall be provided along the interior toe of the construction to collect seepage through the dike or levee. All seepage and storm drainage shall be collected at a sump or sumps where it may be pumped out over the dike. Normal surface runoff within and into the diked area during nonflood periods may be discharged through appropriate drainage pipes or culverts through the dike. Such culverts shall have a dependable flap, slide gate, or backflow preventing device which would close either automatically or manually to prevent backflow during

a flood. Scour protection measures for dikes and levees shall comply with the requirements of 612.2.2. Clearance from the toe of the dike or levee to the building shall be a minimum of 20 feet or twice the height of the dike or levee above the interior finished grade, whichever is greater.

Sec. 612.3.2 FLOODWALLS: Floodwalls may be constructed of concrete, steel sheet piling, or other suitable structural materials. Regardless of type, the wall shall have adequate strength and stability to resist the applied loads. The provisions of 612.3.1 shall be followed, as applicable, regarding removal of unsuitable materials, provision of impervious cutoffs, provision of seepage and storm drains, drainage ditches, sumps and sump pumps, and the minimum clearances from the floodwall to the building. It shall be recognized in the drainage provisions that substantial amounts of leakage may occur through the interlock of a steel sheet piling wall. Adequate expansion and contraction joints shall be provided in the walls. Expansion joints will be provided for all changes in wall direction. Contraction and expansion joints in concrete walls shall be provided with waterstops and joint sealing material both in the stem and in the base. Steel sheet piling walls may be encased in concrete for corrosion protection or shall be coated with a coal tar epoxy coating system and periodically inspected and maintained. Steel sheet piling walls may be used as the impervious core of a dike.

CHAPTER 7

CLOSURE OF OPENINGS

SECTION 700.0 SCOPE

Sec. 700.1 GENERAL: Openings in exterior and interior walls of buildings or structures in a Flood Hazard Area which are wholly or in part below the RFD shall be provided with waterproof closures meeting the requirements of this chapter.

SECTION 701.0 TYPES OF CLOSURES

Sec. 701.1 CLASSIFICATION: Closures shall be classified into five types according to their compatibility with the the waterproofing standards of the various flood-proofing classes.

Sec. 701.1.1 Type 1 Closures – shall form a complete sealed barrier over the opening that is impermeable to the passage of water at the full hydrostatic pressure of a flood to the RFD.

Sec. 701.1.2 Type 2 Closures – shall form essentially dry barriers or seals, allowing only slight seepage during the hydrostatic pressure conditions of flooding to the RFD.

Sec. 701.1.3 Type 3 Closures – shall form barriers or seals that are impermeable to the passage of water-borne contamination under equalized pressure conditions.

Sec. 701.1.4 Type 4 Closures – shall form barriers to the passage of flood carried debris and the loss of floating items from the interior, but are not required to form impermeable seals.

Sec. 701.1.5 Type 5 Closures – are those of existing spaces which do not meet the requirements of any of the above described types, but are in use as required by "The Building Code".

SECTION 702.0 REQUIREMENTS

Sec. 702.1 DESIGN STANDARDS FOR CLOSURE ASSEMBLIES: The structural capacity of all closures shall be adequate to support all flood loads acting upon its surface. Closure assemblies may be fabricated of cast iron, steel, aluminum, or other adequate and durable structural material, provided with a continuous support around its perimeter, and shall be attached to the building or structure at its immediate location of use i.e.; hinged, on slides, or in a vertical recess. The closure device shall be capable of being set in place with minimal manual effort. Seals, where required, shall be gasketed pressure types permanently anchored or attached to the structure or to the closure assembly. Closures designed to lift into vertical recesses for storage when not in use, and/or located so that the open position of the assembly will not impede fire exit or the functioning of fire closure assembly, shall be supported in the open position by auxiliary supports or safety latches that can be released at times of flooding. In the closed position the closure assembly shall engage fixed wedging blocks that will force the closure into a tight sealing position. The entire closure assembly should be inspected by the owner annually and suitably maintained to preserve its waterproof and structural quality, or be replaced as required.

Sec. 702.2 FRAMES FOR OPENINGS: Each opening below the RFD shall have a metal frame suitable for providing an adequate sealing surface and for supporting the flood-proofing closure assembly. The frame shall be connected

to the adjacent walls and floors and provide adequate bearing surface and anchorage to transfer the panel loading into the wall. It shall be supported upon adjacent floor or wall intersections or sufficient reinforcement shall be provided around the opening in the concrete or masonry wall to transfer the panel load to such intersections as required.

Sec. 702.3 OPENINGS IN SHAFTS: All buildings or structures which have inclosing walls, decks, or shafts with horizontal or inclined openings at the top that are at or below the RFD and which would inundate W1 or W2 spaces shall be provided with Type 1 closure assemblies that can be readily positioned and secured to prevent entrance of flood waters. Construction of such openings shall provide for permanently affixed doors, wall extensions, gates, panels, etc., that are either hinged or on slide tracks to facilitate prompt and positive sealing of opening with only minimal manual effort. Windows, grilles, vents, door openings, etc. in the side walls of a shaft and below the RFD shall be provided with flood-proofing closures meeting the requirements of 701.0.

Sec. 702.4 FIRE RESISTIVITY OF CLOSURE ASSEMBLIES: All flood-proofing closure assemblies shall have a fire resistive rating that conforms to the requirements of "The Building Code" and the particular fire protection requirements for the occupancy group and building type of the structure.

SECTION 703.0 SPECIAL APPLICATIONS OF CLOSURE ASSEMBLIES

Sec. 703.1 APPLICABILITY: Residences, firms, businesses or institutions with fewer than 10 permanent employees; or spaces which are or would be unoccupied and unattended in their foreseeable normal operation for periods of greater than 72 hours shall not have any window, doorway, or other such opening any part of which is below the RFD unless at least one of the following conditions is met:

(1) Type 1 and 2 closures are utilized and are fully automatic types.

(2) Manually installed closure devices meeting requirements of the appropriate flood-proofing class are provided and are installed in their protective position by the Owner at any time in the season of high flood danger during which the space will be unoccupied and unattended for periods of longer than eight (8) hours. This requirement shall be considered in the Owner's Contingency Plan and noted by the Building Official on the permit and Certificate of Occupancy.

(3) Watertight exterior walls, dikes, levees or floodwalls of adequate design (as specified in Chapter 6) are constructed to prevent flood waters up to the RFD from entering the structure or space.

CHAPTER 8

INTERNAL FLOODING AND DRAINAGE

SECTION 800.0 SCOPE

Sec. 800.1 GENERAL: The provisions of this chapter shall apply to the intentional flooding of buildings, structures, and spaces with water from potable or flood water sources for the purpose of balancing internal and external pressures to protect a structure and/or its components from damage or failure during floods up to the RFD.

SECTION 801.0 INTENTIONAL FLOODING WITH POTABLE WATER

Sec. 801.1 APPLICABILITY: Spaces to be intentionally flooded (W3 spaces) to maintain a balanced internal and external pressure condition shall be filled automatically with potable water from a source provided by the Owner as required by 801.2 and approved by the Building Official. This level of filling shall be equal to that of the external flood surface unless a reduction in the internal flooding level is requested in writing by the Owner, and such approval is granted by the Building Official. The Owner shall, together with the written request, submit sufficient evidence that full internal flooding is unnecessary to protect the structure. The potable water flooding system shall activate and operate automatically and completely without human intervention and shall act independently of the emergency flooding system utilizing flood waters as required for these spaces by 801.3. An automatic drainage system shall also be provided that will assure positive drainage of the space(s) at a rate comparable to the reduction of exterior flood height when flood waters are receding.

Sec. 801.2 POTABLE WATER SOURCES: At any location where disruption of water supply service from a public utility may occur, or such service may be deemed inadequate, the Building Official shall require the Owner to provide an independent source of potable water that will be stored at the location of the improvement. In areas with a history of multiple cresting, the Building Official may require that the supply of stored water be increased by a specified amount to cover this condition.

Sec. 801.3 SAFEGUARD AGAINST FAILURE OF POTABLE WATER FLOODING SYSTEM: Where intentional flooding with a potable water flooding system is used for maintaining the structural integrity of buildings, structures or spaces during flood events to the RFD, an emergency (back up) flooding system utilizing flood waters shall be provided and maintained in a state of readiness for automatic implementation in event of failure of the primary potable water flooding system. The emergency flooding system shall comply with all requirements of 802.0.

SECTION 802.0 AUTOMATIC FLOODING WITH FLOOD WATER

Sec. 802.1 APPLICABILITY: Spaces to be intentionally flooded with flood water (W4) shall be provided with the necessary equipment, devices, piping, controls, etc. necessary for automatic flooding during the flood event and drainage of the space(s) when flood waters recede. The automatic flooding and drainage system(s) shall utilize approved piping materials and have sufficient capacity for raising or lowering the internal water level at a rate comparable to the anticipated rate of rise and fall of a flood that would reach the RFD. These pipe systems shall be directly connected to the external flood waters to maintain a balanced internal and external water pressure condition. Provisions shall be made for filling the lower portions of the structure first and for interconnections through or around all floors and partitions to prevent unbalanced filling of chambers or parts within the structures. All spaces

below the RFD, shall be provided with air vents extending to at least _____ feet above the elevation of the RFD to prevent the trapping of air by the rising water surface. All openings to the filling and drainage systems shall be protected by screens or grills to prevent the entry or nesting of rodents or birds in the system.

SECTION 803.0 EMERGENCY FLOODING OF WATERPROOFED SPACES

Sec. 803.1 APPLICABILITY: Spaces which have been waterproofed (W1 or W2) to the RFD shall be provided with an automatic internal flooding system meeting all requirements of 802.0 to maintain structural integrity during floods which exceed the RFD elevation. Inverts shall be located at the RFD elevation unless an increase in invert elevation(s) above the RFD is requested in writing by the Owner, and approval is granted by the Building Official. Approvals shall not be granted by the Building Official until sufficient evidence has been furnished by the Owner that automatic internal flooding at the RFD elevation is not necessary to maintain structural integrity. Outlets for the drainage of water from water-proofed spaces shall be located properly to drain the water from all parts of the spaces. To prevent the inflow of water at flood levels below the RFD each exterior drainage outlet shall be provided with a device for preventing backflow of water (flood) through the drainage system. Auxiliary outlets shall be provided as required to evacuate all water from upper floor levels before draining the lower spaces. All watertight walls shall be designed for an internal hydrostatic pressure equal to at least two (2) feet of differential head to provide for unknown factors that may cause malfunction of the required drains.

CHAPTER 9

FLOORING

SECTION 900.0 SCOPE

Sec. 900.1 GENERAL: This chapter shall govern the design and use of floor systems and their constituent materials for buildings and structures located in a Flood Hazard Area.

Sec. 900.2 BASIS FOR RESTRICTION: Floor systems and flooring materials are restricted according to their vulnerability to flood water. For the purpose of these Regulations, vulnerability of a given floor or floor material may result from one or more of the following:

(1) Normal suspended-floor adhesives specified for above grade use are water-soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.

(2) Flooring material contains wood or paper products.

(3) Flooring material is not resistant to alkali or acid in water.

(4) Sheet type floor coverings (linoleum, rubber, vinyl) restrict evaporation from non-W1 slabs.

(5) Flooring material is impervious but dimensionally unstable.

SECTION 901.0 FLOORING CLASSIFICATIONS

Sec. 901.1 CLASSES OF FLOORING: Floor systems and flooring materials are divided into five classes according to their degree of vulnerability. Class 1 floorings require conditions of dryness provided by W1 spaces. Class 2 floors require essentially dry spaces which may be subject to water vapor and slight seepage that is characteristic of W2 spaces. Class 3 flooring may be submerged in clean water during periods of intentional flooding as provided by W3 spaces. Class 4 floorings may be exposed to and/or submerged in flood waters in interior spaces and do not require special waterproofing protection. Class 5 floors are permitted for semi-inclosed or outside uses with essentially unmitigated flood exposure.

Sec. 901.1.1: Floors of a given class may be used in any application for which a lower-numbered class is permitted by these Regulations unless specifically restricted by notation in the chart below. For example, concrete (a Class 5 floor) may be used whenever floors of Classes 1, 2, 3, 4, or 5 are permitted.

Sec. 901.1.2 CLASSES OF TYPICAL FLOORING MATERIALS: The following chart is intended as an aid to the Owner, Architect/Engineer and the Building Official in assessing the vulnerability of typical materials with respect to the criteria stated in 900.2 (1-5). In disputes arising over the merits of particular materials or methods of construction, the Building Official shall be guided by and decided on the basis of those criteria.

	Class
Asphalt tiles (A)	1
with asphaltic adhesives	3
Carpeting (glued-down types)	1

	Class
Cement/bitumenous, formed-in-place	4
Cement/latex, formed-in-place	4
Ceramic tiles (A)	1
with acid and alkali-resistant grout	3
Chipboard	1
Clay tile	5
Concrete, precast or in situ	5
Concrete tile	5
Cork	1
Enamel felt-base floor coverings	1
Epoxy, formed-in-place	5
Linoleum	1
Magnesite (magnesium oxychloride)	1
Mastic felt-base flood coverings	1
Mastic flooring, formed-in-place	5
Polyurethane, formed-in-place	5
PVA emulsion cement	1
Rubber sheets (A)	1
with chemical-set adhesives (B)	5*
Rubber tiles (A)	1
with chemical-set adhesives (B)	4
Silicone floors, formed-in-place	5
Terrazzo	4
Vinyl sheets (homogeneous) (A)	1
with chemical-set adhesives (B)	5*
Vinyl tile (homogeneous) (A)	1
with chemical-set adhesives (B)	4
Vinyl tile or sheets (coated on cork or wood product backings)	1
Vinyl-asbestos tiles (semi-flexible vinyl) (A)	1
with asphaltic adhesives	4
Wood flooring or underlayments	1
Wood composition blocks, laid in cement mortar	2
Wood composition blocks, dipped and laid in hot pitch or bitumen	2

*Not permitted as Class 2 flooring

Notes: (A) Using normally-specified suspended floor (i.e., above-grade) adhesives, including sulfite liquor (lignin or "linoleum paste"), rubber/Asphaltic dispersions, or "alcohol" type resinous adhesives (cumar, oleoresinous).

(B) e.g. epoxy - polyamide adhesives or latex-hydraulic cement.

CHAPTER 10

WALLS AND CEILINGS

SECTION 1000.0 SCOPE

Sec. 1000.1 GENERAL: This chapter shall govern the design and use of wall and ceiling systems and their constituent materials for buildings and structures located in a Flood Hazard Area.

Sec. 1000.2 BASIS FOR RESTRICTION: Materials treated in this chapter are those which constitute interior walls and ceilings including their finishes and structural constructions upon which they depend such as sheathing and insulation, and are restricted according to their susceptibility to flood damage. For the purpose of these Regulations, susceptibility of a given interior material or construction is dependent on one or more of the following:

(1) Normal adhesives specified for above-grade use are water-soluble or are not resistant to alkali or acid in water, including ground seepage and vapor.

(2) Wall or ceiling material contains wood, wood products, gypsum products, or other material which dissolves or deteriorates, loses structural integrity, or is adversely affected by water.

(3) Wall or ceiling material is not resistant to alkali or acid in water.

(4) Material is impervious but dimensionally unstable.

(5) Materials absorb or retain water excessively after submergence.

SECTION 1001.0 WALL/CEILING CLASSIFICATIONS

Sec. 1001.1 CLASSES OF WALL/CEILING: Wall and ceiling systems and materials are divided into five classes according to the degree of vulnerability. Class 1 materials require conditions of dryness provided by W1 spaces. Class 2 materials require essentially dry spaces which may be subject to water vapor and slight seepage that is characteristic of W2 spaces. Class 3 wall and ceiling materials may be submerged in clean water during periods of intentional flooding as provided by W3 spaces. Class 4 materials may be exposed to and/or submerged in flood waters in interior spaces and do not require special waterproofing treatments or protection. Class 5 wall and ceiling materials are permitted for semi-inclosed or outside uses with essentially unmitigated flood exposure.

Sec. 1001.1.1: Materials of a given class may be used in any application for which a lower-numbered class is permitted by these Regulations. For example, concrete (a Class 5 wall/ceiling material) may be used whenever materials of Classes 1, 2, 3, 4, or 5 are permitted.

Sec. 1001.2 CLASSES OF TYPICAL WALL/CEILING MATERIALS: The following chart is intended as an aid to the Owner, Architect/Engineer and the Building Official in assessing the vulnerability of typical materials with respect to the criteria stated in 1000.2 (1-5). In disputes arising over the merits of particular products or of materials not listed below, the Building Official shall be guided by and decide on the basis of those criteria.

	Class
Asbestos-cement board	5
Brick, face or glazed	5
common	2
Cabinets, built in	
Wood	2
Metal	5
Cast stone (in waterproof mortar)	5
Chalkboards	
Slate, porcelainglass, nucite glass	5
Cement-asbestos	2
Composition, painted	2
Chipboard	1
Exterior Sheathing Grade	2
Clay tile	
Structural glazed	5
Ceramic veneer, ceramic wall tile-mortar set	4
Ceramic veneer, organic adhesives	2
Concrete	5
Concrete block	5
Corkboard	2
Doors	
Wood hollow	2
Wood, light weight panel construction	2
Wood, solid	2
Metal, hollow	5
Metal, Kalamein	2
Fiberboard panels, Vegetable types	
Sheathing grade (asphalt coated or impregnated)	2
Otherwise	1
Gypsum products	
Gypsum board	2
Keene's cement on plaster	2
Plaster, otherwise, including acoustical	2
Sheathing panels, exterior grade	2
Glass (sheets, colored tiles, panels)	4
Glass blocks	5
Hardboard	
Tempered, enamel or plastic coated	2
All other types	2
Insulation	
Foam or closed cell types	4
Batt or blanket types	1
All other types	2
Metals, non-ferrous (aluminum, copper or zinc tiles)	3
Ferrous	5
Mineral fiberboard	1
Plastic wall tiles (polystyrene, urea formaldehyde, etc.) with waterproof adhesives, pointed with waterproof grout	3

	Class
Set in water-soluble adhesives	2
Paint	
Polyester-epoxy and other waterproof types	4
All other types	1
Paperboard	1
Partitions, folding	
Metal	4
Wood	2
Fabric-covered types	1
Partitions, stationary	
Wood frame	4
Metal	5
Glass, unreinforced	4
Reinforced	4
Gypsum, solid or block	1
Rubber, mouldings and trim with epoxy-polyamide adhesive or latex-hydraulic cement	4
All other applications	1
Steel, (panels, trim, tile) with waterproof applications	5
With non-waterproof adhesives	2
Stone, natural solid or veneer, waterproof grout	5
Stone, artificial non-absorbent solid or veneer, waterproof grout	5
All other applications	2
Strawboard	
Exterior grade (asphalt-impregnated kraft paper)	2
All other types	1
Wall coverings	
Paper, burlap, cloth types	1
Wood	
Solid (boards, sheets, or trim)	2
Plywood	
Exterior grade	2
Otherwise	1

CHAPTER 11

CONTENTS OF BUILDINGS AND STRUCTURES

SECTION 1100.0 SCOPE

Sec. 1100.1 GENERAL: This chapter shall govern the types of contents permitted and protection requirements for contents of spaces in buildings or structures located in the Flood Hazard Area(s).

Sec. 1100.1.1: The contents of an improvement consists of all items situated or placed within the confines of a space not permanently and structurally integral with the improvement. Electrical and mechanical equipment that is installed as a building services feature and/or required to be in operation during a flood is covered in Chapters 12 and 13. Contents are restricted by these Regulations whenever they are or potentially may be:

(1) Hazardous to the general public welfare due to the possibility of spreading highly flammable, explosive, corrosive, or otherwise harmful substances in the event of a flood-induced spill.

(2) Hazardous to the welfare of other Owners due to the creation of projectiles which could cause damage by impact.

(3) Hazardous as in (1) or (2) above when stockpiled in quantity, although such items may be permitted if stored in lesser amounts for isolated or occasional use.

(4) Hazardous to the health or safety of the Owner or to other persons occupying or in the vicinity of the improvement due to the possibility of explosion or electric shock caused by flood water contact with operating mechanical or electrical equipment.

(5) Vulnerable as a loss to the Owner, necessitating replacement, extensive repair, and/or excessive period of inoperation resulting from prolonged exposure to moisture, clean water, flood water, or the unmitigated effects of flooding.

SECTION 1101.0 CLASSES OF CONTENTS

Sec. 1101.1 APPLICABILITY: Contents are divided into seven classes according to the degree of flood-proofing required to protect them from becoming hazards or losses as defined above.

(1) **Class XX** items are extremely hazardous or vulnerable to flood conditions and require their prohibition in the Flood Hazard Areas at all times.

(2) **Class X** items are sufficiently hazardous or vulnerable to require their prohibition in all spaces below the RFD, i.e., requiring their placement at least one floor level above the RFD.

(3) **Class 1** items require the protection assured by W1 spaces.

(4) **Class 2** items require the protection assured by W2 spaces.

(5) **Class 3** items require only the protection assured by W3 spaces.

(6) **Class 4** items are generally not damageable by flood waters moving at low velocities and require the minimum protection given by W4 spaces.

(7) **Class 5** items are sufficiently non-hazardous and non-vulnerable to permit their placement in spaces exposed to unmitigated flooding conditions.

Sec. 1101.2 WAIVER OF RESTRICTION: Upon approval of the Owner's Contingency Plan, which shall include plans for temporary movement of items to a place of safe refuge above the RFD or in spaces below the RFD where these items are permitted, the Building Official may waive specific content restrictions for non-W1 spaces on non-hazardous items that are movable or for which the degree of water-proofing required by the flood-proofing class can be achieved upon receipt of a flood warning or alert. This waiver of restriction, however, shall not apply to residences and their ancillary spaces; to firms, businesses, or institutions with fewer than 10 permanent employees and their ancillary spaces; or to any spaces which are or would be unoccupied and unattended in their foreseeable normal yearly operation for periods greater than 72 hours; and in no case shall a waiver of restriction be construed to permit the creation of spaces for human habitation.

Sec. 1101.3 CONTENTS CLASSES FOR TYPICAL ITEMS: The following chart is intended as an aid to the Owner, Architect/Engineer, and the Building Official in assessing the hazard potential and vulnerability to loss of typical contents of an improvement with respect to criteria listed in 1100.1.1 (1-5). In disputes arising over the classification of particular items or of items not listed below, the Building Official shall be guided by and decide on the basis of those criteria. In no case, however, shall changes of classification for items listed in Classes X and XX be permitted.

Sec. 1101.3.1: Contents of a given class may be situated or placed in any space for which a lower-numbered contents class is permitted by these Regulations. For example, items which are listed in Class 3 may also be placed in any spaces in which Class 1 or Class 2 contents are permitted.

Sec. 1101.3.2: Temporary placement of items of a given contents class in a space with a higher-numbered flood-proofing class may be permitted in those cases where contingent removal is approved by the Building Official, and in conformance with 1101.2. Temporary placement may be permitted for certain items, subject further to the restrictions of 1101.2 as indicated by numbers in parenthesis in the list; in each case the number in parenthesis is that of the highest-numbered flood-proofing class in which temporary placement may be considered.

	Class
Acetone	XX
Acetylene gas containers	X
Ammonia	XX
Animals (pets, livestock, laboratory specimens)	X(5)
Appliances, electrical	
Washer-dryers, unit air conditioners, lamps refrigerators, sewing machines, electric clocks, etc.	2
Art works (paintings, sculpture, etc.)	1
Barrels, bouyant (empty or non-hazardous contents)	2
Constrained and/or without tops or lids	4
Benzene	XX
Books, magazines, publications	1(3)
Cabinets,	
Solid wood or veneer	2
Metal	4
Calcium carbide	XX

	Class
Carbon disulfide	XX
Cardboard boxes	1
Carpeting and floor rugs	1(3)
Celluloid	XX
Chlorine	XX
Clothing	2(3)
Cotton (loose) wadding or waste	2
Curtains and drapes	
Fabric (Non-Fast Dyes)	2
Fabric (Fast Dyes)	3
Plastics	4
Drugs - in quantity	X
Electrical distribution equipment (Storage only)	
Waterproof or submersible types	4
Non-waterproof	2
Protected contingently (B)	4
Electronic equipment (Storage only)	
Television, stereo equipment, radios	2(3)
Computers, etc.	1
Fabrics (Textile Raw Materials)	
Non-water-soluble dyes	3
Otherwise	2
Food Products	X
Furniture	
Upholstered	1
Unupholstered	
Wood construction (A)	2
Metal construction, painted	4
Gasoline	X
Hydrochloric acid	XX
Hydrocyanic (Prussic) acid	XX
Magnesium	XX
Matches and sulfur products (in quantity)	X
Mattresses & box springs	1(2)
Musical instruments	
Pianos, organs, violins, etc.	1
All other types	2(3)
Nitric acid, oxides of nitrogen	XX
Oxygen	2(3)
Paints, enamels, varnishes (in quantity)	2
Paper or paper products	1
Petroleum products storage	
(unless buried and constrained)	X
Phosphorous	XX
Potassium	XX
Recreation equipment	
Sports gear, toys	2(3)
Pool tables	1

	Class
Scrap metal, constrained	5
Soaps, detergents (in quantity)	X
Sodium	XX
Sulphur	XX
Tires (Open storage)	X
constrained	4
Wood products, raw or finished (in quantity)	X

Notes: (A) Solid wood construction with pinned joints, reinforced corners, and lacquered or factory-baked finishes.

(B) Contingent protection shall be protection equal to that of 6 mils of polyethylene sealed to be water-tight or "moth-balled".

CHAPTER 12

ELECTRICAL

SECTION 1200.0 SCOPE

Sec. 1200.1 GENERAL: Where buildings or parts of buildings and structures extend below the RFD, the electrical materials, equipment and installation shall conform to the requirements of this section of the Regulations.

SECTION 1201.0 REQUIREMENTS AT LOCATIONS ABOVE AND BELOW THE RFD

Sec. 1201.1 MAIN POWER SERVICE: The incoming main commercial power service equipment, including all metering equipment, shall be located above the RFD. Whenever a building or structure is not accessible by a bridge, walkway or other connecting means except by boat during periods of flooding to the RFD, a disconnecting means for the incoming main commercial power service shall be provided at an accessible remote location above the RFD.

Sec. 1201.2 STATIONARY AND PORTABLE EQUIPMENT: Switchgear, control centers, transformers, distribution and main lighting panels in addition to all other stationary equipment shall be located above the RFD. Portable or movable electrical equipment may be located in any space below the RFD provided that equipment can be disconnected by a single plug and socket assembly of the submersible type and rated by the manufacturer as submersible for not less than 72 hours for the head of water above the assembly to the RFD. All disconnect assemblies shall be provided with submersible seals attached to the disconnect assembly by means of a corrosion resistant metal chain for immediate use when needed to insure safety to all personnel during a flood. All portable or movable equipment should be de-energized and/or moved out of potentially flooded spaces at time of flood warning and prior to flood waters reaching floor levels where such equipment is located.

Sec. 1201.3 NORMAL AND EMERGENCY LIGHTING CIRCUITS: All circuits except emergency lighting circuits, extending into areas below the RFD shall be energized from a common distribution panel located above the RFD. All emergency lighting circuits into areas below the RFD shall be energized from an independent distribution panel also located above the RFD. Each distribution panel shall have the capability of being de-energized by a separate single disconnecting device.

Sec. 1201.4 EMERGENCY LIGHTING REQUIREMENTS: All areas of the building or structure that are below the RFD, where personnel may be required to conduct emergency operations or work with water present on the floor of the area during a flood, shall be provided with automatically operated emergency lighting facilities and automatically operated electrical disconnect equipment to insure that all electrical circuits into these areas, except emergency lighting circuits, are de-energized prior to personnel working in water. The electrical circuits shall be de-energized prior to the presence of any water on the floor of the affected area. All components of emergency lighting systems installed below the RFD shall be so located that no component of the emergency lighting system is within reach of personnel working at floor level in the areas where emergency lighting systems are utilized unless the emergency lighting circuits are provided with ground-fault circuit interrupters having a maximum leakage current to ground sensitivity of five (5) milliamperes. The energy for emergency lighting may be furnished by a storage battery(s), prime mover-generator system, a separate commercial power supply system, the same commercial power system, or a combination thereof, subject to the following provisions of this section.

Sec. 1201.4.1 STORAGE BATTERY (including battery operated lighting units): Battery operated lighting units shall be completely self contained and shall indicate the state of charge of the battery at all times. Lighting units shall automatically provide light when the normal source of lighting in the areas is de-energized. Sufficient number of

emergency lighting units shall be provided to enable personnel to perform their assigned emergency tasks and to permit a safe exit to areas above the RFD.

Sec. 1201.4.2 SEPARATE COMMERCIAL POWER SUPPLY SYSTEM: This source of energy shall have a degree of reliability satisfactory to the Building Official. A system fed from a substation other than that used for the regular supply and not on the same poles (except service pole) as the regular supply is deemed to have the required degree of reliability. A secondary circuit fed from the same primary network circuit as the regular supply shall be regarded as a separate system.

Sec. 1201.4.3 SAME COMMERCIAL POWER SUPPLY SYSTEM: The system shall be an underground secondary network system and a separate service shall be connected on the line side of the service switch or breaker of the regular service.

Sec. 1201.5 LIGHTING CIRCUITS BELOW REGULATORY FLOOD DATUM: Lighting circuit switches, receptacles and lighting fixtures operating at a maximum voltage of 120 volts to ground may be installed below the RFD, provided that these circuits shall be de-energized as noted in 1201.4. Should any switch, receptacle or lighting fixture be flooded, its particular circuit shall not be re-energized until such circuits and devices, and/or any part thereof, have been disassembled and thoroughly checked, cleaned or replaced, and approved for use by qualified personnel.

Sec. 1201.6 SUBMERSIBLE EQUIPMENT: Except for the switches, receptacles and lighting fixtures noted herein, all other electrical equipment permanently installed below the RFD shall be of the submersible type rated by the manufacturer for submergence for not less than 72 hours for a head of water above the equipment to the RFD.

Sec. 1201.7 SUBMERSIBLE WIRING REQUIREMENTS: All electrical wiring system[illegible] the RFD shall be suitable for continuous submergence in water and shall contain no fibrous components. Only submersible type splices will be permitted in areas below the RFD. All conduits located below the RFD shall be so installed that they will be self draining if subject to flooding conditions.

Sec. 1201.8 ELEVATORS: All electric power equipment and components of elevator systems shall be located above the RFD. Automatic type elevators shall be provided with a home station to which the elevator will automatically return after use, with home station located above the RFD.

Sec. 1201.9 ELECTRIC HEATING EQUIPMENT: Electric unit heaters installed below the RFD shall be capable of disconnection and removal in the manner described for portable electrical equipment in 1201.2. Electric controls on gas and oil furnaces located below the RFD shall not exceed 120 volts to ground and the control circuits shall be automatically de-energized prior to the presence of any water on the floor of the affected area in accordance with 1201.4.

Sec. 1201.10 SUMP PUMP INSTALLATION: Buildings and structures utilizing sump pumping equipment of any type to keep areas within the structure free of water shall be provided with float operated warning alarms that shall act independently of any other float actuating devices used to start and stop pumping equipment. All buildings or structures utilizing sump pumping equipment shall be provided with automatic starting standby electrical generating equipment located above the RFD. The standby generating equipment shall be capable of remaining in continuous operation for a period of 125% of the anticipated duration of the design flood.

CHAPTER 13

MECHANICAL

SECTION 1300.0 SCOPE

Sec. 1300.1 GENERAL: All mechanical systems, including heating, air conditioning, ventilating, plumbing, sanitary, and water systems, in or serving buildings or structures in a Flood Hazard Area shall be designed and installed to comply with the requirements of this chapter.

SECTION 1301.0 HEATING, AIR CONDITIONING AND VENTILATION SYSTEMS

Sec. 1301.1 APPLICABILITY: Heating, air conditioning, and ventilation systems, including all appurtenances, in buildings or structures in a Flood Hazard Area shall be designed and installed to comply with the requirements of these Regulations.

Sec. 1301.2 LOCATION: Heating, Air Conditioning, and Ventilating Equipment should, to the maximum extent possible, be installed in areas and spaces of buildings that are above the RFD. When not feasible, said equipment shall be located in W1 or W2 spaces (below the RFD) with direct access provided from a location above the RFD, and shall conform to all requirements of this Section.

Sec. 1301.2.1 Heating systems utilizing gas or oil fired furnaces shall have a float operated automatic control valve installed in the fuel supply line which shall be set to operate when flood waters reach an elevation equal to the floor level of the space where furnace equipment is installed. A manually operated gate valve that can be operated from a location above the RFD shall be provided in the fuel supply line to serve as a supplementary safety provision for fuel cutoff. The heating equipment and fuel storage tanks shall be mounted on and securely anchored to a foundation pad or pads of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. As an alternate means of protection, elevation of heating equipment and fuel storage tanks above the RFD on platforms or by suspension from overhead structural systems will be permitted. All unfired pressure vessels will be accorded similar treatment. Fuel lines shall be attached to furnaces by means of flexible or swing type couplings. All heating equipment and fuel storage tanks shall be vented to an elevation of at least _____ feet above the RFD. Air supply for combustion shall be furnished if required for systems installed in W1 or W2 spaces, and piping or duct work for such purpose shall be terminated at least _____ feet above the RFD.

Sec. 1301.2.1.1: All duct work for warm air heating systems which is located below the RFD shall be provided with emergency openings for internal flooding and drainage of the ducts with all openings having covers with gravity operators for closure during normal operation. Where duct work must pass through a water-tight wall or floor below the RFD, the duct work shall be protected by a mechanically operated closure assembly and shall be provided with the operator control position above the RFD. The closure assembly in its open position shall not impede the normal function of the heating system.

Sec. 1301.2.1.2: Steam or hot water heating pipes located below the RFD, shall be provided with shut-off valves sufficient to isolate the piping system when warning of flooding to the RFD is received.

Sec. 1301.2.1.3: Electric heating systems, where utilized in Flood Hazard Areas, shall be installed in accordance with requirements of Chapter 12.

Sec. 1301.2.2: Air conditioning and ventilation systems that will be located below the RFD shall be installed in W1 or W2 spaces only. All installation, piping, duct work, connections, and safety features shall conform to the same requirements stated for Heating Systems in 1301.2.1.

Sec. 1301.2.3: Where heating, air conditioning, or ventilating systems (as defined in 1301.2) are installed in other than W1 or W2 spaces, all bearings, seals, shafts, gears, clutches, valves, or controls which are not capable of withstanding water or silt damage or hydrostatic or hydrodynamic loading shall be provided with suitable protective waterproofing enclosures as may be required by the Building Official, unless they are considered expendable.

Sec. 1301.2.4: All fuel supply lines that originate either outside of W1 or W2 spaces or pass through areas that would be flooded, shall be equipped with automatic shut-off valves to prevent loss of fuel in the event of a line breakage. The wall opening shall be made flood-proof by use of imbedded collars, sleeves, waterstops, or other means as may be approved by the Building Official.

Sec. 1301.2.5: Electrical connections to all mechanical systems covered by this chapter shall conform to the requirements of Chapter 12.

SECTION 1302.0 PLUMBING SYSTEMS

Sec. 1302.1 **APPLICABILITY**: For the purpose of these Regulations, plumbing systems shall include sanitary and storm drainage, sanitary facilities, water supply, storm water and sewage disposal systems.

Sec. 1302.1.1: Except as otherwise provided herein, nothing in these Regulations shall require the removal, alteration, or abandonment of, nor prevent the continued use of, an existing plumbing system.

Sec. 1302.1.2: No plumbing work shall be commenced until a permit for such work has been issued by the Building Official. Application for plumbing permits, denial of permit, time limitation on permits, and inspections shall be in accordance with requirements of 205.0.

Sec. 1302.1.3: Plumbing materials shall be selected with due consideration given to the hydrostatic, hydrodynamic and chemical actions of flood waters on the interior of piping systems, of the soil, fill or other materials on the exterior of piping systems, on joints, connections, valves, traps, seals (and calking), and fixtures.

Sec. 1302.2: **BELOW RFD**: Sanitary sewer and storm drainage systems that have openings below the RFD shall be provided with automatic back water valves or other automatic backflow devices that are installed in each discharge line passing through a building exterior wall. In W1 spaces, manually operated shut-off valves that can be operated from a location above the RFD shall also be installed in such lines to serve as a supplementary safety provision for preventing backflow in case of automatic backflow device failure or line break between the space(s) and the device.

Sec. 1302.2.1: Spaces in buildings that are to be protected from flood waters by implementation of the Owner's Contingency Plan may utilize standpipes attached to floor drains, cleanouts, and other openings below the RFD, and/or manually operated shut-off valves or closure devices.

Sec. 1302.2.2: Where the state of dryness of a space is dependent on a sump pump system, or where the stability of a structure during a flood event depends on the relief of up-lift pressures on building components, all interior storm water drainage or seepage, appliance drainage, and underslab drain tile systems shall be directly connected to a sump (pump) and discharged at an elevation at least ____feet above the RFD.

Sec. 1302.2.3: Sanitary sewer systems, including septic systems, that are required to remain in operation during a flood shall be provided with a sealed holding tank and the necessary isolation and diversion piping, pumps, ejectors and appurtenances required to prevent sewage discharge during the flood. The holding tank shall be sized for storage of at least 150% of the anticipated demand for the duration of a flood to the RFD.

Sec. 1302.2.3.1: All vents shall extend to an elevation of at least ___ feet above the RFD.

Sec. 1302.2.3.2: All pipe openings through walls below the RFD shall be flood-proofed to prevent flood water backflow through spaces between pipes and wall construction materials. (See 1301.2.4).

Sec. 1302.3 **SEWAGE DISPOSAL/TREATMENT**: Individual sewage disposal and/or treatment facilities, except for cesspools and seepage pits, will be permitted in a Flood Hazard Area but only at locations where connection with a public sewer system is not possible or feasible. The design of such systems shall take into consideration their location with respect to wells or other sources of water supply, topography, water table, soil characteristics, available area for improvements, and the effects of flooding to the RFD. Installations in low swampy areas or areas with generally high water tables or which may be subject to periodic flooding will not be permitted.

Sec. 1302.3.1: Cesspools will not be permitted as permanent installations for sewage disposal, except that in those instances where connection to a public sewer system will be possible within a one (1) year period the Building Official may approve such an installation as a temporary expedient. The one (1) year period shall expire on the anniversary date of the written approval of the Building Official. Because of the public health hazard involved, extreme care shall be exercised in locating the cesspool. Under no circumstances shall a cesspool be located closer than 150 feet to a water supply well or be permitted to penetrate the ground water stratum.

Sec. 1302.3.2: Seepage pits shall, for purposes of these Regulations, conform to the same requirements set forth above for cesspools.

Sec. 1302.4 **WATER SUPPLY**: Potable water supply systems that are located in a Flood Hazard Area shall be designed and installed in such a manner as to prevent contamination from flood waters up to the RFD. No water supply well shall be located within the foundation walls of a building or structure used for human habitation, medical or educational services, food processing or public service type facilities.

Sec. 1302.4.1: Water supply wells, tanks, filters, softeners, heaters, and all appliances located below the RFD shall be protected against contamination by covers, walls, copings, or castings. All vents shall be extended to a minimum elevation of ____ feet above the RFD.

Sec. 1302.4.2: Approved backflow preventers or devices shall be installed on main water service lines at water wells and at all building entry locations to protect the system from backflow or back siphonage of flood waters or other contaminants in the event of a line break. Devices shall be installed at accessible locations and shall be maintained in good working condition by the person (s) responsible for maintenance of the water supply system.

Sec. 1302.4.3: Individual water supply wells that are utilized in Flood Hazard Areas shall be of either the drilled or driven type and located at a site slightly higher than surrounding ground levels to assure positive drainage from the well.

Sec. 1302.4.3.1: Private potable water well supplies shall not be developed from a water table located less than 25 feet below the ground surface, nor from any deeper supply which may be polluted by contamination entering through fissured or crevice formations.

Sec. 1302.4.3.2: Each well shall be provided with a water tight casing to a distance of at least 25 feet below the ground surface and shall extend at least one (1) foot above the well platform. Casings shall be large enough to permit installations of a separate drop pipe with a watertight seal between the drop pipe and the casing. Casings shall be sealed at the bottom in an impermeable stratum or extend several feet into the water bearing stratum.

Sec. 1302.4.4: In the event that flood water contamination occurs in the water supply system, all potable water equipment, piping, water storage tanks, etc. shall be disinfected in the manner prescribed by paragraph 10.9 of the National Plumbing Code.

CHAPTER 14

PROCEDURES

SECTION 1400.0 SCOPE

Sec. 1400.1 PURPOSE: The purpose of this chapter is to present and explain some practical aspects of flood-proofing and to show by means of examples and diagrams the effects of flood-related loads on structural elements of a building and other protective constructions. The structural elements discussed include concrete and masonry basement walls, concrete and masonry retaining walls, basement floor slabs, and closure panel assemblies. Also included are some concepts of foundation drainage, examples of floodwalls and dikes, and concepts of closure panels, devices and assemblies.

SECTION 1401.0 CRITICAL ASPECTS OF A FLOOD

Sec. 1401.1 GENERAL: No attempt is made here to provide an elaborate definition of the term flood nor to define a typical flood. Instead, critical aspects of a flood are listed below in the order of greatest importance as related to flood damages and their impact on flood-proofing measures.

Sec. 1401.2 DEPTH: Depth of flood waters around a structure is by far the most critical element to be considered in planning and designing flood-proofing measures. The depth of flood waters determines to a great extent the strength and stability requirements for the structure as a whole and for individual structural elements below the design flood level. Except for very special structures and for massive or very high buildings, it is assumed herein that the maximum practical flood depth for which flood-proofing measures are economically effective is 10 feet of free water above grade for a building or structure having a 10-foot space or basement height below grade.

Sec. 1401.3 VELOCITY: Velocity of flood water during overbank flow conditions affects scouring, sediment transportation, debris load, and dynamic loading on structures and obstructions. Flood velocities vary from point to point in a flood plain and over the area of inundation. From a practical standpoint, velocities up to five (5) feet per second are not uncommon or unusual and their effects on structures may be dealt with by application of normal design methods and procedures. Velocities up to 10 feet per second could occur, particularly in close proximity to the channel, but are believed to be unusual and to require special methods and techniques. A velocity of 10 feet per second is considered to be the upper limit for which flood-proofing measures are economically effective, except for special structures and facilities built at the edge of a channel, where permitted.

Sec. 1401.4 DURATION: The duration of a flood, as measured from the time the stream overflows its banks, reaches its crest elevation, and then recedes to within its banks, is important from the standpoint of saturation of soils and building materials, of seepage, achievement of full pressure in soils and under foundations, and other time dependent effects. In addition, the duration of the flood affects the provisions for standby utilities and services.

Sec. 1401.5 RATE OF RISE AND FALL: The rate of rise and fall of a flood to and from its crest affects the sizing of flooding and draining provisions, where such are required. It also affects in certain cases the implementation of contingent or emergency flood-proofing measures, and must be recognized in investigations of slope stability for a condition of quick drawdown.

Sec. 1401.6 ADVANCE WARNING: The length of advance warning available from flood forecasting is all-important, particularly in relation to contingent flood-proofing methods which require definite amounts of lead time for protective measures to be placed into effect.

Sec. 1401.7 DEBRIS LOAD: The amount and type of floating debris carried by the flood waters can result in substantial loads against buildings and structures and can cause blockages of channels and passageways. Debris load includes logs, tree branches and trees, lumber, displaced sections of frame structures, drains, tanks, and runaway boats and barges. One type of floating solids borne by flood waters which is predominant in certain areas of the country during early spring floods consists of broken up ice blocks and at times of large masses of broken up ice sheets. Ice blockage of channels or ice jams that frequently occur in certain areas contribute significantly to the flood hazard and related problems.

Sec. 1401.8 WAVE ACTION: A degree of wave action is inherent to all large expanses of water under the action of the wind. For typical riverine floods, wave action is nominal and allowances can be made for it by providing a suitable freeboard. Wave action is most significant for coastal floods which are caused by persistent storms, e.g. Nor'easters, tsunami waves or hurricanes. These cases are beyond the scope of the Flood-Proofing Regulations and require special design considerations and procedures.

SECTION 1402.0 FLOOD DAMAGES

Sec. 1402.1 GENERAL: Floods are a natural and inevitable part of life in communities along the rivers of our country. The transformation of tranquil rivers into destructive floods occurs hundreds of times each year. No part of the United States is spared. Every year, some 75,000 Americans are driven from their homes by floods. On the average, 80 persons are killed each year. These destructive overflows cause property damages that currently average $1 billion a year. Damages to property, human suffering, and loss of life resulting from floods have been increasing year by year in spite of the expenditure of over seven billion dollars for flood control works. The increase in flood damages has been due primarily to the rapid growth of flood damageable improvements in the flood plains of the rivers and seacoasts. No dollar values can be assigned to human suffering and loss of life caused by a flood. Flood damages to property can be assessed and are substantial. As a rule, damages increase rapidly with depth of flooding. Damages to a building and its contents, as they relate to damage to finishes, trimwork, furniture, appliances, equipment, and storage materials represent a substantial portion of the total loss. For the purpose of this publication however, major emphasis is placed on structural damage to the building or structure or to structural elements thereof, including complete collapse or displacement of the structure.

Sec. 1402.1.1: When flood waters reach a structure they induce unbalanced pressures and loadings on all wetted surfaces which increase rapidly with increased depth. Once interior spaces become flooded, water pressures are automatically equalized. Unbalanced lateral pressures on walls may cause excessive lateral displacement, cracking, tilting, sliding, on and up to complete collapse of the wall. These same pressures can cause overloading and failure of vertical and horizontal framing members of the structure into which the walls are framed. Uplift pressures under basement and floor slabs can displace and collapse the slabs. Saturation of soils on which footings are supported and uplift pressures under the footings and within the soil can greatly reduce the bearing capacity of the soil and cause the footing to become unstable and fail. Uplift pressures under raft or mat foundations with integral walls can cause the entire structure to become bouyant and displace vertically upward, or to become unstable and overturn. In this latter case, unbalanced lateral pressures are also often at work. Dry, checked wooden beams and other structural materials lose their strength, swell, and deflect excessively as they become water-logged. This can cause floors and partitions to settle and sag, frames to become distorted, and plaster walls and ceilings to crack. When the beams, for example, dry up and attempt to return to their original shape, they are prevented from doing so by settled floors and partitions above, and can fail or cause the failure or displacement of other supporting members. The following sections contain examples of structural elements of buildings investigated under hydrostatic loads related to flood waters.

SECTION 1403.0 LOADS

Sec. 1403.1 GENERAL: Flood waters surrounding a structure induce hydrostatic and hydrodynamic loads on the structure itself. Hydrostatic loads (pressures) are induced by water which is either stagnant or moving at low velocity. Hydrodynamic loads result from the flow of water against and around a structure at moderate or high velocities. Impact loads are imposed on the structure by water borne objects and their effects become greater as the velocity of flow and the weight of objects increase.

Sec. 1403.2 HYDROSTATIC LOADS: These loads or pressures, at any point of flood water contact with the structure, are equal in all directions and always act perpendicular to the surface on which they are applied. Pressures increase linearly with depth or "head" of water above the point under consideration. The summation of pressures over the surface under consideration represents the load acting on that surface. For structural analysis purposes, hydrostatic loads are defined to act *vertically downward* on structural elements such as roofs, decks and similar overhead members having a depth of water above them; *vertically upward* or in *uplift* when they act at the underside of generally horizontal members such as slabs and footings and the net effect is upward; *laterally* when they act in a horizontal direction on walls, piers, and similar vertical structural elements. For the purpose of these Regulations, it has been assumed that hydrostatic conditions prevail for still water and water moving with a velocity of less than five (5) feet per second. It is estimated that hydrodynamic effects up to the stated velocity can be conservatively recognized in the freeboard allowance.

Sec. 1403.3 HYDRODYNAMIC LOADS: As the flood waters flow around a structure at moderate to high velocities they impose additional loads on the structure. These loads consist of frontal impact by the mass of moving water against the projected width of the obstruction represented by the structure, drag effect along the sides of the structure and eddies or negative pressures on the downstream side. For the range of velocities discussed in 1401.3 (0-10 feet per second), it is considered most practical to make allowances for the hydrodynamic effects by converting them into an equivalent hydrostatic condition. For special structures, conditions, and for velocities greater than 10 feet per second, a more detailed analysis and evaluation should be made utilizing basic concepts of fluid mechanics and/or hydraulic models.

Sec. 1403.4 IMPACT LOADS: These loads are induced on the structure by solid objects and masses carried by or floating on the moving water surface. These loads are the most difficult to predict and define with any degree of accuracy, yet reasonable allowances must be made for these loads in the design of affected buildings and structures. To arrive at a realistic allowance, a great deal of judgment must be used, along with reliance on the designers experience with debris problems at the site, and consideration of the degree of exposure of the structure.

SECTION 1404.0 STRUCTURAL ELEMENTS

Sec. 1404.1 GENERAL: The following sections present a discussion of loading assumptions and design criteria for structural elements of buildings, such as basement and retaining walls, floor slabs and closure panels, under the effects of flood related loads. All the examples herein assume a "structurally" flood-proofed structure, (Classification W1 or W2 of the Regulations), where flood waters are prevented from reaching interior spaces and full imbalanced hydrostatic loads attain on the exterior of the structure. Secondary loading effects associated with flood waters, such as wave action, debris loads and hydrodynamic loads are not included in this discussion.

Sec. 1404.2 BASEMENT SLABS: Under flood conditions, and often under normal non-flood conditions in cases where conditions of high water table prevail, basement slabs may be subjected to high uplift pressures. To overcome this condition, the slab can be made thick enough to have sufficient weight to counteract the uplift pressures. This solution is very seldom economical.

Sec. 1404.2.1: For relatively large, heavy structures, a more economical solution would be to design thinner reinforced concrete slabs that are tied into the footings, walls and columns, such that the overall weight of the structure is utilized in resisting the uplift forces acting on the floor slabs. This type of construction would then provide the additional stability required to prevent flotation and overturning of the structure from other flood loads. The slab (commonly referred to as mat or raft type construction) must be capable of resisting all applied loads and distributed pressures, either when uplift pressures are acting at full intensity, as is the case during a flood, or when such loads are non-existent, as could be the case under normal condition. Integral slab construction can be utilized equally well for buildings supported on piles. In these cases, column and wall loads are supported by the piles, and the uplift pressures are transferred by the reinforced slab to the columns and walls so as to utilize the building loads (weight) as the downward resistive force.

Sec. 1404.2.2: In many cases, however, where uplift pressures are excessive, the most practical solution would be to relieve (or reduce) these uplift pressures under the slab by providing adequate and dependable drainage, combined where necessary with impervious blankets and cutoffs on the outside of the structure. Illustrations of foundation drainage methods that may be used for relief of uplift pressures are shown on Figure 5. Where it is found impractical to stabilize the slab and structure by one of the methods shown on Figure 5, or a combination thereof, it may be more expedient to anchor the slab and/or structure to the ground (and preferably to an underlying rock formation) or to provide the required protection by means of dikes, levees, retaining walls, or floodwalls.

Sec. 1404.3 **BASEMENT AND RETAINING WALLS**: Under normal or nonflood conditions, the primary loading on basement and retaining walls consists of lateral soil pressures caused by the backfill material. For selected granular backfills and normal heights of the wall, this load is relatively small. Other secondary or associated loads on walls are lateral loads resulting from surcharge conditions, loads resulting from frost action, and any vertical or other applied loads which the wall is intended to resist. Under flood conditions, by far the most significant load on a wall is that caused by lateral hydrostatic pressures. This load amounts to several times the intensity of the normal loads and as such will govern the strength and stability requirements for the wall. Provisions of backfill drainage are commonly used to reduce water pressure behind a wall and are known to be effective for ground water control if carefully designed, constructed and maintained. In the case of walls subject to flood loading, a reduction in water pressure behind the wall is not considered practical nor dependable. When an infinite source of water exists and free water stands above grade, the most efficient drainage provisions are likely to be inadequate. For cases where the wall is protected by impervious membranes, blankets and cutoffs, even a minimal rupture, separation or failure of the membrane or blanket, or cutoff, can cause the attainment of full hydrostatic pressures on the wall and cause failure of an inadequately designed wall.

Sec. 1404.4 **CLOSURE OF OPENINGS**: All exterior wall openings and other openings located below the RFD should be closed and sealed for effective flood protection. Existing structures shall be reviewed to assure that walls and supporting members can safely support the added pressures induced by closing the openings. Under no circumstances should a building be made watertight if the additional flood loads can not be satisfactorily transferred to the walls or supporting members. Closing the openings under these conditions may lead to a structural failure that could be much more serious than the damages resulting from unrestricted flooding. In designing new structures, all openings which are not necessary for proper functioning of the structure should be omitted, or at least kept to a minimum, both in number and size.

Sec. 1404.4.1: Openings should be provided with either permanent closures or closure assemblies that can be easily installed or positioned in an emergency flooding situation. Openings that are no longer necessary for building operation should be permanently closed and sealed. Permanent closures can be accomplished with reinforced concrete plugs, concrete masonry units, or metal assemblies that are keyed or anchored to the existing wall and supports. Additional support and strengthening may have to be provided to carry the additional loads from flood waters acting on the closure assemblies.

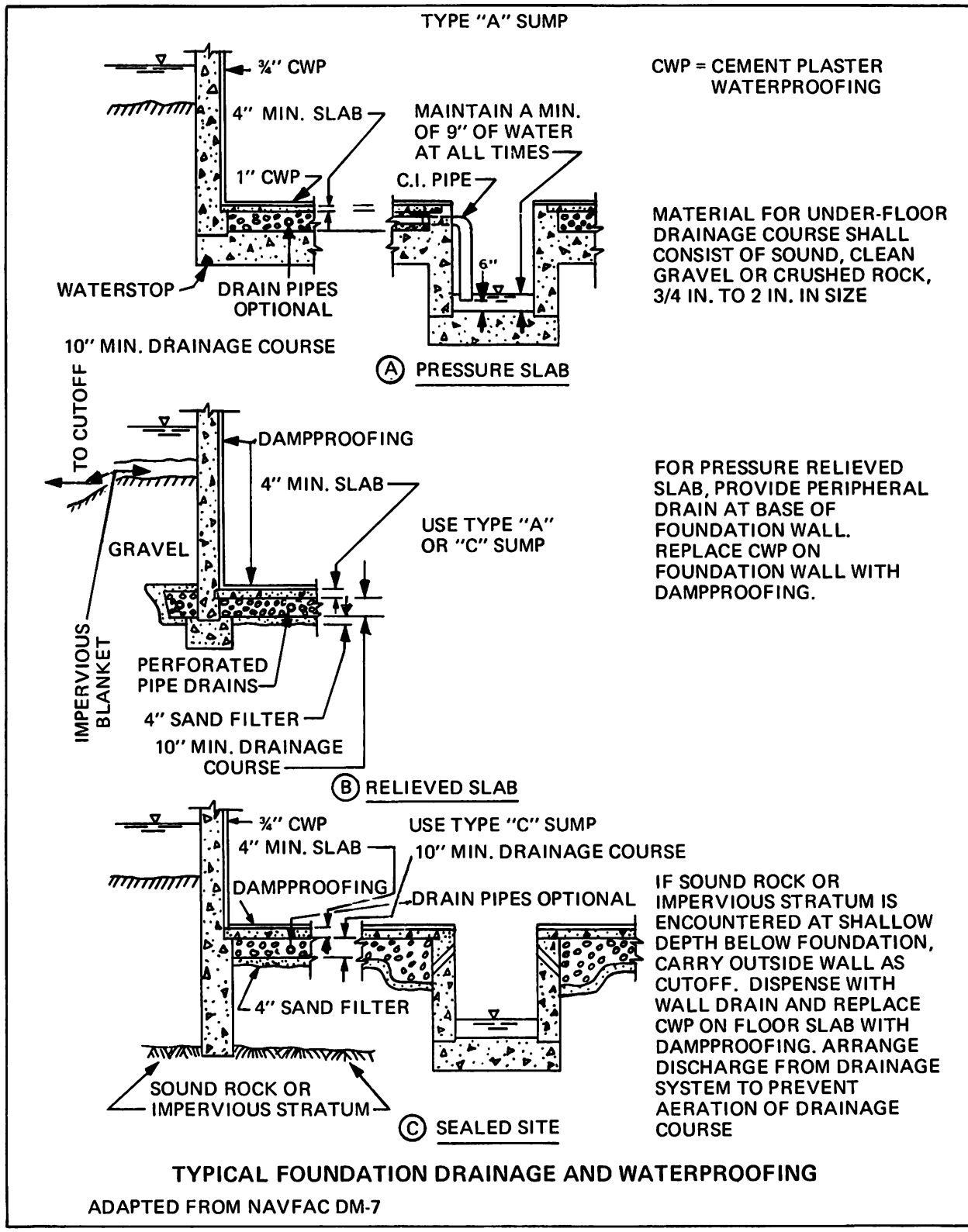


Figure 5

Sec. 1404.4.2: The closure or closure assembly must be designed for the full water pressure resulting from the heights calculated from the highest and lowest points of the closure to the RFD. Consideration must be given to loads resulting from debris impact and other loads as specified in these Regulations. The closure should be supported along at least three (3) edges and be capable of being secured around the opening perimeter by some self-acting means or latching devices. Bolting may be used as a means of securing the closure in place; however, it is recommended that such a procedure be avoided if at all possible and especially for closures at large and/or critical openings. A bolted type closure would generally require more lead time (flood warning) to assemble, transport, and install equipment held in storage, generally require trained personnel to affect the installation, and might well depend on the use of material handling equipment or additional personnel to handle large, heavy, or cumbersome closure panels or assemblies.

Sec. 1404.4.3: Whenever possible or required, the closure assembly should attach to a metal frame that surrounds the opening and be of sufficient width to provide an adequate watertight sealing surface. The frame may attach or be connected to the adjacent wall or supporting members or be constructed as an integral part thereof and be strong enough to transfer the closure loads to the building structural components without exceeding the allowable stresses. The walls are to be designed to transfer the loads to the building structural system and conform to the structural requirements of the Building Code. The seal may be attached to the closure door (panel, etc.) or sealing frame and with sealing to be achieved by applying pressure through bolting or latching of the closure or some other self-acting and positive means.

Sec. 1404.4.4: All closures, whenever possible, should be external to the opening, such that the water pressure helps in providing a continuous seal, thereby eliminating the need for extensive anchors, blocking and bolting, as would be required for reverse loading cases.

Sec. 1404.4.5: Horizontal closures should be designed to support the full weight of water above the closure assembly to the RFD. The closure should be supported and have a watertight seal along its entire perimeter. A frame with a smooth sealing surface and capable of transferring the load to the structure is to be provided.

Sec. 1404.4.6: Permanent closures of an opening may be accomplished by any structural means or system that would not require further actions during a flood. These closures may consist of walling an unneeded window, vent, chute, etc. with masonry units, reinforced concrete plugs, metal shields or other approved materials. All closure systems used shall provide the required protection to the RFD.

Sec. 1404.4.7: Closures for openings in existing structures that would have to be assembled and set in place in preparation for a flood would be classified as temporary or emergency flood-proofing closures. These openings are necessary for the continual operation of the building and their functions will be disrupted when the closures are set. Closures should be of metal construction and sized for easy and quick assembly and installation. Closure panels should be stored at a convenient location near the opening and should be properly marked and identified for each opening. Bolts, latches, and other equipment used to install the closures should be similarly stored and identified. Examples of emergency closures, are closures used to block doors, windows, vents, loading docks, or chutes.

Sec. 1404.4.8: Contingent closures may be set into position by either mechanical or manual operation of the assembly. Design of the assembly must take into consideration the type of placement operations, weight of the closure, space required, esthetic considerations, available work force, and total number of openings to be closed. Mechanical placement of closures can be accomplished through rollers, cable and weights, levers, and hinges.

Sec. 1404.4.9: Seals on all closures should be watertight and preferably of rubber or neoprene. The entire closure and frame should be inspected and tested periodically to insure that they are still functional and in good condition.

Sec. 1404.4.10: Some permanent closures may be designed to protect against flood waters and still maintain the functions of the opening. A window could be designed with intermediate supports consisting of reinforced concrete beams or structural members encased in concrete. The window would then be made up of tempered plate glass sections capable of withstanding impact loads spanning between intermediate supports. Metal doors can be made to protect against floods by providing a watertight seal and adding stiffeners and latching devices to the door. Examples of opening reinforcement, fastening methods and devices, and closures for typical conditions are illustrated in Figures 6 through 18.

Sec. 1404.5 ADDITIONAL CONSIDERATIONS: It should be noted that the preceding design examples do not contain coverage of several structural elements and framing methods used in normal practice. Included in this category are wall and column footings, mats or rafts, integral or continuous wall and slab construction, horizontally framed walls, and other similar items. Also omitted are examples of bearing masonry walls, curtain walls, percast concrete, metal and "sandwich" panels, and similar items. These items either involve too many variables, or are too complex for tabulated treatment, or relate to highly specialized technology. In all cases, coverage of these topics did not lend itself to a simplified treatment and was thereby omitted.

SECTION 1405.0 ALTERNATE METHODS OF FLOOD-PROOFING

Sec. 1405.1 SITE SELECTION: The one method of assuring complete flood hazard protection of a building or structure is to select a site or structure location which places all spaces in the structure above the "flood plain flood." This could apply to sites both inside or outside the flood plain limits. Locating a structure outside the flood plain would eliminate the need to consider flood water loads in the building design. The building could be located in the flood plain and be protected to design-flood level by dikes, levees, or floodwalls; also eliminating the need for flood load consideration in the building design for flooding to a design-flood level.

Sec. 1405.2 FLOOD-PROOFING BY ELEVATING THE BUILDING:

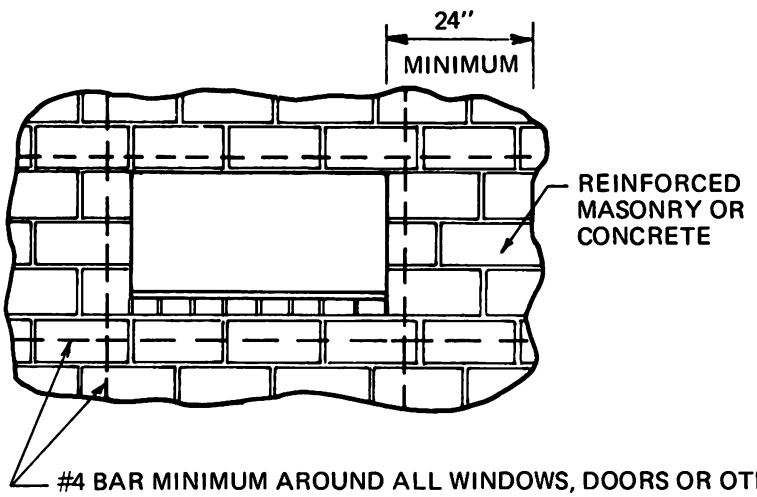
Sec. 1405.2.1 NATURAL TERRAIN – Structures constructed above the RFD and outside the regulatory-flood plain will not be subject to loads from regulatory-flood waters if basements are not used. The effect of soil saturation on basement walls and foundations may still have to be considered. Natural slopes should be investigated for stability and scour potential if the structure is to be built at the regulatory-flood-run-out line on the ground surface. A building located outside the regulatory-flood plain is shown at the left side in Figure 19.

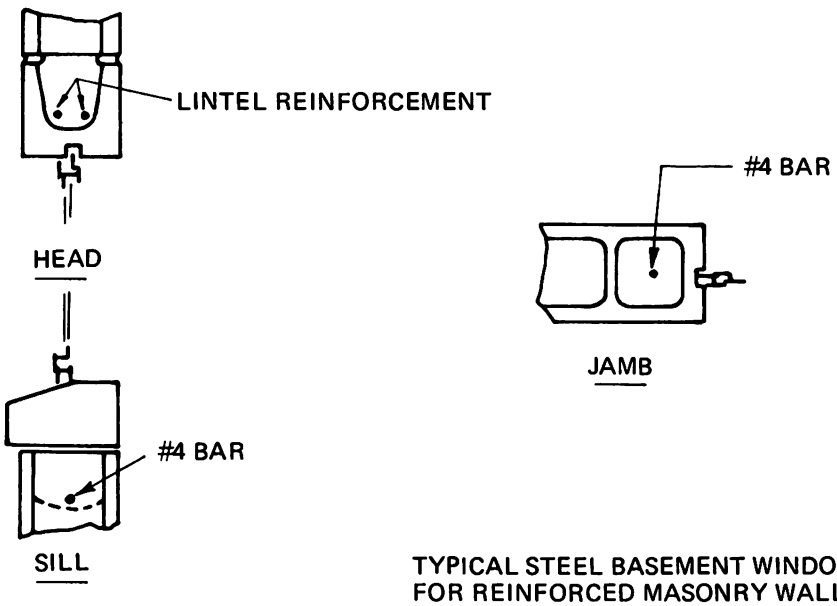
Sec. 1405.2.2 BUILDING ON FILL – Buildings can be located within the flood plain or primary flood hazard area on a fill constructed to an elevation above the RFD. This method of protection can be accomplished by constructing an earth fill either partially or entirely within the flood plain, as also shown in Figure 19. Such a design should provide assurances that the fill does not restrict or obstruct the flow of flood waters or reduce the hydraulic efficiency of the channel, which in turn could cause flood water back-up and resultant higher flood water elevations upstream of the filled building site.

Sec. 1405.2.2.1: The fill material should be suitable for the intended purpose as determined by an investigation of the soil properties. The earth fill should be compacted to provide the necessary permeability and resistance to erosion or scour. Where velocities of floodwaters are such as to cause scour, adequate slope protection should be provided with vegetation or stone protection as required. Slope stability should be analyzed by an experienced soils engineer to assure its adequacy.

Sec. 1405.2.2.2: Where the fill is partially within the flood plain, access and utilities should be provided from the "dry" side. If the fill is entirely in the flood plain, access and utilities could be provided by constructing an access road or bridge to an elevation above the RFD.

RECOMMENDED REINFORCEMENT AROUND SMALL OPENINGS
AND FOR SHALLOW DEPTH OF FLOODING

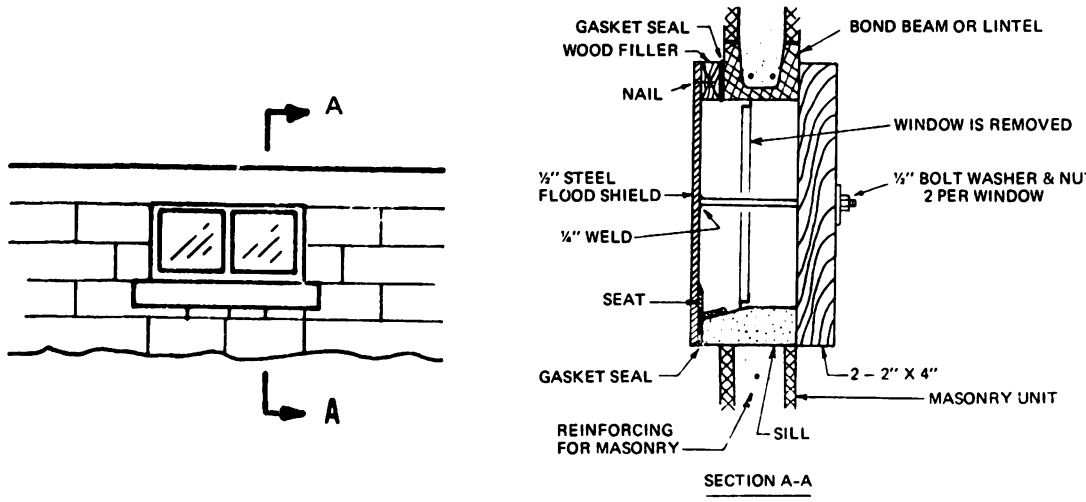




TYPICAL STEEL BASEMENT WINDOW
FOR REINFORCED MASONRY WALLS

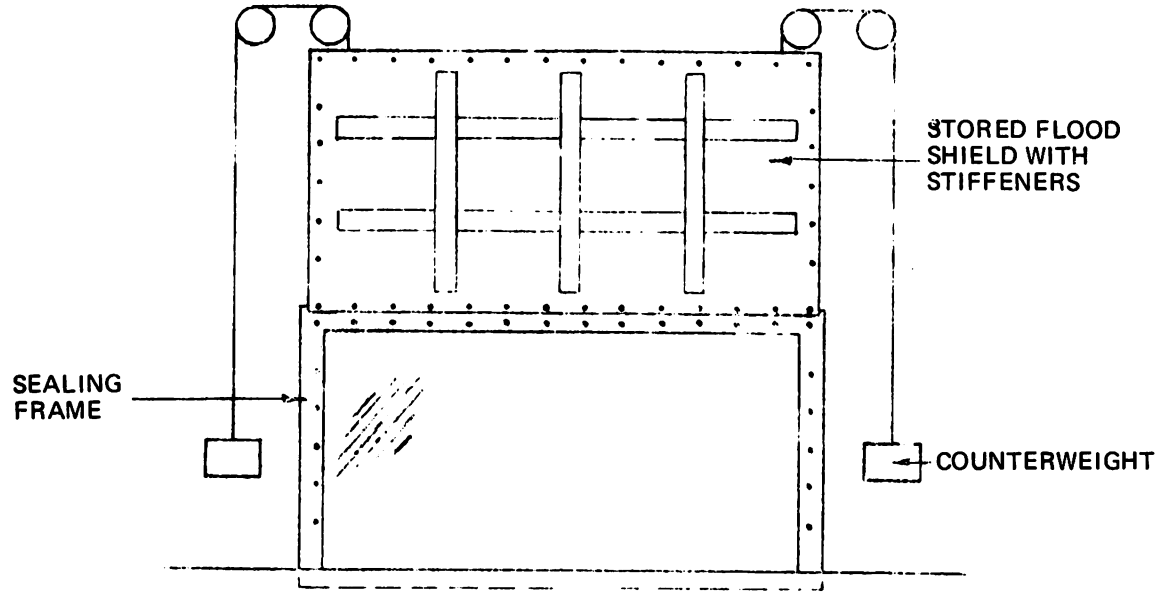
NOTE:
IF OPENING BEGINS AT THE TOP OF A FOOTING, HORIZONTAL REINFORCING SHALL BE PROVIDED AT THE TOP OF THE FOOTING.

Figure 6



CLOSURE PANEL FOR BASEMENT WINDOW
FOR SMALL WINDOWS AND SHALLOW DEPTH OF FLOODING

Figure 7



FLOOD SHIELD BEHIND WINDOW
LOWERED INTO POSITION & ATTACHED TO
FRAME WITH QUICK DISCONNECT TYPE FASTENERS.

Figure 8

BOND BEAMS & VERTICAL REINFORCEMENT AT LARGE OPENINGS

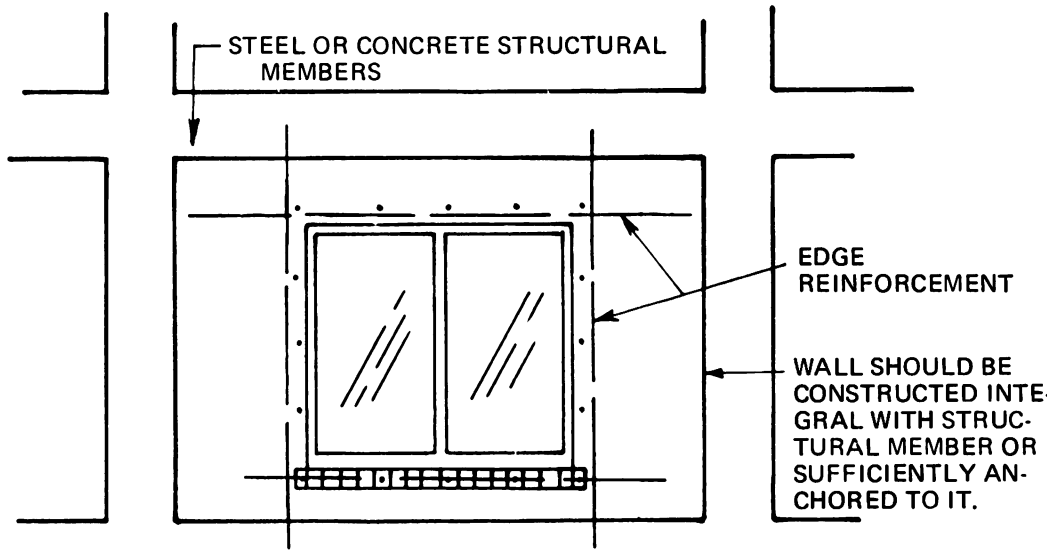
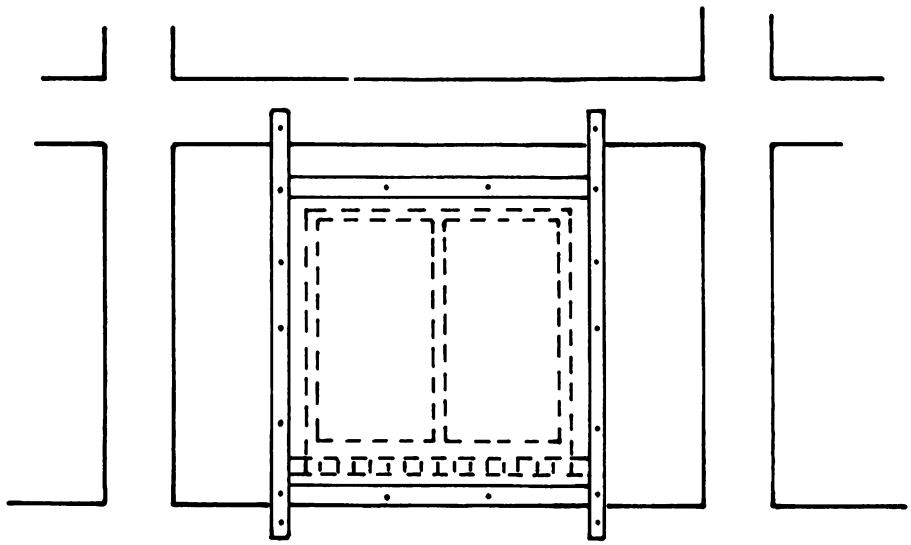


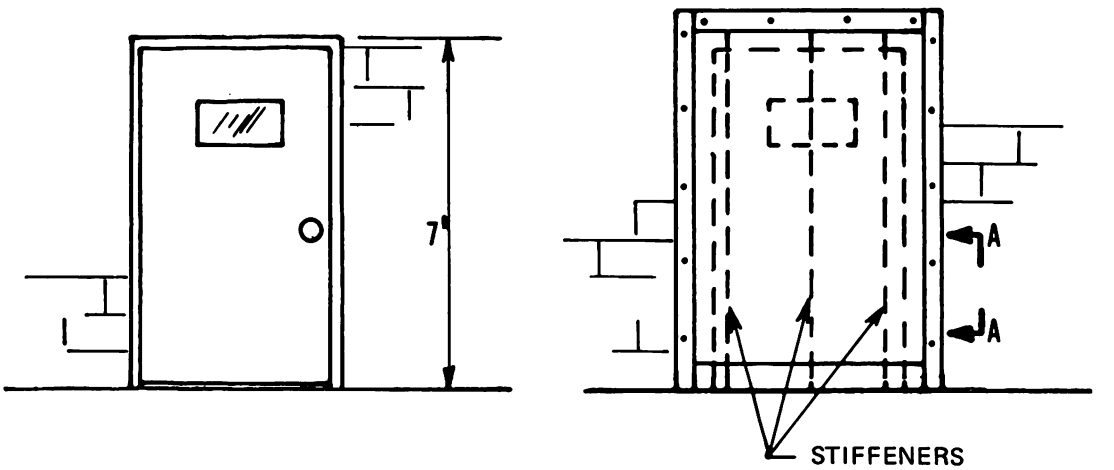
Figure 9

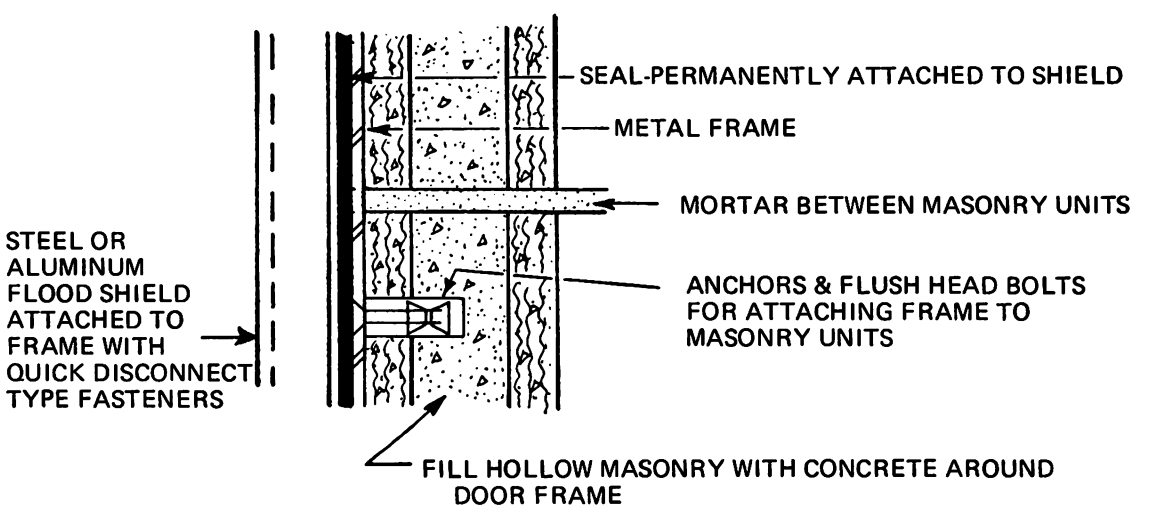


REINFORCING FOR BOND BEAMS AND VERTICAL STEEL MAY BE REDUCED IF FORCES ARE TRANSMITTED TO STRUCTURAL MEMBERS BY THE FLOOD SHIELD FRAME AS SHOWN ABOVE.

Figure 10

TYPICAL DOOR



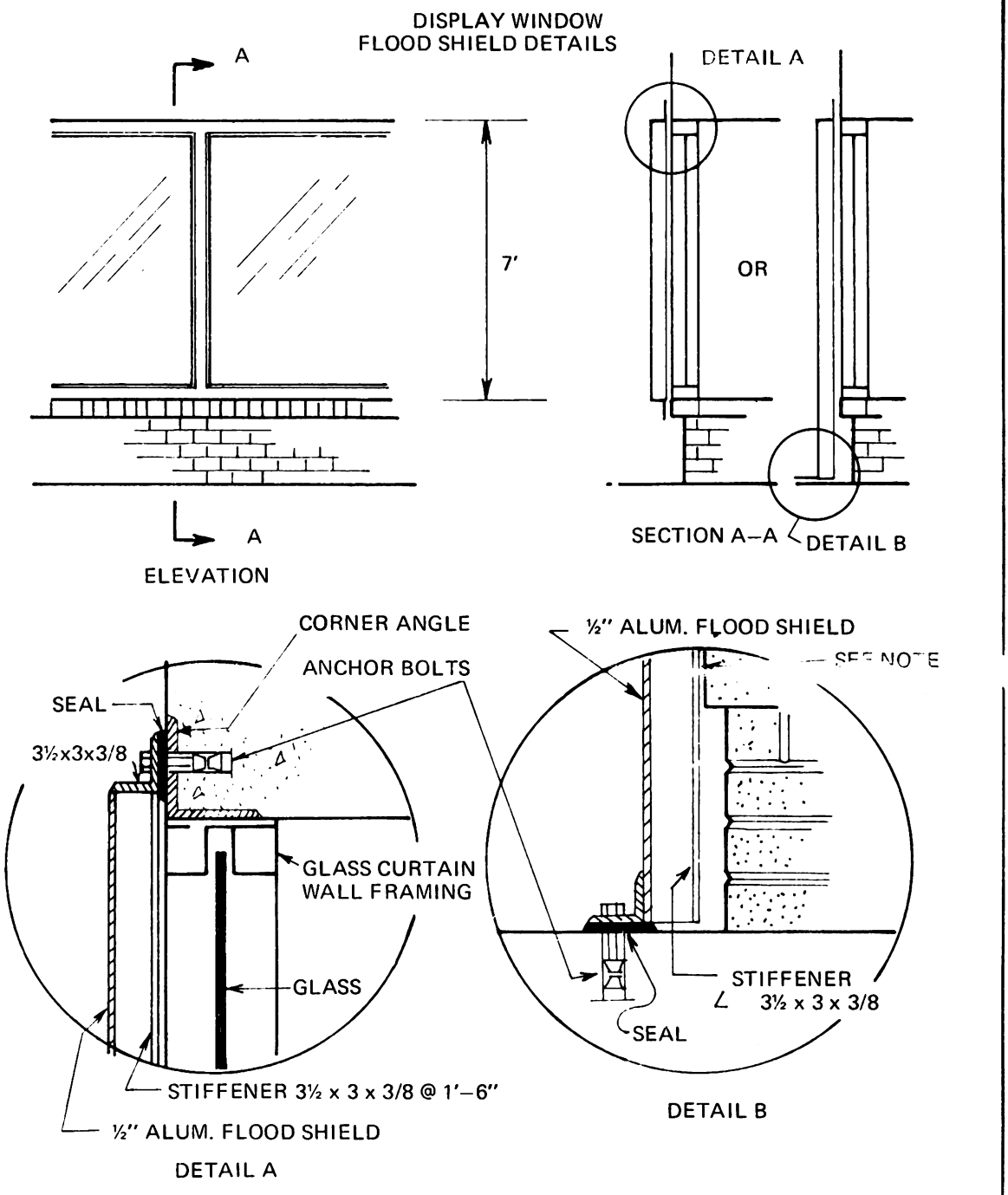


SECTION A–A

ALL CELLS AROUND OPENINGS IN HOLLOW MASONRY CONSTRUCTION SHOULD BE FILLED WITH CONCRETE. LARGE OPENINGS SHOULD HAVE BOND BEAMS, VERTICAL REINFORCEMENT, AND METAL FRAMES AROUND OPENING.

MORTAR JOINTS THAT LIE WITHIN FLOOD SHIELD SHOULD BE STRUCK FLUSH WITH THE MASONRY UNITS SO THERE WILL BE A BETTER SEAL.

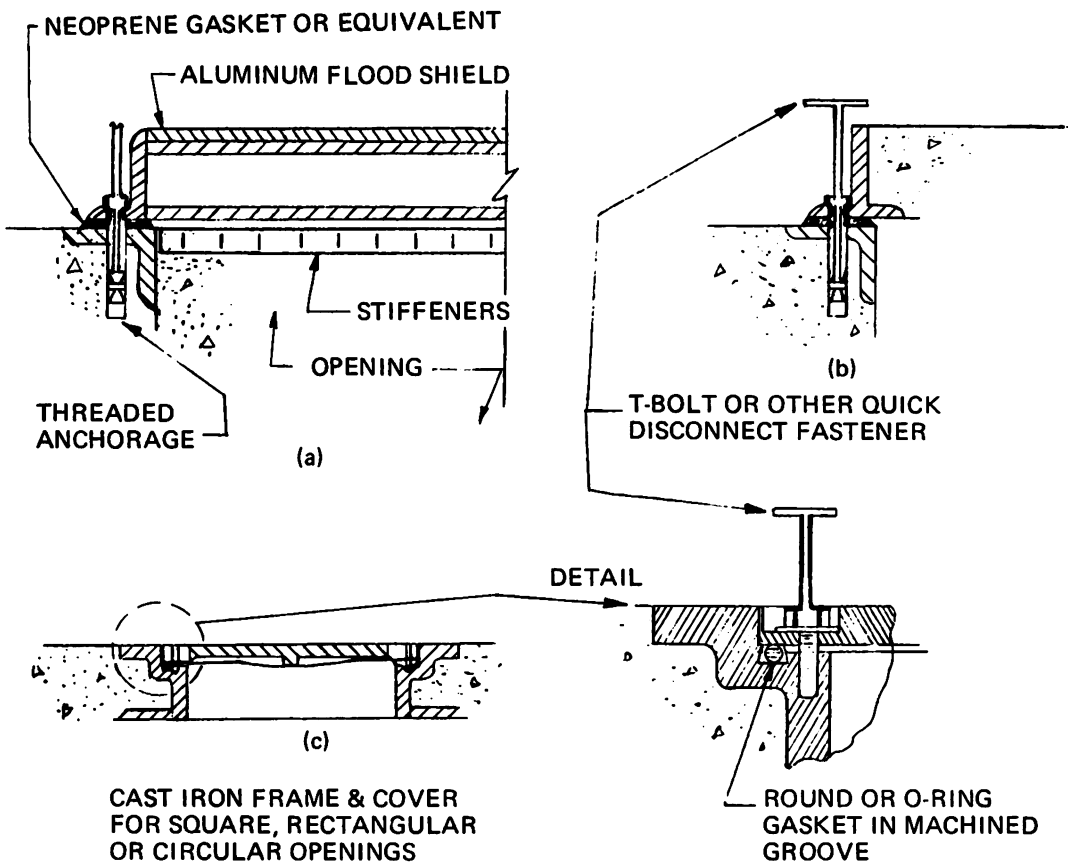
Figure 11



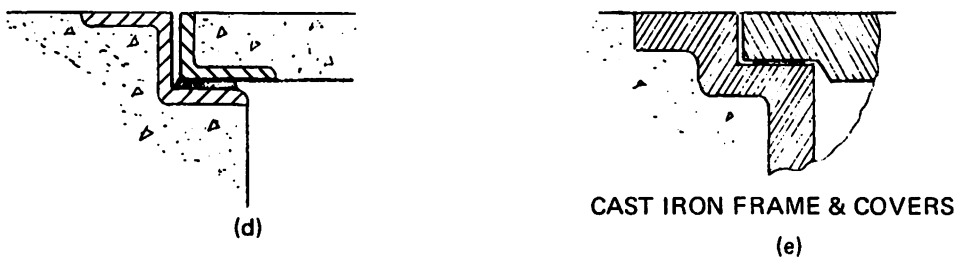
NOTE:
SUPPORT IS ASSUMED AT THIS LOCATION. WHERE SUPPORT IS NOT AVAILABLE, INCREASE SIZE OR NUMBER OF STIFFENERS AND PROVIDE SUPPORT AT BOTTOM. MEMBERS ARE SIZED FOR WATER LEVEL AT TOP OF DISPLAY WINDOW.

Figure 12

CLOSURES FOR HORIZONTAL OPENINGS BELOW RFD



COVERS FASTENED TO FRAME



GRAVITY TYPE COVERS
(HELD IN PLACE BY WEIGHT ALONE)

Figure 13

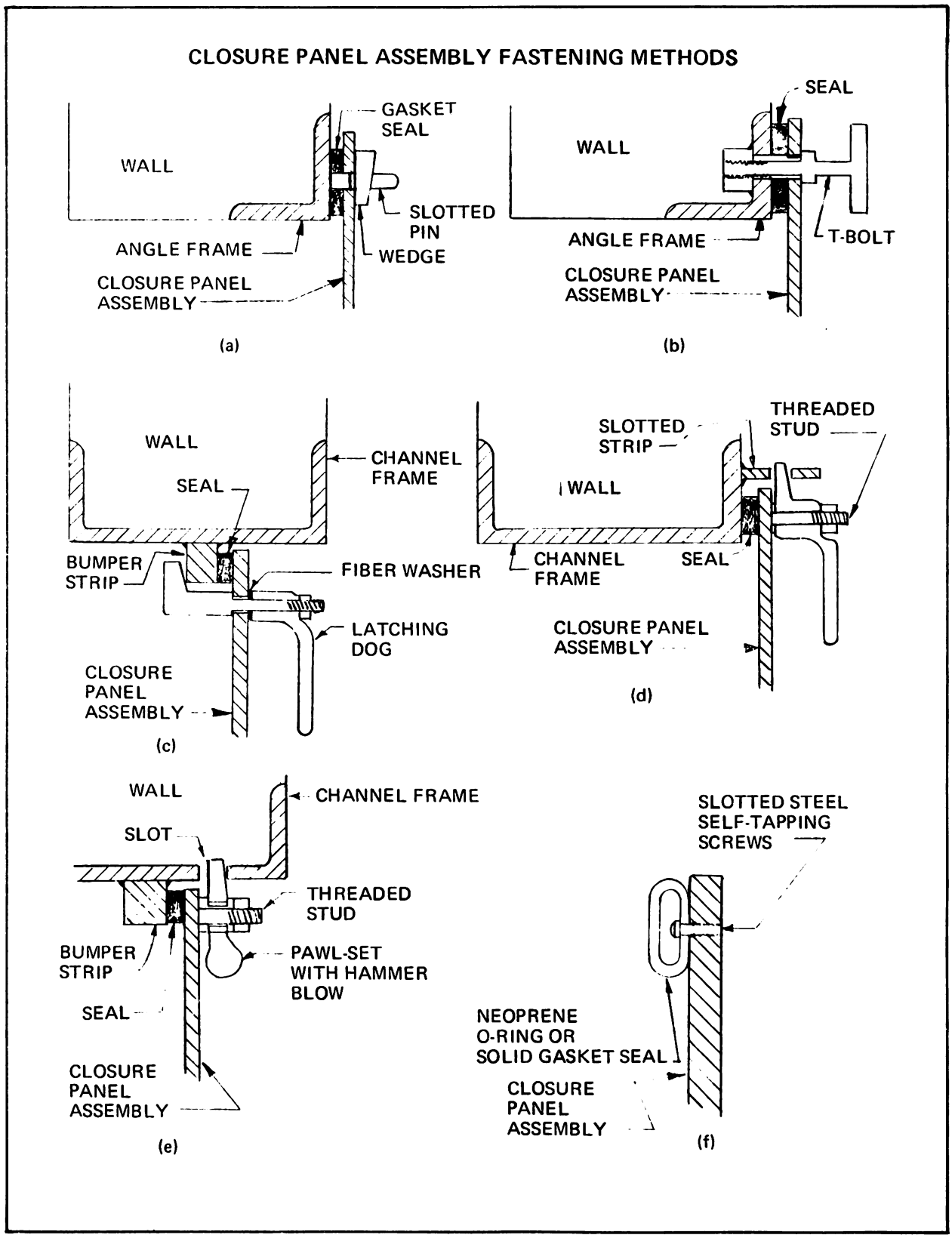
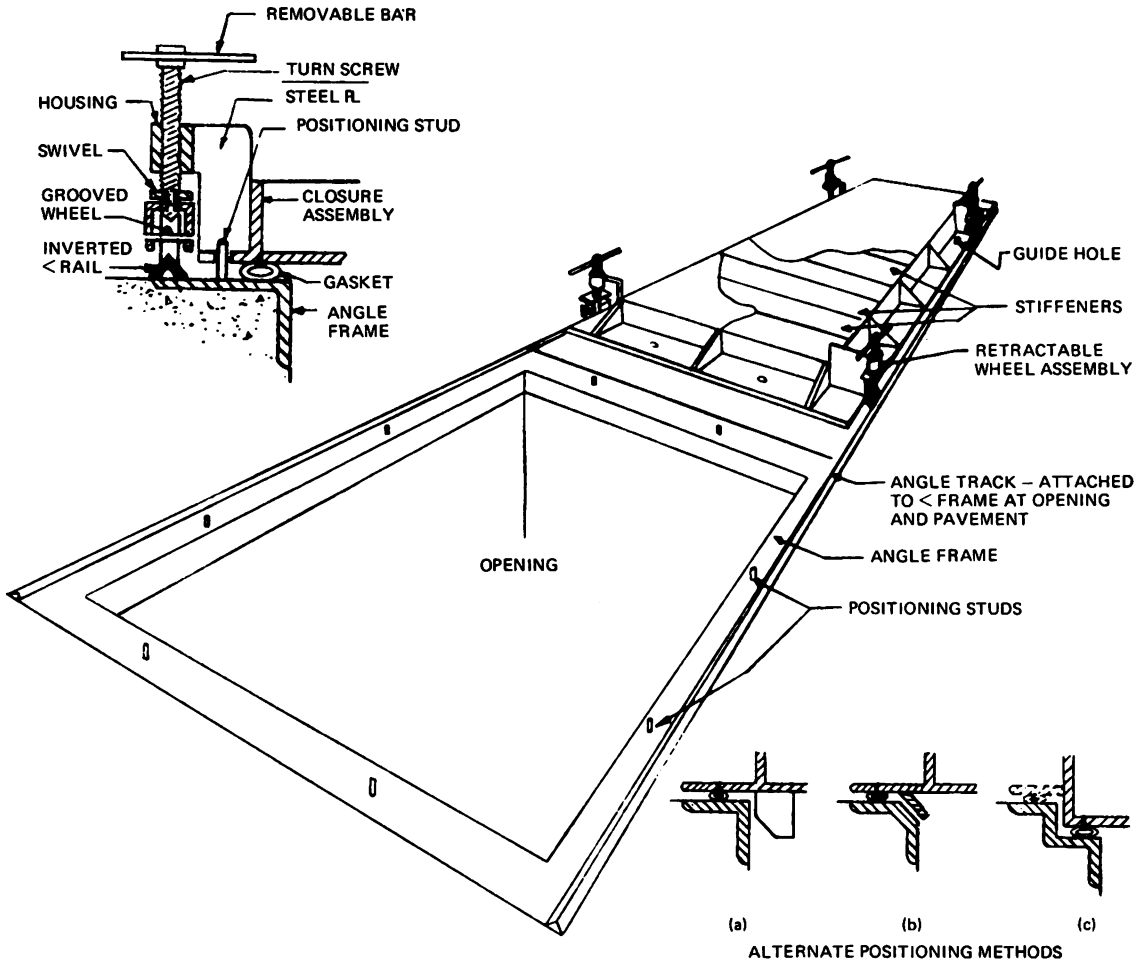


Figure 14

FLOOD-PROOFING CLOSURE FOR LARGE HORIZONTAL OPENING BELOW RFD



PROCEDURE

BEFORE FLOOD – Closure assembly remains in stored position and rests on blocks to keep assembly weight off O-Ring or flat sealing gasket-wheels in an up position and operating bars removed. Wheel assembly is coated with heavy grease and covered with plastic or canvas sheet.

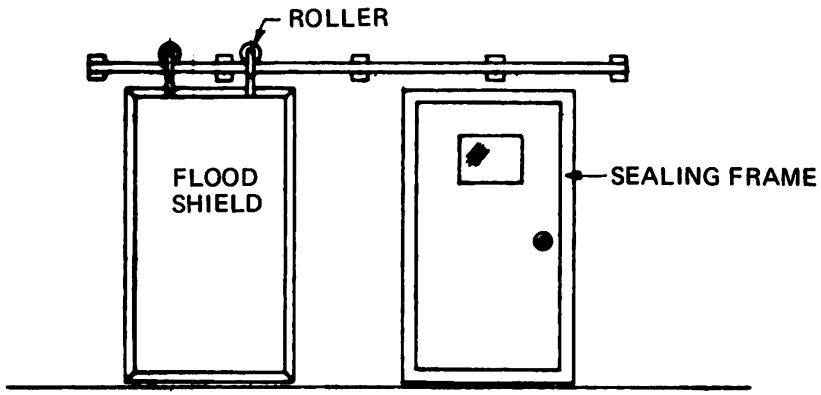
DURING FLOOD – When flood warning is received, operating bar(s) inserted in retractable wheel assembly and wheels lowered to engage rails, raising closure assembly off storage blocks and high enough to clear positioning studs; closure assembly rolled into position where guide holes are directly over positioning studs; closure assembly lowered to engage studs until all wheels are free of guide rails and contact established between gasket and frame; operating bars then removed from wheel assembly. Positive seal is maintained during flood by weight of closure assembly and flood water weight; positioning studs prevent displacement or movement of closure assembly.

AFTER FLOOD – Closure assembly washed down to clear mud and debris, raised into rolling position, rolled to storage location and positioned, inspected for possible damage, then "moth-balled" for future use.

NOTE: This illustrates only one of many schemes that may be considered for horizontal opening flood-proofing. Closure assemblies should be of durable materials for repeat type use, should require minimum maintenance, and require minimal installation effort. Variations may include hinged and/or counter-balanced assemblies; lever, ratchet or hydraulic systems for movement and positioning of assembly; positioning lugs, wedges, recesses, etc. where exposed studs cannot be tolerated; and use of positive fastening methods and devices for special locations or situations. The methods, procedures, and equipment that may be utilized are limited only by the designer's imagination and the owner's pocketbook.

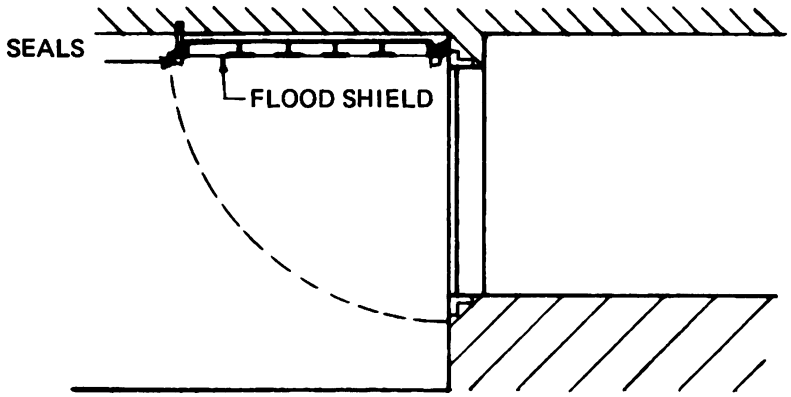
Figure 15

FLOOD SHIELD INSTALLATIONS



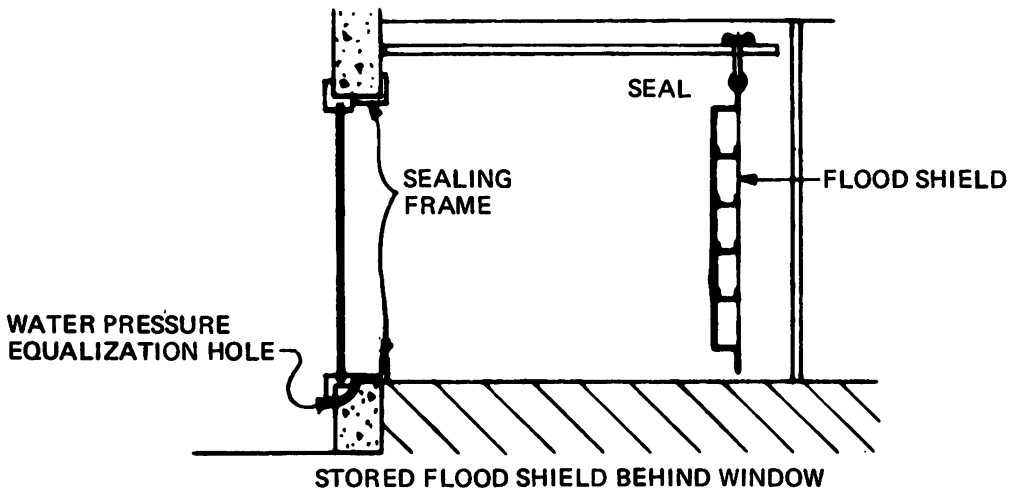
SLIDING FLOOD SHIELD FOR DOOR

Figure 16



HINGED FLOOD SHIELD FOR LOADING DOCK

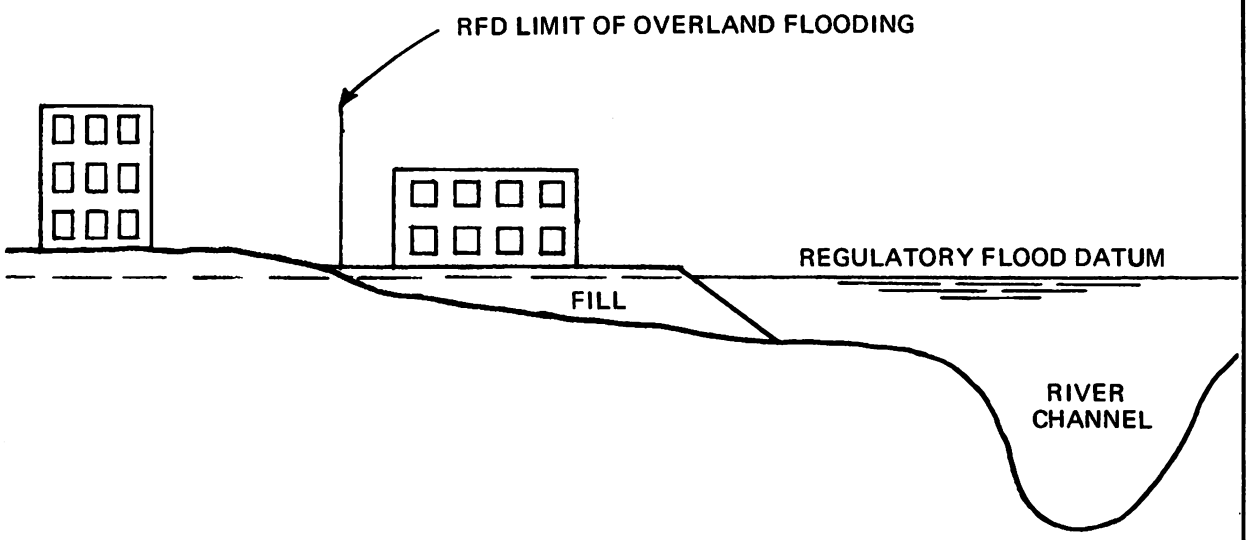
Figure 17



STORED FLOOD SHIELD BEHIND WINDOW

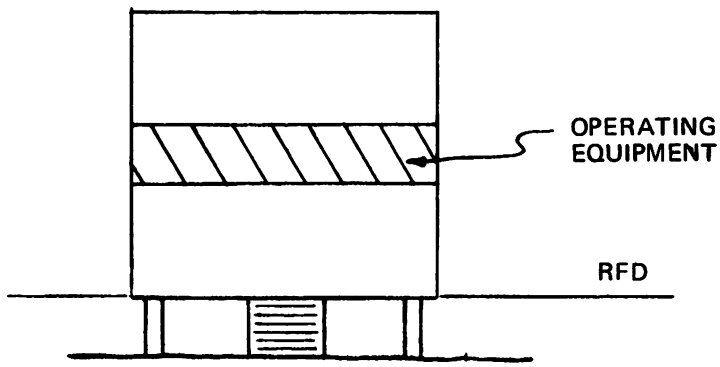
Figure 18

SECURED TO SEALING FRAME BY LATCHING DOGS, WEDGE ASSEMBLIES, OR OTHER QUICK DISCONNECT FASTENERS.



STRUCTURES ON NATURAL TERRAIN OR FILL

Figure 19



BUILDING ON STILTS

Figure 20

Sec. 1405.2.3 **BUILDING ON STILTS** – Often it is geographically undesireable or economically not feasible to locate a structure outside the flood plain. Available land areas are being developed rapidly and communities are finding it necessary to permit construction in the fringe areas of floodways. In these areas, structures can be built which place all functional aspects above the RFD by building on "stilts" as shown in figure 20.

Sec. 1405.2.3.1: In elevating a building on "stilts", piles, columns, piers, and walls, or other similar members are used to raise the functional floors or spaces of the building above the RFD elevation. The design should consider the loads that result from possible debris blockage between supporting members and impact of floating debris.

Sec. 1405.2.3.2: The open space created at ground level below the functional floors could be used as a plaza, parking area, materials handling, or recreational area, or for storage of special nondamageable materials, equipment, etc. This open space would be essentially free from the damaging effects of flood water, except that lobbies and entrance would have to be protected by some approved flood-proofing method.

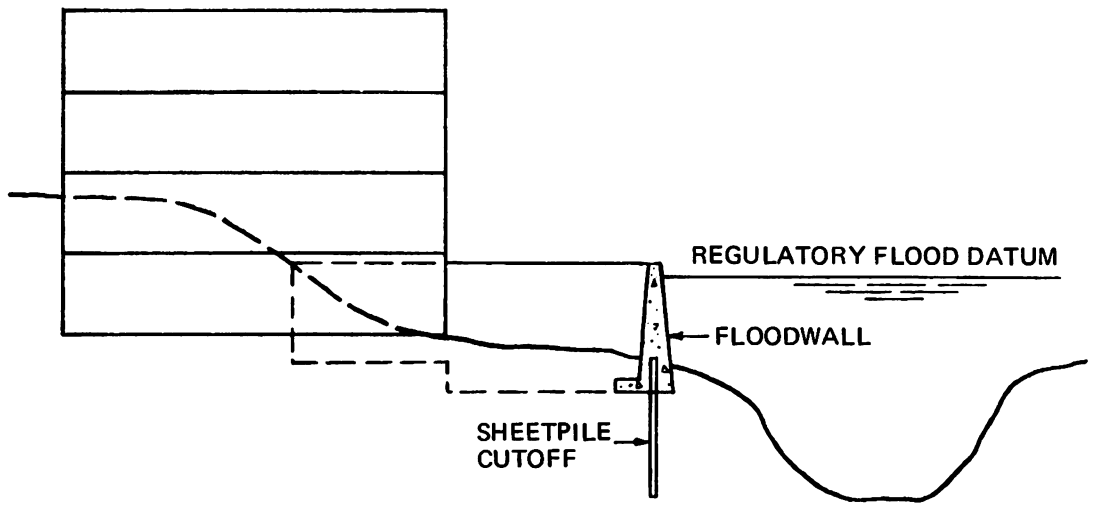
Sec. 1405.2.3.3: The equipment necessary to maintain building functions should be located safely above the RFD. If access to the building were provided from a location above the RFD, the normal building activities would not be disrupted and the building could continue to function during the flood emergency.

Sec. 1405.3 **PROTECTION BY DIKES' LEVEES AND FLOODWALLS:** As an alternate to providing flood protection through building or structure modifications, the necessary protection may be achieved by detached dikes, levees or floodwalls. The primary purpose of these constructions is to prevent the flood from reaching the structure and associated functional land areas. The choice of using a dike or floodwall is made on the basis of economic considerations when compared to structural flood-proofing modifications, the ability of a structure to be structurally modified, and the degree of protection to be provided. The type of protection barrier depends on location, availability of material, foundation conditions, and right-of-way restrictions. Floodwalls would be used in tight, restriced areas where foundation conditions are favorable. Dikes or levees would be used where adequate space and material are available. The dike or floodwall may not have to completely surround a structure. Protection may be required only on the low sides as illustrated in Figures 21 and 22. The ends of the works would be tied into the existing high ground or to the structure depending on local conditions.

Sec. 1405.3.1 **DIKES** – If used, dikes should be constructed to a section capable of supporting the imposed loads and providing the required impermeability. Suitable material preferably should be available at the site and should be tested and approved for use prior to constructing the dike. An investigation should also be made of the foundation material to determine the presence of, location, and extent of unsuitable materials and necessity for drainage of cutoff provisions.

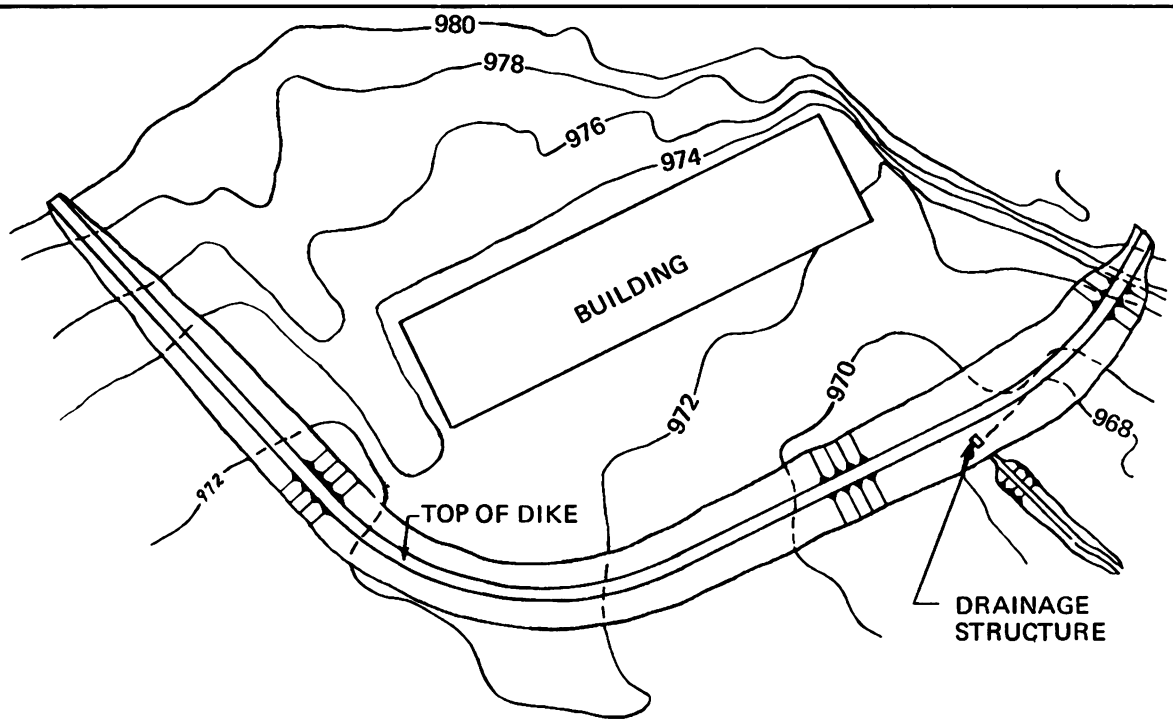
Sec. 1405.3.1.1: At locations where the foundation material has a high degree of permeability, an impervious cutoff may be necessary to reduce seepage through the in-situ foundation materials. The cutoff may be a sheet pile wall, compacted barrier of impervious soil, fabric reinforced membrane, concrete wall, or a grouted cutoff. As no cutoff is totally impermeable, provisions should be made to collect the excess seepage and any seepage from less permeable soils without cutoffs. The excess seepage can be collected with drainage blankets, pervious trenches, or perforated pipe drains placed at the toe of the embankment and on the dry landward side. Typical dike sections, cutoffs, and drainage provisions are shown in Figures 23, 24, and 25.

Sec. 1405.3.1.2: If any drain pipes or related structures are within a dike, they should be designed to resist all applicable loads and be provided with gates to prevent backflow to the dry side. Backflow through conduits can be prevented by installing flap gates, manually operated valves, or slide gates that would be closed when flood waters would reach critical elevations.



FLOOD PROTECTION WITH FLOODWALLS

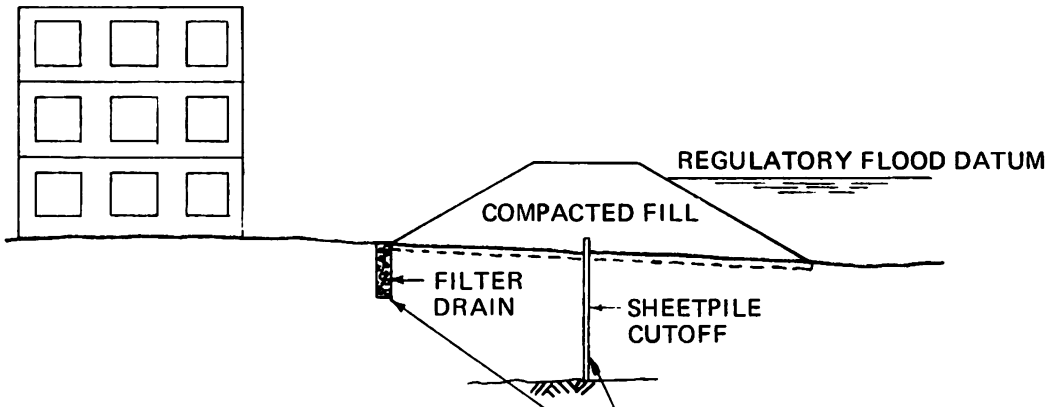
Figure 21



FLOOD PROTECTION BY DIKES

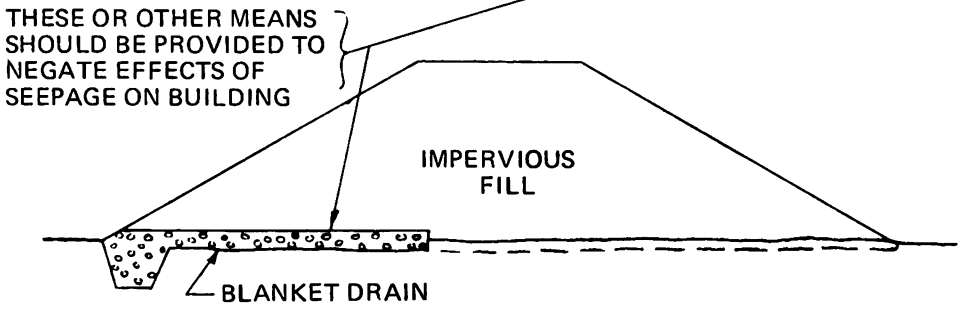
Figure 22

DIKE OR LEVEE PROTECTION



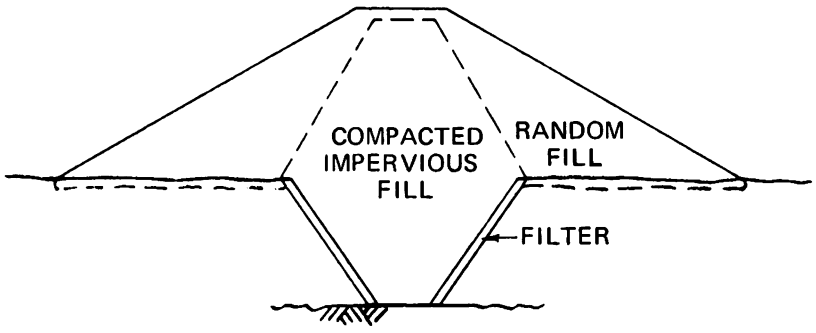
FLOOD PROOFING WITH DIKES

Figure 23



DIKE WITH BLANKET DRAIN

Figure 24



DIKE WITH IMPERVIOUS CORE

Figure 25

ROCK OR IMPERVIOUS STRATUM

Sec. 1405.3.2 FLOODWALLS – A floodwall is subject to hydraulic loading on one side with little or no earth loading as a resisting force on the opposite side. Floodwalls can be constructed as cantilever I-type sheet piling walls, cellular walls, buttress walls, or gravity walls.

Sec. 1405.3.2.1: The walls should be founded on and keyed into rock where suitable rock is encountered reasonably close to the founding elevations. Where the soil provides inadequate bearing capacity and removal of unsuitable material and replacement is costly, an adequately designed system of piling should be considered. Cutoffs and drains should be used to intercept seepage as required in 612.3.2. Drain pipes should not be placed directly under the wall base and any drainage provided should not be considered as a factor for reduction of uplift pressures. The problem of scour should be further investigated and corrective measures provided where necessary.

Sec. 1405.3.2.2: Drainage features through flood walls should be equipped with the necessary devices to prevent backflow. Typical sections of various flood wall types are shown in Figure 26.

Sec. 1405.4 CONTROLLED OR INTENTIONAL FLOODING: In many situations, the basement walls and floor slab(s) of existing buildings and structures lack the structural strength required to withstand flood loadings. The expense of reinforcing an existing structure or replacement with a new structure at the same location to withstand such flood loadings is, in most cases, not justified. As an alternate means of flood-proofing these structures, provisions may be made for flooding of the structure interior to balance the external flood pressures on the building components. This intentional flooding would have to be accomplished in such a manner as to keep the unbalanced hydrostatic pressures safely within the load carrying capacity of the slab and walls. Provisions must be made for interconnections through and around all floors and partitions in order to prevent unbalanced filling of chambers or spaces within the structures.

Sec. 1405.4.1 FLOODING: Flooding should be with potable water from a piping or storage system of adequate capacity to fill the basement at a rate consistent with the anticipated flood water rise. The provisions should be such as to keep the internal water surface as nearly even with the outside as possible. All spaces should be provided with air vents to prevent the trapping of air by the rising water surface.

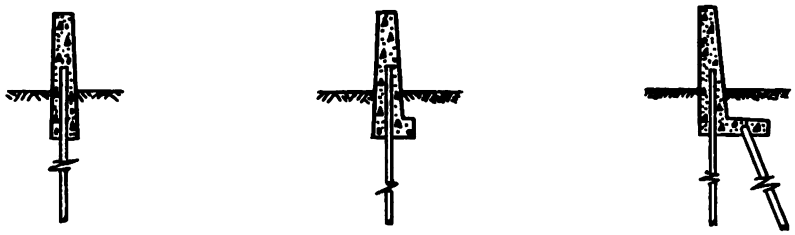
Sec. 1405.4.2 DRAINING: Outlets to drain the water as flood waters recede should be located to completely drain the structure and all spaces at a uniform rate corresponding to that of the receding waters. The water level in all interior spaces should be kept even and all spaces should be completely drained. Upper spaces and levels should be drained before the lower spaces. All watertight walls should be designed for an internal hydrostatic pressure resulting when waters trapped in the building are higher than those of the receding floodwaters outside; a possibility with malfunction of required drains.

Sec. 1405.4.3 USE: Where provisions are made for internal flooding, all floors and spaces below the RFD should be restricted as to types of use permitted. Examples of controlled flooding of structures with restricted use are shown on Figures 27 and 28.

Sec. 1405.4.4 BACKFLOW: Where intentional flooding with potable water is proposed (or where flood water backflow through the sewer system may occur), backflow preventers should be installed in the sewer lines. Various types of backflow preventers are illustrated in Figure 29.

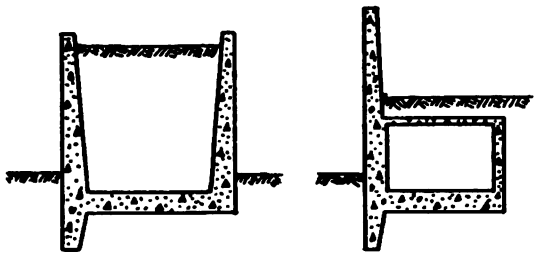
SECTION 1406.0 TOTAL APPROACH

Sec. 1406.1 GENERAL: The design and implementation of flood-proofing systems and procedures requires a total approach. No element or item, regardless of how minute it might appear, should be overlooked or left to chance. The most elaborate, extensive, and expensive flood-proofing system may be rendered useless by a minor omission or by the failure of a weak link in the system.

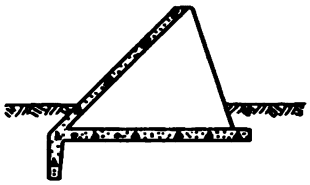


Type 1 Type 2 Type 3

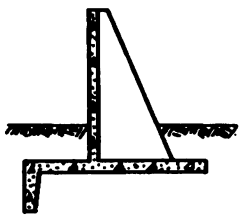
CANTILEVER 1–TYPE SHEET PILING



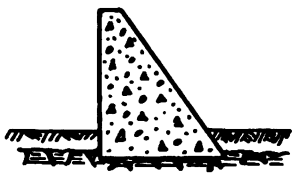
CELLULAR

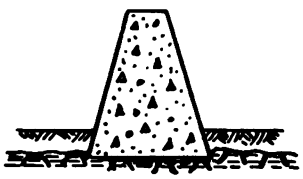


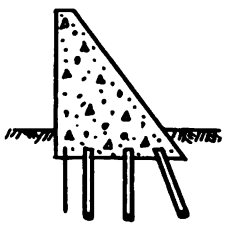
FLAT DAM



BUTTRESS AND COUNTERFORT





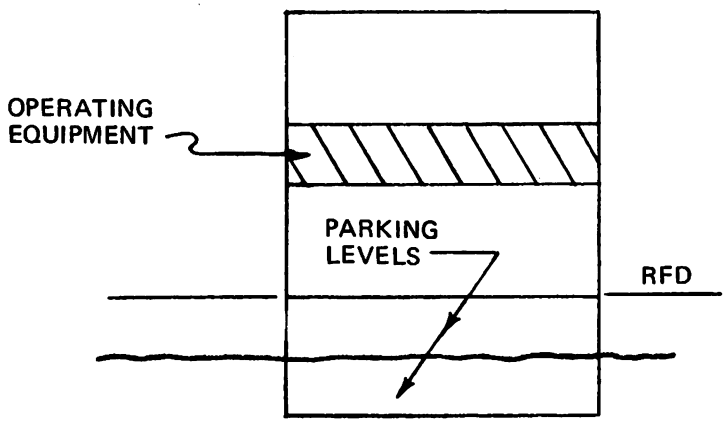


GRAVITY

VARIOUS FLOOD WALL TYPES

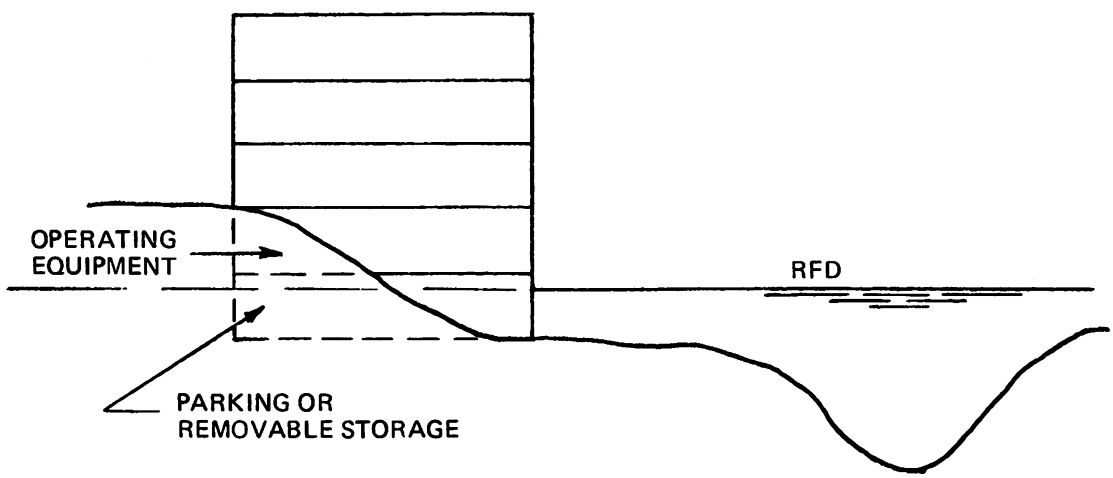
Figure 26

STRUCTURE WITH RESTRICTED USE



STRUCTURE ON NATURAL TERRAIN OR FILL

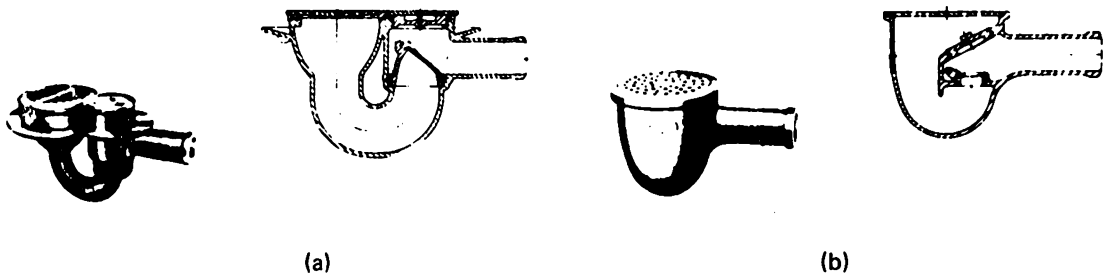
Figure 27



STRUCTURE ON NATURAL TERRAIN OR FILL

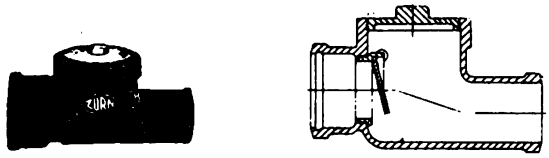
Figure 28

PREVENTION OF BACKFLOW THRU SEWER SYSTEM

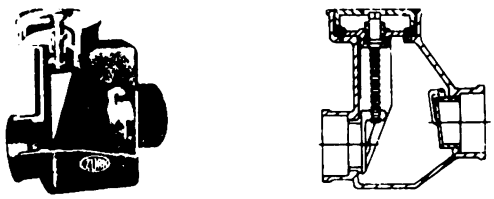


(a) (b)

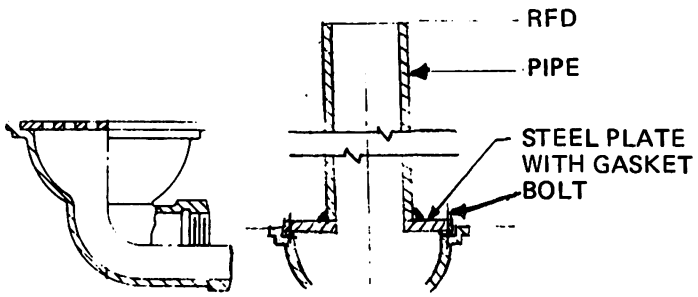
FLOOR DRAIN WITH INTEGRAL BACKWATER VALVE



BACKWATER VALVE – FLAPPER TYPE – AUTOMATIC



BACKWATER VALVE – GATE TYPE COMBINATION – MANUAL & AUTOMATIC



REMOVE GRATE AND INSTALL STANDPIPE. USE ONLY WHERE FLOOR SLAB WILL TAKE UP-LIFT PRESSURES

EXISTING BASEMENT DRAIN FLOOD-PROOFING

Figure 29

Sec. 1406.2 STANDARD OPERATING PROCEDURE: The same "in toto" approach is necessary in establishing detailed procedures for making a contingently flood-proofed system ready for an expected flood. Standard operating procedure for mobilizing and implementing the flood-proofing measures, referred to in these Regulations as "The Owner's Contingency Plan", should be developed by the original designer of the system. It requires a degree of completeness such that all details, sequences, and implementing personnel assignments are fully spelled out. The building owners and all other personnel assigned to implement the Plan should be thoroughly acquainted with all aspects of the operation and procedure. All personnel should periodically inspect the system and participate in scheduled "dry runs" or exercises of the flood-proofing plan. The standard operating procedure should be in the format of a manual containing all descriptive information and operational sequences, along with necessary illustrations, drawings, and maintenance requirements for all measures. Personnel designated to perform each task should be noted and, if possible, alternatives should be assigned to assist during times of emergencies or to take over and act if the regularly assigned personnel are absent or unavailable for flood emergency duties. In addition, summarized procedures should be be posted at prominent building locations to facilitate and expedite the operation. Color-coding of flood-proofing implements, such as closure panels, backflow valves, and similar features would be helpful in assuring the most efficient implementation of the Plan.

Sec. 1406.2.1: As preparation of a building for a flood event often involves auxiliary personnel, equipment, and materials, planning for simple logistics should be developed and be closely keyed to available advance time. In this respect, information from flood forecasting and warning sources must be obtained at the earliest possible time. Since floods can occur at any time of the day or night, or even on weekends or holidays, a plan for emergency readiness must be established. It should include establishment of definite lines of communications and control, and identification of key personnel who can be counted on to respond whenever needed.

Sec. 1406.2.2: All systems and implements of flood-proofing must be kept in a perfect state of readiness and be easily accessible at all times. The emphasis on periodic inspection, testing, and continued maintenance cannot be adequately stressed.

REFERENCES

1. Design of Welded Structures, Omer W. Blodgett, The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio

2. Introduction to Flood Proofing, John R. Sheaffer, The Center of Urban Studies, 1967, University of Chicago, Illinois

3. Wall Design, Flood Walls, Part CXXV Chapter 1, January 1948, Dept. of the Army, Corps of Engineers, Office of the Chief of Engineers, Washington, D.C.

4. Design Manual – Soil Mechanics, Foundations and Earth Structures NAVFAC DM-7, March 1971, Dept. of the Navy, Naval Facilities Engineering Command, Washington, D.C. 20390

5. Flood-Proofing: An Element in a Flood Damaged Reduction Program, John R. Sheaffer, Chicago: University of Chicago, Dept. of Geography, Research Paper No. 65, 1960

*U.S. GOVERNMENT PRINTING OFFICE: 1980-0-722-018/311

The county entered the emergency phase of the NFIP on March 24, 1972, and the regular program on March 2, 1981. However, county regulations are more restrictive than those called for by the NFIP. Since 1979 a county building code has prohibited virtually all development within the 100-year floodplain. Stormwater management design standards were also adopted in December 1979.

Prior to 1975, the county had a piecemeal approach to flood problems. However, in that year the newly elected county executive established a floodplain management planning program under the leadership of a task force and the head of the department of permits and licenses. After studying structural and nonstructural measures for eight watersheds, the task force recommended acquisition and relocation of properties in six of these watersheds. The ultimate goal is a linear park system suitable for active recreation along the rivers.

A strong public education program was initiated. Opposition by floodplain landowners diminished when the county provided opportunity for sale of houses.

As of December 1980, almost $11 million has been spent to vacate three watersheds. The project was scheduled so that expenditures would not exceed $4,500,000 annually—approximately the amount spent for past public works payments for damages.

Problems: Initially, inadequate funding, landowner apathy.

Keys to Success: Strong leadership, involvement of citizen task groups, development of comprehensive floodplain management plans, strong public education programs, demonstration of economic benefits of acquisition and regulations in reducing repeated flood and drainage damages to community facilities, financially attractive relocation incentives.

General Applicability: This is a prime example of strong community initiative to combine various local funding sources.

Sources of Information:

(1) Onsite visit

(2) John Seyffert, Federal Emergency Management Agency

(3) Stuart Braman, Ralph Field Associates
Westport, Connecticut

(4) Marguerite Whilden, Maryland Department of Natural Resources

(5) Baltimore County
Department of Public Works
Towson, Maryland 21204

Howard County, Maryland

Innovation: Tight floodplain regulations have been combined with a stormwater management ordinance, relocation, and evaluation procedure, detailed flood management studies, and a floodproofing loan program.

Background: Howard County, population 128,000, lies in central Maryland. The county has been active in floodplain management since 1972 when it passes a resolution requiring that residential dwellings be built two feet above the 100-year flood elevation. Zoning, subdivision control and building regulations have been adopted. Subdivision regulations adopted in 1975 also contained detailed and restrictive provisions requiring that building sites be safe from flooding and requiring that the 100-year floodplain either be dedicated to the county or, if the county waived its right of dedication, to a legally construed property owners' association for maintenance and preserva-

tion. In 1976 the subdivision regulations were updated. In lieu of dedication, the 100-year flood boundary may be included within lots but the minimum lot area must not include more than 50% of the area of the floodplain.

In addition to these floodplain regulations, the county council in April 1978 adopted a stormwater design manual which required comprehensive stormwater management design standards for all private and public projects in the county. These standards are designed to mitigate potential damages from ultimate development for the 2-year and 10-year storms. The 100-year stormwater management standard is proposed for 1983.

Strict enforcement is provided for regulations; extensive engineering review is provided for permits. No permits for new dwellings within the floodplain have been permitted since 1972. Many developers have dedicated floodplain areas so that they will be relieved of taxation and maintenance. State permits from the department of natural resources as well as local permits are also required for any structural change to the established floodplain. Several detailed watershed studies have been conducted to facilitate floodplain management efforts.

Nonregulatory measures have also been adopted. After Hurricane Eloise in 1975, the county purchased and razed 22 homes and one church along Deep Run with county capital improvement funds. The county entered the emergency phase of the National Flood Insurance Program in October 1971 and the regular phase in March 1977.

The Howard County Office of Civil Defense in 1976 adopted "standard operating procedure number 10" which established the procedures and governmental responsibilities for predicting and responding to various types of flooding. This was operational in 1979 when the county ordered the evacuation of the lower end of Ellicott City due to the threat of flooding from the Patapsco River.

Problems: Development pressures, need for refinement of NFIP maps (underway), existing development.

Keys to Success: Public awareness, early warning system for potential flood problems, knowledgeable and trained staff, state assistance, coordination of all county agencies.

General Applicability: This innovative combination of techniques may be broadly applicable to other urbanizing and urban areas.

Sources of Information:

(1) CAPE, Region III, August 10, 1979

(2) Marguerite Whilden, Maryland Department of Natural Resources

(3) Elizabeth A. Calia, PE
Department of Public Works of Howard County
3430 Court House Drive
Ellicott City, Maryland 21043
(301) 992-2400

Prince George County, Maryland

Innovation: Restrictive state and local floodplain regulations have been combined with master planning for individual watersheds and regulations for stormwater runoff.

Background: Prince George is a rapidly growing county in the Washington metropolitan area with a 1980 population of 665,071. The northern third of the county is heavily urbanized; the southern two-thirds rural and agricultural. About 7% (20,000 acres) of the county is in the floodplain; about 15% of the floodplain is developed (1975). Damaging floods occur along the Potomac and Patuxent Rivers and their many tributaries which are normally low gradient and slow-moving

streams. Flood damages accompanying tropical storm Agnes in 1972 exceeded $10 million and affected 1,100 dwellings.

Both Prince George County and the State of Maryland regulate floodplain development. After Tropical Storm Agnes, the county council formed a task force on flooding which made many recommendations, several of which have been adopted.

The county adopted floodplain regulations in 1975 and joined the emergency phase of the National Flood Insurance Program in 1970. The county converted to the regular program in 1972 when detailed floodplain studies and maps were prepared for the county for its participation in the NFIP. Much development has taken place within the county since those floodplain maps were prepared, resulting in expanded flood limits and higher water surface elevations. A major effort is underway to update the floodplain studies, and to identify areas presently susceptible to flooding and those that would become flood-prone due to future development.

To minimize the impact of development on streams and environmentally sensitive areas, the county has instituted land use management measures. Subdivision regulations have been adopted with design standards intended to foster cluster development. The county's proposed subdivision regulations would require proposed subdivisions to demonstrate adequate control of increased runoff due to the 10- and sometimes 100-year storm and the submission of a storm drainage concept study prior to final plat approval. Such controls could be structural (detention ponds, levees, roof-top detention facilities) or nonstructural measures such as porous pavements, minimizing the use of natural drainages, infiltration pits, and increasing open space. Furthermore, the proposed subdivision regulations would restrict or prohibit the subdivision of land found to be unsafe due to flooding, erosive stream action, high water table, unstable soils or severe slopes. The existing county building code prohibits the construction or placing of any structure or obstruction, filling or changing the cross section or flow characteristics within the 100-year floodplain. Growth management policies include staged development so as not to overburden streams and to preserve stream valley parks. The Maryland-National Capital Park and Planning Commission reviews all subdivision applications and rezoning requests for compatibility with county and planning area comprehensive plans. Master plans include floodplain conservation.

Some relocation has taken place. Residents of a subdivision in Cheverly were relocated out of the floodplain and the land converted to open space at a cost of $800,000.

At the state level, permits are required for construction, reconstruction, or alteration in any manner of the course, current or cross section of a stream or body of water, including any changes to the 100-year floodplain of free-flowing streams. The state planning office has recommended that the entire 100-year floodplain in the county be considered a critical area. Perhaps most important, the Maryland Secretary of Health and Mental Hygiene imposed a sewerage moratorium in the Piscataway, Blue Plains, Western Branch, and Parkway Sewers area in 1970. Numerous flood control projects have also been undertaken including two upstream dams and reservoirs on the Patuxent River.

Problems: Lack of detailed, current flood maps, lack of public awareness, development pressures, and existing development.

Keys to Success: Recent and severe flood problems, the need for open space and environmental corridors, state regulations and technical assistance, federal maps and technical assistance, a high level of public environmental awareness, good county staff with expertise, the incentive of flood insurance, and the combination of management techniques.

General Applicability: Prince George illustrates an innovative combination of regulatory and nonregulatory approaches which have broad applicability.

Sources of Information:

(1) CAPE, Region III

(2) Marguerite Whilden, Maryland Department of Natural Resources

(3) Stan Udhiri
Maryland-National Capital Park and Planning Commission
County Administration Building
Upper Marlboro, Maryland 20772
(301) 952-3650

Rockville, Maryland

Innovation: Restrictive floodplain regulations have been combined with stormwater management and sediment control ordinances.

Background: Rockville, Maryland's second largest city, is in the Washington, D.C. metropolitan area, and has a population of 44,726. Flooding has frequently occurred along smaller creeks and streams. Development is increasing runoff and flood problems in "drainagebeds" such as Watts Branch, Cabin John, and Rock Creek.

It entered the emergency phase of the NFIP in December 1972 and the regular phase in December 1977. The floodplain ordinance prohibits floodplain development except by variance. Applicants must determine base flood elevations by engineering methods. In three years the city has granted only two variances. Compliance is excellent.

In addition to floodplain regulations, the city has adopted erosion control measures for steep slopes and a stormwater management program. A grading, erosion and sediment control ordinance requires that all land-disturbing activities involving more than 5,000 feet of disturbed area must incorporate stormwater management measures to provide for the onsite storage of water generated by a 10-year storm. The water released from the site may not exceed that of a two-year storm. A developer must either construct stormwater management systems or must make a monetary contribution to city stormwater management facilities. As a result of this program, 26 public stormwater management measures have been constructed. Sixteen more public facilities are planned with construction begun on four. A project to compile 1"≈50' scale maps of the city's 15 linear miles of stream valley is presently underway. These are to be used to locate, monitor and maintain existing and proposed off-site stream valley stormwater management facilities and as tools to determine good locations for additional stream valley stormwater management facilities. Most are dry ponds designed to contain a 10-year storm and release it at a two-year rate, although some will control larger frequency storms. In addition there are approximately 100 private on-site stormwater management structures of varying sizes within the city. Most of these were constructed prior to 1978 (adoption of present ordinance) and were designed to control the increase for the 2-year storm. In order to help insure that on-site stormwater management facilities are maintained and are functioning properly, new onsite systems must have recorded access and right of way easements to and over them, together with a maintenance covenant. Permits for floodplain development must receive approval from the state program as well as from the city. Public facilities in the floodplain are now being floodproofed to the 100-year flood elevation.

Problems: Development pressures, problems with map scales.

Keys to Success: Recurrent flood problems, a strong state program, motivated local officials.

General Applicability: Restrictive floodplain zoning combined with stormwater management has widespread application to other communities.

Sources of Information:

(1) CAPE, Region III, September 30, 1980

(2) Marguerite Whilden, Maryland Department of Natural Resources

(3) M. Rod LaFever
Environmental Engineer
City Hall
Maryland at Vinson
Rockville, Maryland 20850
(301) 424-8000

Charles River Watershed, Massachusetts

Innovation: Planning and implementation have taken place through regulations, acquisition, and flood control works on a regional (watershed) basis. Much of the floodplains and wetlands of the Charles River has been acquired to preserve valley storage. This is the first extensive floodplain/wetland project completed by the Army Corps of Engineers.

Background: The Charles River watershed (307 square miles) contains approximately 1,400,000 people including much of metropolitan Boston and a rural watershed area. The river flows 80 miles from its origin to its outlet, becoming increasingly urbanized along the way. The floodplain of the Charles River has been subject to frequent and severe flooding (1807, 1818, 1886, 1938, 1955, 1968). The 1955 flood caused $5.5 million in property damage.

The Corps conducted studies of flooding problems along the Charles and concluded that construction of a dam was most appropriate for the lower Charles. It later expanded this recommendation and proposed acquisition of 8,500 acres of wetland/floodplain (natural storage areas) in the middle and upper watershed. Watershed municipalities were to regulate floodplain development in an additional 8,000 acres.

To date the Corps has acquired approximately 6,000 acres. A condition to acquisition was that the 16 watershed municipalities adopt floodplain regulations for the unacquired areas. Most communities have adopted the regulations. Recently floodplain/wetland regulations for the Charles were sustained by a Massachusetts appellate court.

Problems: Delays in the acquisition and adoption of state and local floodplain and wetland restrictions have been due to lack of detailed flood data, including flood encroachment lines, and the state's conservative approach towards adopting protection orders. Some floodplains have been developed.

Keys to Success: Leadership by the Corps, federal funding, a strong wetland protection policy by the state of Massachusetts and some of the towns, support of Charles River Watershed Association, citizen committees and land trusts.

General Applicability: The combination of federal, state and local acquisition for wetlands with regulation of floodplain areas to preserve storage has applicability to many areas. However, the physical situation and the institutional approach tried here are unusual and may not be widely applicable.

Source of Information:

(1) Onsite visit

(2) Rutherford H. Platt, George M. McMullen, *Fragmentation of Public Authority Over Floodplains: The Charles River Response*, Pub. No. 101, Water Resource Research Center, University of Massachusetts, Amherst, MA (January 1979).

(3) Arthur F. Doyle, Chief
Comprehensive River Basins Section
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02254
(617) 894-2400

Concord, Massachusetts

Innovation: A comprehensive planning and zoning approach for resource protection has been applied, including floodplain and wetland regulations designed to preserve flood storage. A public education effort has been undertaken. Some acquisition has also occurred.

Background: Concord is a wealthy community with a population of 17,000 northwest of Boston. The Concord, Assabet, and Sudbury Rivers flow through the town. All are subject to occasional flooding. the river and its adjacent wetlands and floodplains have great beauty and historical significance. For many years public awareness of environmental values has been high.

Floodplain zoning was first adopted in 1965 and wetland regulations in 1976. These ordinances and subsequent amendments are highly restrictive. Protection of water supplies, pollution control, and protection of open space are major regulatory objectives. All development that could raise flood heights is prohibited. Generally, floodplain and wetland areas may not be counted as buildable areas for the purpose of cluster and planned development densities. The board of appeals, with recommendations from the natural resources commission and planning board, exercises jurisdiction over both floodplains and wetlands. Strong community education has taken place.

A consultant was hired to prepare a composite wetland map at a scale of 1"=100' on assessors maps based on existing data (2-foot contour maps, aerial photos, soils maps) and extensive field analysis. Each household recieved a notice and was individually contacted during the mapping effort. Floodplain delineations based upon a HUD/NFIP study have also been placed on the 1"=100' map. Some floodplain and wetland areas have also been acquired.

Problems: Poor initial floodplain maps, some development pressures, legal challenges.

Keys to success: Widespread environmental awareness and concern in the community, active role of the natural resources conservation commission, multiple objective floodplain and wetland management, careful map preparation, good community staff, good public education.

General Applicability: Strong public involvement and education and restrictive regulation are broadly applicable to similar resource-oriented communities.

Sources of Information:

(1) Onsite visit

(2) Judy Chanoux
Town Planner
Monument Square
Concord, Massachusetts 01742
(617) 369-8454

Austin, Minnesota

Innovation: Strict enforcement of a floodplain zoning ordinance has been combined with acquisition and relocation. A major role was played by a citizen task force.

Background: Austin is a city of 25,094 with floodplains along the Cedar River and Dobbins and Turtle Creeks. It has been subject to repeated floods with severe flooding along the Cedar River in 1962, 1965, and 1978. As a result of flooding in the 1960s, the city adopted floodplain regulations and entered the emergency phase of the NFIP in September 1970 and the regular phase in May 1971. No new construction is permitted in the floodway. New construction in the flood fringe must be one foot above the 100-year flood line.

In July 1978, flash flooding washed out basements and caused water damage to both basements and first floors. The area recieved a Presidential disaster declaration. Cleanup and repair was under way when, 10 days later, a second serious flood occurred. The city formed strong neighborhood groups, including a "floodway action citizens task force." Data was gathered for the city to apply for a HUD Community Development Block Grant to acquire floodplain areas. In 1979 Austin received a $1.7 million grant, which is being used to acquire and relocate or demolish 78 homes that are seriously flood-prone. Priority in this 3-year program has been given to 26 homes that had their first floors flooded, that are considered movable, and that have owners willing to move. All acquisitions have been voluntary. Additional homes will be acquired and demolished. Efforts are being made to integrate acquisitions into a Cedar River Park Corridor.

Problems: Landowners who did not take flooding problems seriously until two disasters occurred in a very short time, the slow speed of federal funding for the acquisition, problems with FEMA maps.

Keys to Success: The severity of the flooding threat, state and FEMA technical assistance, financial incentives from HUD, local leadership.

General Applicability: The combination of regulations to prevent future flood problems with acquisition and floodproofing to deal with existing ones is broadly applicable.

Sources of Information:

(1) Minnesota Department of Natural Resources, *Reducing Flood Damages by Acquisition and Relocation, The Experience of 4 Minnesota Communities*, Minnesota Department of Natural Resources, Division of Waters, St. Paul, Minnesota

(2) Pat Bloomgren, State Coordinator, National Flood Insurance Program, Minnesota Department of Natural Resources

(3) CAPE, Region V, January 12, 1979

(4) John Erichson
Assistant City Engineer
500 4th Avenue, N.E.
Austin, Minnesota 55912
(507) 437-7671

Bassett Creek Flood Control Commission, Minnesota

Innovation: Nine municipalities have joined to form the Bassett Creek Flood Control Commission to develop a flood hazard reduction plan, regulate floodplain development, and undertake other floodplain management measures.

Background: Bassett Creek watershed is a small watershed west of Minneapolis with a 1974 population of 62,500. In 1969 all nine watershed municipalities entered into a formal agreement to form the Bassett Creek Flood Control Commission under a state law authorizing the formation of such commissions. Bassett Creek is subject to severe flooding with current annual flood damages of about $500,000. Particularly severe flooding occurred in 1974 and 1975. Prior to establishment of the commission, the Corps studied flood problems in the watershed and in 1966 proposed a series of dams and channel improvements. However, the watershed communities rejected the proposed structural solutions.

The Commission first prepared a comprehensive watershed management plan which was completed with the help of a consulting firm in 1972. The plan identified the 100-year floodplain

and made various recommendations for restricting the use of the land. Emphasis was placed on maintaining runoff levels so that a downstream conduit would not become quickly outdated.

Considerable attention was given to determining what would be required of each community in preserving flood storage and how to reach an agreement with each community about its role in implementation. Agreement was finally reached. Implementation of the agreement is being carried out by the individual municipalities, primarily through floodplain regulations that tightly control development and runoff.

The St. Paul District of the Corps has prepared a new watershed plan emphasizing nonstructural measures including the floodproofing of 19 structures. The plan also calls for replacing the single conduit outlet to the Mississippi River and installing a series of small control structures to impound flood waters.

Problems: Existing development, landowner opposition, inadequate funding to implement the flood control plan.

Keys to Success: Severity of the flooding problems, technical assistance from the state and the Corps, traditions of cooperation among the municipalities in the area, a statute explicitly authorizing the formation of the commission, strong public interest.

General Applicability: This program is in many ways a model for intergovernmental cooperation in flood hazard mitigation planning.

Sources of Information:

(1) Rutherford Platt
131 King Street
Northampton, Massachusetts 01060
(413) 584-3494

Clay County, Minnesota

Innovation: Restrictive county regulations have been supplemented by a moratorium on building in one subdivision and acquisition of selected properties.

Background: Clay County is a northern Minnesota county with a population of 53,000. It had severe flooding along the Red River in 1969, 1975, and 1979. Flood insurance claims alone exceed $800,000 for 1975, 1978 and 1979. Approximately 350 structures are located in the floodplain.

The county entered the regular phase of the NFIP in May 1972. The county's ordinance requires developers to provide a case-by-case hydraulic analysis to insure that the floodway is not being developed and that building requirements for flood fringe areas are being met. After flooding in 1979, the county board adopted a moratorium denying the issuance of building permits in the 100-year floodplain in River Oaks subdivision, which had been repeatedly and severely flooded.

Regulation is being supplemented by acquisition in River Oaks. A funding proposal was developed to relocate 21 of these homes. As part of FEMA's Section 1362 program, six structures in River Oaks subdivision have been designated for acquisition. Removal of the remaining structures in the floodplain is contingent upon further flood damage and funding. The county also has a proposal to use $1.5 million in funds to purchase open floodplain areas.

Problems: Inadequate flood data, inadequate funds for acquisition, some landowner opposition.

Keys to Success: Serious flood problems, technical assistance from the state, federal financial assistance, motivated local officials.

General Applicability: Adoption of a moratorium after a disaster and the combination of regulations with acquisition are applicable to other communities.

Sources of Information:

(1) CAPE, Region V, June 27, 1980

(2) Pat Bloomgren, Minnesota Department of Natural Resources

(3) Jack Frederick
Planning Director
Clay County Courthouse
807 North 11th Street
Moorhead, Minnesota 56560
(218) 299-5041

Crookston, Minnesota

Innovation: Restrictive floodplain regulations have been combined with an active enforcement program. Flood hazard areas have been marked.

Background: Crookston is a community of 8,600 residents. Low-lying areas in Crookston are subject to overflow from the Red Lake River, particularly during spring breakup of ice. A combination of melting snow and heavy rains causes the most severe damages. Major recent floods occurred in 1950, 1965, 1967, 1969, 1974, and 1978. The flood of record occurred in 1950 and was nearly equalled in 1969.

An emergency levee system was first constructed in the 1950s. Even though these levees were raised and strengthened following a subsequent flood, they do not provide permanent protection, in part because of their "emergency" nature. Severe flooding along the Red River of the North and its tributaries in April 1978 resulted in a Presidential disaster declaration.

Crookston entered the emergency phase of the NFIP in July 1973 and the regular phase in September 1977. The most current floodplain ordinance was adopted in July 1977.

City regulations comply with state and federal requirements. Only temporary and open space uses are permitted in flood fringe and floodway areas. Building permits have been issued for some structures but only for repairs with a value less than 50% of the structure's market value. The city estimates that 100 structures in the community need substantial improvements. Building permits for less than 25% of the value of a structure are granted. Permits for 25-50% of the value are granted only if the improvements meet current building code specifications.

Flood elevations have been posted in flood hazard areas with special labels prepared for the city by the Corps. Approximately 120 labels have been posted.

Problems: Extensive existing development, basement construction, substantial improvements, questions concerning the treatment of development behind emergency levee systems.

Keys to Success: Repeated flooding, broad public awareness, flood insurance incentives, state standards, motivated city staff and officials.

General Applicability: Restrictive regulations combined with marking of flood hazard areas are applicable to many communities.

Sources of Information:

(1) CAPE, Region V, January 29, 1979

(2) Pat Bloomgren, Minnesota Department of Natural Resources

(3) Dick Widseth
City Engineer, Crookston
216 South Maine Street
Crookston, Minnesota 56716
(218) 281-6522

Lilydale, Minnesota

Innovation: Regulations have been combined with acquisition and relocation of the entire lower part of the town as part of a regional park program, funded and implemented through a joint powers agreement involving three units of government.

Background: Until 1975 Lilydale was a small town (several hundred) lying entirely within the 100-year floodplain of the Mississippi about three miles from downtown St. Paul. It was repeatedly flooded to considerable depths, with significant damage in 1965 and 1969. Most dwellings were mobile homes, some of which were moved to higher ground during times of flood.

The town entered the emergency phase of the NFIP in April 1971. However, FIA suspended it several times for failure to adopt new regulations. Following a court order, the community adopted satisfactory regulations and was reinstated in 1976.

The Ramsey County Open Space Planning Office developed an acquisition and relocation plan for most of the town. About 97% has been implemented. It called for county acquisition of approximately 320 acres, including eight businesses and 113 households (mostly mobile homes) with funds from the state and the Minnesota Metropolitan Council. Total project costs are estimated at $4,750,000 not counting development costs estimated to be an additional $1,931,000. The town site is being converted to use as a park.

Problems: Landowners' opposition to floodplain regulations.

Keys to Success: Repeated and severe flood damages, lack of a structural solution, low property values, state-mandated regulations, availability of funds.

General Applicability: Open space acquisition and intergovernmental cooperation on relocation have application to other areas. However, the involvement of the county and metropolitan council and the severe flooding make the situation unusual.

Sources of Information:

(1) Onsite visit

(2) Stuart Braman, Ralph Field Associates, Westport, Connecticut

(3) Bernard L. Edmonds
Assistant Director, Ramsey County Parks and
Recreation Department
1850 White Bear Avenue
St. Paul, Minnesota 55109
(612) 777-1361

Arnold, Missouri

Innovation: Restrictive regulations are being combined with acquisition.

Background: Arnold is a community of 19,100 lying approximately 10 miles south of St. Louis. Periodically the community has been severely flooded by the Mississippi River, Meramec River,

Pomme Creek, and Muddy Creek, including a 1979 flood which caused $1.5 million in damages. Approximately 650 homes and businesses lie in the Meramec River floodplain.

The community entered the emergency phase of the NFIP in 1974. Regulations exceed minimum NFIP standards by requiring freeboard. In addition, state health and sanitary codes as well as zoning tightly control further development in the area.

The community's long-range plan calls for removal of all floodplain structures. Prior to 1979 the city had acquired approximately 150 acres of floodplain through Land and Water Conservation Fund monies and private donations. Through its 1362 program, FEMA has purchased and cleared 34 structures at an estimated total cost of $831,715.

Problems: Extensive existing development, lack of funds to purchase and relocate existing structures.

Keys to Success: Severity of flood problems, concerned citizens, availability of federal flood insurance, acquisition funds.

General Applicability: A combination of regulation and acquisition is generally applicable to communities throughout the nation.

Sources of Information:

(1) FEMA (Washington staff)

(2) Stuart Braman, Ralph Field Associates, Westport, Connecticut

Gladstone, Missouri

Innovation: Restrictive floodplain regulations have been combined with stormwater management regulations, some acquisition, and a flood warning system. Detailed mapping has been carried out for one area.

Background: Gladstone is a rapidly growing suburb of Kansas City with a population of 30,000. Severe flooding along Big Shoal and Old Maid Creeks occurred in 1974. As a result the city adopted a floodplain zoning ordinance in 1975. Regulations prevent most new development in the 100-year floodplain.

In addition to floodplain regulations, the city adopted a stormwater management ordinance that requires onsite detention. The city also prepared a $100,000 flood study for Rock Creek. Funding was provided by a developer and by the city. A system of detention ponds is planned. The developer is donating a 13-acre dry storage and park area along Rock Creek. As part of the Rock Creek study, air photo base maps were prepared at a scale of 1"=200'.

Some of the floodplain is in public ownership and more acquisition is planned for flood detention areas. The city has an active storm warning system and an active civil defense patrol.

Problems: Some existing development, problems with FEMA flood maps, development pressures, lack of budget for remedial measures.

Keys to Success: Repeated flooding, fairly high community awareness, aggressive city council, cooperation from developers.

General Applicability: A combination of restrictive floodplain regulations and stormwater management regulations is broadly applicable to other areas.

Sources of Information:

(1) CAPE, Region VII, July 17, 1978

(2) Ray Schick, Engineering Aide
Mark Achen, City Manager
Gladstone City Hall
7010 N. Holmes
Gladstone, Missouri 64118
(816) 436-2200

Beatrice, Nebraska

Innovation: State-supervised local regulations have been combined with limited acquisition to reduce damage to floodplain uses.

Background: Beatrice is a southeastern Nebraska community of approximately 12,500 with flooding problems along both Indian Creek and the Blue River. Serious floods occurred in 1941, 1947, 1951, 1967, and 1973.

City planning to address flood hazards dates from 1965-1967 when a HUD comprehensive planning effort was carried out. After that 1973 flood, the city requested a Corps study to focus on levees and nonstructural floodplain management techniques.

The city entered the emergency phase of the NFIP in January 1974. Regulations prohibited new floodway development and required elevation of structures in outer fringe areas. The city also began an acquisition program and delineated a floodway that was used to decide where land acquisition and relocation of *nonconforming* structures was to occur. In September 1977, when Beatrice received detailed flood data and maps through the NFIP, the community delineated a considerably larger and different floodway.

Since initiation of the acquisition project, 54 structures have been removed from the floodway through voluntary purchase. Project costs to date have been roughly $860,000 with most of the funding coming from a discretionary grant from the HUD Community Development Block Grant Program.

Problems: Existing development, landowner opposition, inadequate flood maps, inadequate funding for acquisition. Landowner opposition to the relocation plan and regulations increased as floodway boundaries were broadened in light of technical studies.

Keys to Success: Serious flooding, the lack of cost effective structural solutions, a state floodplain regulatory program, a planning effort which dates from the 1960s, community leadership, public education efforts, federal funding.

General Applicability: Similar combinations of regulations and acquisition are widely applicable.

Sources of Information:

(1) Stuart Braman, Ralph Field Associates,
Westport, Connecticut

(2) Terry Doyle
Office of Building Inspection
Town of Beatrice
Beatrice, Nebraska 68310
(402) 223-3569

(3) Richard D'Andrea
Community Development Office
City Hall
205 North 4th Street
Beatrice, Nebraska 68310
(402) 223-4938

Keene, New Hampshire

Innovation: *Floodplain subdivision and zoning regulations have been combined with some acquisition, a flood warning system, and flood control works.*

Background: Keene is a southern New Hampshire community of 22,000 and has severe flood problems. A 100-year flood would inundate about 3,120 acres along the Ashuelot River. An additional 370 acres would be flooded along Beaver Brook. The total flood-prone area represents about 14.7% of the city.

It was one of the first communities in the nation to adopt floodplain regulations, although the initial ones were minimal. The community entered the emergency phase of the NFIP in 1974. *Present regulations prohibit development in floodway areas. Flood storage and infiltration must* be protected in outer flood fringe areas. Plats must show floodplain boundaries. Some private *floodproofing* has taken place—for example, new dormitories for Keene State College.

Because of inaccuracies in initial floodplain maps, the city has prepared special maps with 1- and 2-foot contour intervals. Due to the vastness of its floodplain, the community has under way an acquisition program to supplement regulations. In 1968 the community established a conservation commission, which initiated an acquisition program with donation of approximately 400 acres and purchase of 400 acres with Land and Water Conservation Fund monies and other funding. A citizens' committee has been studying additional acquisition.

In addition, the community has undertaken a channel modification project to enhance the floodway along Beaver Brook. The Corps of Engineers has constructed upstream flood control structures. *The city has requested the Corps to help develop a flood warning system* and evacuation plan.

Problems: Substantial development pressures due to the large downtown area in the floodplain, lack of good flood maps until recently, conflicts between federal agencies.

Keys to Success: The severity of the flooding threat, good staff, a citizens committee, assistance from the Corps and local leadership.

General Applicability: A combination of regulations, acquisition, and flood warning systems is applicable to many flood-prone *communities*.

Sources of Information:

(1) New England River Basins Commission, *The River's Reach*

(2) Onsite visit

(3) Jerry McCullough
Planning Department
3 Washington Street
Keene, New Hampshire 03431
(603) 352-3254

Hamilton Township, New Jersey

Innovation: Prohibition of development in flood-prone areas has been combined with some flood control measures and acquisition.

Background: Hamilton Township is a middle-class city of approximately 87,000 adjacent to the state capital (Trenton). Creeks such as Pond Run and Assipink Creek have flooded repeatedly, with major flooding as recently as 1975. Development in the floodplain prior to 1977 was considerable. The community entered the emergency phase of the NFIP in 1977 and the regular program in 1978.

A 1977 ordinance prohibits development in the 500-year floodplain except under special conditions. The prohibition applies if any portion of a lot is within the floodplain. However, some permits may be obtained in outer areas only if the cuts balance fills to protect storage. Structures in outer areas must be elevated to the 500-year flood. Most disturbance of land (clearing, filling, grading) in the floodplain is also prohibited.

New development is essentially prohibited, and the town has developed several dams and stream channelization projects to reduce flooding in existing uses. These have considerably reduced flood threats. The town is now clearing stream beds to protect their flow capacity.

The community has prepared its own flood maps, including "experience flood maps" based on the flooding of 1975. It uses a combination of FEMA maps, experience flood maps, and other maps for regulatory purposes. The most restrictive maps apply. Consultants were also hired to study flood problems in some areas. They recommended that drainage regulations now require onsite detention for the 15-year flood. Regulations are being drafted to provide detention for the 100-year flood.

Some of the floodplain has been acquired. Along one creek (Pond Run) a consultant is defining the boundaries for a linear park.

Problems: Existing development, lack of citizen and council interest prior to 1977.

Keys to Success: Severe flooding, good staff, creative approaches, strong support from the mayor, council, and planning board, aggressive enforcement, citizen awareness, accurate flood maps.

General Applicability: A similar combination of tight control of new development with selective acquisition and flood control measures for existing structures is broadly applicable.

Sources of Information:

(1) Mr. John Leverence
Director of Engineering, Planning and Inspection
Township of Hamilton
2090 Greenwood Avenue
Hamilton, New Jersey 08650
(609) 890-3683

Wayne Township, New Jersey

Innovation: Restrictive floodplain regulations, including a building moratorium and 0.2-foot allowable floodway rise, have been combined with code enforcement, urban renewal, and education to eliminate existing structures or encourage private floodproofing of them.

Background: Wayne Township, an area of many lakes and streams in the New York-Newark Metropolitan Area, had more than 50,000 residents in 1975. Much of the older portion of the town, including its business district, is located in the floodplain. The 27,000 acres of flood hazard

area comprise 17% of the township. About `,250 acres (46%) are undeveloped. An estimated 5,800 persons live in the floodplain.

Floodplains are subject to federal, state and local regulations. The New Jersey Administrative Code prohibits new buildings, additions, obstructions to flow, and the net importation of fill in state-delineated floodways. A state permit is required for all activities in the floodplain. Filling must not raise the 100-year flood more than 0.2 feet in contrast with NFIP regulations which permit a 1-foot rise. A local floodplain ordinance has also been adopted with standards closely parallelling those of the state. The state has also provided Wayne with a map delineating the floodplain as the area inundated by the 1903 flood. New residential structures must have a 1-foot freeboard above the flood of record. Commercial and industrial buildings can be built at or above the flood of record. Floodplain regulations have been in effect in the community since 1955. The town has been in the NFIP since 1971.

Pending floodway delineation, in 1973 the township imposed a residential area construction moratorium in the floodplain. This was subsequently lifted and a regulation was adopted prohibiting new residential development unless it could tie into an existing public sewer. Only about five new homes were built in flood hazard areas between 1973 and 1977.

A zone change was permitted to allow 122 clustered townhouses on a 40-acre site near the Ramapo River, with nine on the fringe of the floodplain and 113 beyond the floodplain. The transfer of density rights from the floodplain to non-hazard areas was used to preserve the floodplain in open space.

Stimulated by a building department education program, more than 50 homes have been privately elevated to or above the 100-year flood stage. Postflood inspections and the citing of examples have been used to encourage private floodproofing. Floodproofing has been required for all renovations, improvements, and additions to structures in flood hazard areas.

Some floodplain areas have been acquired. Limited flood control works are planned, including the widening, straightening, and contouring of channels. Urban renewal in some of the floodplain is also planned.

Problems: Substantial existing development in the floodplain; conflicts between state and federal standards and maps for floodplain regulation; lack of detailed flood data, including floodway delineation.

Keys to Success: Broad public awareness of flood problems, concern for open space as well as flooding, a creative municipal staff, state floodplain regulations.

General Applicability: The use of a moratorium, public education to encourage floodproofing of existing uses, and density transfer approaches are applicable to other areas.

Sources of Information:

(1) Sheaffer and Roland, *Case Study of Wayne Township*, prepared for the NFIP

(2) CAPE, Region II, October 12, 1976

(3) Mr. Donald Giles
Township Planner
475 Valley Road
Wayne, New Jersey 07470
(201) 694-1800

Raleigh, North Carolina

Innovation: Floodplain regulations have been supplemented by sediment and erosion control ordinances, some floodplain acquisition, a flood warning system, and limited flood control works.

Background: Raleigh is a city of 156,727 (1978 population) and the capital of North Carolina. About 16% of Raleigh's planning area, a total of 12,000 acres, and 662 buildings lie within the 100-year floodplain, primarily along Crabtree Creek. The Corps of Engineers has estimated that average annual flood damages are $1,020,900 (1977 estimate).

Because of these flood problems, Raleigh adopted two overlay floodplain zones in 1973. These were revised in 1978 to comply with NFIP requirements. Raleigh entered the emergency phase of the NFIP in March 1973 and the regular phase in August 1978.

Regulations applying to floodplain areas in Raleigh include floodway and floodplain regulations, subdivision regulations, sediment and erosion control ordinances, and zoning. Floodplain regulations require a permit for all new construction or additions within the 100-year floodplain. Obstructions in floodway areas are prohibited; new structures in outer flood fringe areas must be elevated or floodproofed. A licensed engineer or architect must certify that all building requirements are met. A licensed surveyor must certify that elevations of the first floor meet requirements before a structure is occupied.

Regulations have been supplemented by a greenway program, which by 1978 had acquired roughly 300 acres, 55 acres by purchase and the rest through dedication by land developers. Dedication has been encouraged by a density transfer scheme. An early-warning system for the Crabtree Creek area—a result of the 1973 floods—has been installed. Eight dams have been constructed and three more are planned.

Problems: Low public awareness of flood hazards, increased construction costs for floodproofing private residences have favored commercial uses.

Keys to Success: Recurrent flood problems; technical assistance from the Corps, SCS, and the NWS on overall land planning and zoning program.

General Applicability: Raleigh's experience is applicable to many other modest-sized communities.

Sources of Information:

(1) French, Steven P., Todd L. Miller, Raymond J. Burby, and David Moreau, *Managing Flood Hazard Areas: A Field Evaluation of Local Experience*, Center for Urban and Regional Studies, University of North Carolina at Chapel Hill.

(2) Stuart Braman, Ralph Field Associates, Westport, Connecticut

(3) Wayne Baker
Public Works Department, Inspection Division
Raleigh, North Carolina
(919) 755-6281

Tulsa, Oklahoma

Innovation: Restrictive floodplain and stormwater runoff regulations linked to future watershed conditions have been adopted.

Background: Tulsa is a middle-sized city (1980 population of 360,919) subject to repeated flash floods along Haikey Creek, Mingo Creek, and the Arkansas River. Many proposals have been made to deal with these problems but only a few have been adopted. The city entered the emergency phase of the NFIP in 1970. However, regulations did not comply with NFIP standards until they were upgraded after a severe flood in 1974.

In 1975 the City of Tulsa and Tulsa County adopted regulations requiring that new developments provide facilities and/or open space to convey a 100-year flood (calculated as if the entire watershed were developed) safely through the developments and to provide detention facilities so that

runoff rates not exceed predevelopment conditions. In late 1975 the city and county also imposed a moratorium on building permits and filling on the floodplains of Haikey and other creeks until floodplain maps could be drafted or updated.

Despite control of new development, damage to uses existing before the moratorium reached $34 million in a 1976 flood. Consequently, the city adopted an even broader moratorium upon new construction in all areas subject to flash flooding. An appeal process was adopted to deal with special situations. A floodplain management advisor was hired.

In December 1977 the city revised its ordinances to prohibit new floodplain development (including fill) that would cause any measurable increase in heights, flows, or velocities of the 100-year flood. These measures were calculated as if the drainage basin were urbanized. New growth management planning adopted in that year had stormwater management and floodplain management as principal elements. In 1977 the Tulsa District of the Army Corps of Engineers also began an urban stormwater management study which is now near completion.

Tulsa has begun an ambitious program of land acquisition to provide park facilities along four miles of the Arkansas River. The city has spent $2.5 million in urban renewal to date. Anticipated total cost will be between $30 and $40 million. Acquisition has been used along Mingo Creek where 31 homes have been or soon will be moved into a nearby urban renewal area. The city is also purchasing 125 acres of undeveloped land in this area and is developing plans for a $7.6 million funded regional stormwater detention facility. This will be the first of a three-cell flood detention storage project. In addition, plans are complete for a $5 million flood detention facility at 34th Street and Mingo Creek. Presently, 670,000 cubic yards of dirt have been removed from the site.

Problems: Inadequate flood data, extensive existing development, continuing pressures for new development, inadequate coordination of efforts among the several municipalities along Haikey Creek.

Keys to Success: Severe and recurrent flood problems, technical assistance from the Corps of Engineers, active citizen groups, community leadership, cooperation of the private sector.

General Applicability: A similar comprehensive approach to floodplain management combining restrictive regulations with some acquisition and significant drainage improvements is broadly applicable to other areas.

Sources of Information:

(1) Rutherford Platt, University of Massachusetts, Amherst

(2) Sheaffer and Roland, (Draft). *Evaluation of the Social, Economic and Environmental Effects of Floodplain Regulation.* Field Study Report. Tulsa, Oklahoma (1977)

(3) Charles Hardt, City Hydrologist
City Hall
Tulsa, Oklahoma 74103
(918) 581-5011

Bensalem Township, Bucks County, Pennsylvania

Innovation: Restrictive floodplain regulations have been combined with a careful monitoring system.

Background: Bensalem Township has a population of 52,211. It adopted a two-district floodplain overlay zoning ordinance in December 1954, with the 50-year floodplain as the floodway boundary and the 100-year line as the outer fringe boundary. Only open space uses were permitted in the floodway. Other uses were permitted in the outer fringe area if protected one foot above

the 100-year flood level. A 1977 amendment permitted only open space uses throughout the entire floodplain.

The town entered the emergency phase of the NFIP in December 1972 and the regular program in July 1978. Nonstructural uses such as fill and grading are regulated throughout the entire township. Fill is prohibited in the floodplain. Building sites are also prohibited in subdivisions where construction would affect the floodplain.

The township has prepared its own set of floodplain maps (57 map sheets) for the four watercourses in the township. Four permit applications have been received since 1978. Applications for structures were denied since the ordinance prohibits structures in the 100-year floodplain. This included denial of a variance for reconstruction of a house in the floodplain which had been destroyed by fire and not rebuilt within one year. The Township Hearing Board held that the use had been "abandoned."

The town owns much of the floodplain along Neshaminy Creek. This was obtained by dedication from the Bucks County Redevelopment Authority through condemnation of properties along the creek. Several other areas have been acquired. Water and sanitary sewage systems operated by the township are floodproofed.

Problems: Some existing development.

Keys to Success: Good floodplain maps, strong support from township council.

General Applicability: Tight restriction of floodplain areas to reduce future flood losses is broadly applicable to other towns, particularly in rural areas.

Sources of Information:

(1) CAPE, Region III, May 12, 1980

(2) June McLoughlin, Zoning Officer
Bensalem Township Board of Supervisors
3800 Hulmeville Road
Bensalem Township, Pennsylvania 19020
(215) 639-2500

Bucks County, Pennsylvania

Innovation: The county combined public education with development of an innovative, "performance" zoning approach to protect county natural resources. The zoning included floodplain and stormwater management regulations requiring that development not increase natural peak flows.

Background: Bucks County has 480,000 residents and floodplains along the Delaware River and many tributary streams including Johicken Creek and Neshaminy Creek.

In 1972 the county developed a model performance zoning approach to protect critical resources (forests, soils, agriculture) including water resources. This incorporated a sliding scale of densities and impermeable surface ratios depending on the slope and other factors. The goal was to maintain natural runoff levels. Approximately 20 municipalities have adopted such performance zoning. All 54 towns have adopted floodplain regulations to comply with NFIP standards. Many towns prohibit all development in the floodplain.

The Bucks County Planning Commission's Division of Natural Resources and its conservation district conducted educational programs, helped draft ordinances, and waged a campaign to encourage communities within the county to adopt stormwater management performance standards as part of their zoning or subdivision ordinances that incorporate a "zero excess discharge" con-

cept. This means that each development plan should include drainage facilities that limit peak flows to natural conditions. This basic concept had been earlier recommended by the Delaware Valley Regional Planning Commission. About half of the towns have adopted stormwater management regulations. Recent state legislation authorizes county-wide stormwater management plans. Once these have been adopted and approved, communities will be required to comply with county minimums.

Problems: No direct county regulation of floodplain, (advisory role only); development pressures.

Keys to Success: Innovative approach, good staff, strong public education, relatively high level of citizen awareness of flood problems and the need for resource protection.

General Applicability: Strong emphasis upon public education and a comprehensive "performance-oriented" resource protection approach are broadly applicable to other areas.

Sources of Information:

(1) Robert Moore
Bucks County Planning Commission
22 South Main Street
Doylestown, Pennsylvania 18909
(215) 348-2911

(2) Kenneth D. Kugel
Director, Countywide Planning Section
Bucks County Planning Commission
22 South Main Street
Doylestown, Pennsylvania 18909
(215) 398-2911

Lewisburg Borough, Union County, Pennsylvania

Innovation: Restrictive regulations have been combined with strong administration and enforcement and some acquisition.

Background: Lewisburg Borough is a town of 5,800 (1970 Census). The town experiences flooding along Limestone Run, Buffalo Creek, and the Susquehanna River. Severe flooding occurred in 1972 and 1975.

The town entered the emergency phase of the NFIP in November 1972 and the regular program in February 1977. In April 1975, the town adopted a floodplain conservation district ordinance. It has delineated a floodway based on the 50-year floodplain and encompassing an estimated 80% of the 100-year floodplain. The town obtained a larger scale overlay map from the FEMA contractor to facilitate enforcement. Strong administration and enforcement procedures have been adopted. Permits have been denied for reconstruction.

With the help of the Union County Redevelopment Authority, between five and eight acres of the floodplain were cleared and acquired. Other lands were acquired prior to development. A total of 73 acres of floodplain have been acquired. An evacuation plan is being prepared.

Problems: Quite extensive existing development, some problems with lowering of tax base.

Keys to Success: Severe flood threats, support of planning commission and council, good staff, incentives of the NFIP.

General Applicability: Similar restrictive floodplain regulation is broadly applicable.

Sources of Information:

(1) CAPE, Region III, June 21, 1979

(2) Donald Vaughan, Manager
Lewisburg Borough
331 Market Street
Lewisburg, Pennsylvania 17837
(717) 524-9573

Lycoming County, Pennsylvania

Innovation: Floodplain regulations have been combined with an active public education program, some relocation, a flood warning system, and an emergency operations plan.

Background: Lycoming County is a north central Pennsylvania county with a 1980 population of 118,500. It is located almost entirely within the drainage basin of the West Branch of the Susquehanna River which flows for 38 miles through the county. The Susquehanna and its tributaries (more than 2,200 miles of stream within the county) are subject to severe flooding with recent major events in 1950, 1959, 1964, 1972, 1975, and 1979. As a result of Tropical Storm Agnes in 1972, approximately 13,000 building were damaged. Of these, 2,800 homes were either extensively damaged or destroyed. Damage in the county totalled $54 million.

Because of the severe flood problem, the county adopted a strong floodplain management program emphasizing nonstructural measures. The county has adopted subdivision regulations which are administered by the county for municipalities without their own ordinances. However, the county does not have zoning power. Consequently, it strongly encourages local zoning. Fifty-one of the fifty-two municipalities are enrolled in the NFIP. Most have adopted floodplain zoning and subdivision regulations.

The county administered a program involving relocation of 235 residences and 36 businesses from six floodplain areas. The county also has developed an emergency operations plan that is applicable to all municipalities.

Floodproofing has been stressed by the county through educational efforts. Several major developers have adopted voluntary floodproofing measures, and Sprout-Waldron (an industry with 1,250 employees) has undertaken a major, highly successful floodproofing project for its entire plant site.

A county flood warning system was developed. Prior to the Agnes Flood in 1972, there was limited stream gauging in the watersheds in the county and the warning system was operated by the National Weather Service. In 1976 the county emergency communications system was greatly expanded. The flood warning system was an outgrowth of this effort and involves federal, state, and local levels of government. Eighty-five local volunteers have been recruited to monitor rain or stream gauges. Once activated, these report rainfall or stream levels on an hourly basis. Once the threat of flooding is considered high, emergency evacuation and protection measures may be taken. Initial investment costs for the warning system were about $500 with annual operating costs of about $4,200 since 1977. This system has paid for itself many times over since its installation.

Problems: Extensive existing vulnerable development, landowner opposition to regulation, lack of detailed flood mapping for scattered areas of the county, lack of county zoning and other regulatory standards.

Keys to Success: Repeated and severe flooding, motivated local governmental officials, motivated private citizens and industry, and federal and state assistance.

General Applicability: The county approach taken here, emphasizing public education and preparedness, is broadly applicable to other areas, particularly where a unit of government lacks strong regulatory powers.

Sources of Information:

(1) Thomas E. Bresenhan
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(2) Kathie Hunter
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Lycoming County Planning Commission
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Rapid City, South Dakota

Innovation: Interim floodplain regulations were adopted to control rebuilding in a severely damaged floodway area. Later, permanent floodway restrictions and outer flood fringe restrictions were combined with a major land acquisition program for the 10-year floodplain.

Background: In 1970 Rapid City had a population of 44,000 with 9,000 living in the floodplain. Serious flooding occurred along Rapid Creek in 1942, 1949, 1952, 1962, and 1972. The last event—the flash flood of June 9, 1972, caused by torrential rains and the bursting of a dam—killed 238, destroyed or damaged 824 structures, 1,300 mobile homes and 5,000 vehicles, and caused property damage of $160 million in Rapid City and the surrounding area.

Because of the recurrent flooding problems, the city tried a number of times to assess flood hazards and to plan for flood control prior to the 1972 flood. Various flood control works were proposed. Floodplain regulations had been proposed but were rejected because of development pressures. An open space plan was also proposed for Rapid Creek but had not been implemented by 1972. The city had been admitted to the emergency phase of the NFIP by 1971, but had not yet adopted regulations. Only 27 houses and two businesses had been insured before the catastrophic flood.

Following the disaster the city adopted interim regulations prohibiting rebuilding in the floodway. These were sustained by the South Dakota Supreme Court. The regulations prohibited development outside the floodway within the 100-year floodplain, except for preflood structures damaged less than 50% of their preflood market value.

Five months after the flood, the city formally began acquiring parcels in the 100-year floodplain as part of an open space plan to acquire 1,400 parcels comprising all private land and structures in the floodplain. Residents and businesses were relocated. The project was completed in 1977, at a total cost of approximately $60 million. Of this amount, the Department of Housing and Urban Development contributed $48 million through an urban renewal grant.

Current Rapid City floodplain regulations prevent all development in the 100-year floodplain of Rapid Creek, now essentially in public ownership. Acquired land is zoned and platted for park use. Parkland can be sold or used for other purposes only after a city-wide vote.

Problems: Public apathy before the 1972 disaster, development pressures.

Keys to Success: Repeated floods, planning prior to the 1972 flood, the seriousness of the 1972 flood, availability of federal funds.

General Applicability: The seriousness of the flood and the large amount of federal money involved limit the precedent value of this program. Nevertheless, it stands as the most extensive relocation program in the country and illustrates the severe loss of life and damages that may result from inadequate regulation and reliance on inadequate control measures.

Sources of Information:

(1) Rutherford Platt, University of Massachusetts, Amherst

(2) Haas, J. E., R. Kates, M. J. Bowden (eds.), *Reconstruction Following Disaster*, MIT Press, Cambridge, Massachusetts.

(3) Richard A. Trankle, Administrative Service Officer
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State Capitol Building
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(4) Bonnie Hughes, *Community Development Office*
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Sioux Falls, South Dakota

Innovation: Restrictive floodplain regulations have been combined with a "greenway" acquisition program.

Background: Sioux Falls is a community of 81,343 with floodplains along the Big Sioux River and its tributaries. A 100-year flood occurred in 1969.

The community first adopted floodplain zoning in 1970 as part of a comprehensive planning and zoning program. Initial regulations limited the floodplain to open space uses. In 1979 the community adopted floodplain regulations more nearly in line with the regular program standards of the NFIP. These prohibited development in floodway areas. Structures in the fringe must be elevated two feet above the 100-year flood. A floodplain zoning map was prepared at the scale of 1"=500'. The city has issued very few floodplain building permits since entry into the regular program.

In addition to regulation, Sioux Falls has an extensive greenway project under way for the Big Sioux River floodplain and its tributaries. In 1975 the city council adopted a resolution to create the greenway. At that time about 400 acres were already in public ownership along the river. Since 1975 the city acquired about 300 additional acres, 5% of which was dedicated by subdividers. The city has acquired 85% of the desired land with monies from local revenue sources, Community Development Block Grants and the Land and Water Conservation Fund, and land dedications by developers and citizens. The community has spent about $1.8 million acquiring floodplain properties.

Problems: Existing development, development pressures, inaccurate flood hazard boundary maps.

Keys to Success: Community awareness of recent floods, enlightened community officials, a supportive citizen group, help from federal agencies.

General Applicability: A similar combination of floodplain regulation and acquisition is broadly applicable to floodplain areas across the nation.

Sources of Information:

(1) CAPE, Region VIII, August 19, 1980

(2) Kim Jacobs, City Planner
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Maryville-Alcoa, Tennessee

Innovation: With the help of the Tennessee Valley Authority (TVA), two communities successfully formed a committee to prepare a floodplain management plan and regulations. Maryville has used acquisition and urban renewal as well as regulations to carry out the plan.

Background: Maryville and Alcoa are two small, adjacent communities (approximately 17,500 and 6,500 residents) in eastern Tennessee. Both have extensive areas within the floodplain of Pistol Creek and both have been subject to repeated and severe flooding. They lie within the jurisdiction of the TVA which was established in 1933 to reduce flood losses and to serve other objectives. TVA has had a local flood relations program since 1953. In 1964 TVA surveyed potential flood losses from a maximum probable flood along Pistol Creek which flows through the two towns and concluded that 73 commercial, industrial, and public utility buildings and 306 homes would be subject to flooding.

In 1958 Maryville and Alcoa jointly requested TVA to study their flood problem. They also requested help from the Tennessee State Planning Office. TVA initially considered a structural solution to the flood problem, but rejected a dam because of an inadequate site and very high costs. Nonstructural approaches were then considered in greater depth. With TVA help the two towns formed a joint flood study committee with four working groups. TVA provided technical assistance. The resulting flood damage prevention plan, which was published in 1965, called for four major actions: channel improvements for sections of Pistol Creek, floodproofing of existing structures, revision of zoning and subdivision control ordinances, and urban renewal of certain developed areas.

Since 1964 some of the measures have been implemented. The channel improvements have not, by and large, been carried out nor have existing structures been extensively floodproofed. However, the zoning and subdivision ordinances were revised and some of the floodplain has become part of an urban renewal project in Maryville. Floodplain regulations of the two communities require open space uses (for new uses) for the floodway and elevation above the base flood elevation (except for floodproofed basements) for flood fringe areas. Three of four urban renewal projects called for in Maryville by the 1965 plan have been carried out thereby creating a greenbelt bordering the stream in downtown Maryville. Thirty dwelling units and a shopping center were cleared. Federal urban renewal funds were used for much of this redevelopment. Relocated persons were given cash settlements or alternative housing at an average settlement cost of about $5,000 per person. From community development funds, a park was developed on the site.

Problems: Lack of funds for channel improvements, floodproofing, and relocation; continuing development pressures.

Keys to Success: Lack of clear structural solutions, recurrent flood problems, a tradition of cooperation between communities, technical assistance from TVA and the Tennessee State Planning Office, low cost to local citizens, local enthusiasm for the plan, availability of urban renewal funds.

General Applicability: The experience of these two communities is a good precedent for intergovernmental cooperation by other areas in assessing, planning, regulating, and otherwise managing flood hazard areas. It is also an example of successful federal technical assistance to communities.

Sources of Information:

(1) Rutherford Platt, University of Massachusetts, Amherst

(2) James Wright, Tennessee Valley Authority, Knoxville, Tennessee

(3) John Jagger
Maryville Department of Community Development
and Housing
Maryville, Tennessee
(615) 984-7900, Ext. 268

(4) Herman Best, City Engineer
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(615) 984-7900, Ext. 212

Dallas, Texas

Innovation: Highly restrictive floodplain zoning and subdivision regulations based on detailed flood maps have been combined with acquisition of developed and undeveloped properties and limited flood control works.

Background: Dallas is a rapidly growing city of nearly one million residents. Particularly severe flooding occurred in 1962, 1964, and 1965. Floodplain zoning was first adopted in 1965. In 1968 the city began enforcing regulations for the 100-year floodplain. It entered the regular program of the NFIP in March 1971. Since 1977, the city has prohibited development and subdivisions in the 100-year floodplain except for minor improvements that will not increase flood heights, assuming an equal degree of encroachment.

Restrictions are placed on grading and cutting of vegetation. Open areas must be revegetated. Subdivision and stormwater management regulations have been adopted requiring protection of the 100-year floodplain. If the floodplain is in a residential subdivision it must be dedicated to the city and its boundary indicated on the plat and marked on the ground. In commercial areas, the floodplain may remain in private ownership but is subject to a floodway easement: density bonuses are given for the floodplain. This differentiation between residential and commercial areas is partially based on the ease of monitoring commercial areas. A "floodway commons" approach is used by some subdivisions. The land may be owned by the subdivision if it is maintained by a homeowners' association. In determining flood flows and floodplain boundaries, fully developed floodplains are assumed, based on projected zoning densities and uses.

Dallas imposes particularly tight restrictions on nonconforming uses. A permit from the board of adjustment is required for any alteration or improvement whose cost exceeds $300. Most proposed improvements have been denied permits.

Detailed flood maps on an orthophoto base have been developed for 35 to 40 creeks. Flood maps at a scale of 1" = 50' to 1" = 200', with 1-foot or 2-foot contour intervals have been produced for most of the city. These have proved very useful.

The city has purchased much of the undeveloped floodplain of the Elm Fork of the Trinity River. The park department has also purchased land on White Rock Creek. Purchase began in the early 1960s, using Land and Water Conservation Funds, HUD open space funds, and monies obtained through a local bond issue. One landowner bequeathed to the city 400 acres on the White Rock Creek.

The city has acquired some flood-prone property through a "voluntary relocation program." Several developed areas along the Trinity River have been cleared, primarily low income neighborhoods with houses valued at $5,000 to $8,000. Residents received federal relocation benefits: approximately 140 structures were moved.

The city's acquisition program was begun in 1975 with a bond issue. The final project was undertaken between 1975 and 1979. A second project, using Community Development Block Grant funds, was initiated in 1977 and is near completion.

The city did some channelization to reduce flooding to existing uses, and has purchased some structures in areas designated for proposed flood retention basins.

Problems: Development pressures, inadequate maps, limited public knowledge of flood problems.

Keys to Success: Severe flooding in the 1960s, motivated and informed citizens, city council leadership, excellent staff, good maps.

General Applicability: A similar combination of restrictive regulation, acquisition, and limited flood control works is applicable to other flood-prone communities.

Sources of Information:

(1) Tommie McPherson
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Clinchport, Virginia

Innovation: Regulations were combined with a flood warning system and acquisition to deal with recurrent flood problems.

Background: Clinchport, a small community in southwestern Virginia with a peak population of 359 in 1950, has had recurrent serious flood problems. Most of the town lies in the floodplain between two rivers. The town had four serious floods in the last 20 years, with catastrophic flooding in April 1977. Because of a well-developed flood warning system, no one died, but property damages were severe.

Because of the flooding problems, TVA conducted a flood hazard study in the middle 1960s and early 1970s. Flood control systems were not considered feasible, but a flood warning system was developed and put into place. At the town's request in 1972, TVA began working on a relocation plan because of problems with sewage and water supply and general economic decline.

Clinchport entered the emergency phase of the NFIP March 11, 1974, and the regular program November 1, 1979. Scott county adopted floodplain regulations meeting NFIP regular program standards in October 1979. After the flooding of 1977, the Scott County Redevelopment and Housing Authority began to acquire flood damaged properties and relocate occupants outside of the floodplain using TVA monies. TVA has contributed approximately $1,700,000 to the project. Acquired land will be used for parks or garden plots.

At Clinchport, 65 property owners were involved. Their holdings, which involved 87 tracts, included residential, commercial, religious, and fraternal buildings, together with a school. A total of 50 families have been relocated.

The county plans to establish an integrated flood observing and warning system in 1982-83 to upgrade the existing system with automated flood warning gauges.

Problems: Initially public apathy, lack of financing for relocation, some lack of landowner cooperation.

Keys to Success: Repeated and severe floods, TVA's mapping and technical assistance programs, availability of funds for relocation.

General Applicability: A similar combination of regulation, flood warning systems, and voluntary acquisition has broad general applicability to flood hazard areas.

Sources of Information:

(1) Stuart Braman, Ralph Field Associates, Westport, Connecticut

(2) Jim Wright, Tennessee Valley Authority, Knoxville, Tennessee

(3) Clinchport, Virginia, General Relocation Plan

(4) Lee Boggs, Former Executive Director
Scott County Redevelopment and Housing Authority
P.O. Box 67
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(5) Franklin Crochett, Executive Director
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Cowlitz County, Washington

Innovation: Building regulations are combined with limited acquisition and dredging and channel stabilization to deal with a volcanic-flooding disaster.

Background: On May 18, 1980, many properties along the Cowlitz River in Washington were destroyed as a result of flooding and mud flows cause by the eruption of Mount St. Helens. Massive amounts of silt and debris were deposited along the Toutle and Cowlitz River Valleys covering portions of the 500-year floodplain with five to 200 feet of mud. One hundred ninety-eight dwellings were significantly damaged or destroyed by the mud flow on both streams. The hydrology of the Cowlitz and Toutle River floodplains was significantly altered as a result of the eruption. The denuded nature of the watershed poses a serious continued runoff threat. Approximately $4.1 million was paid in flood insurance claims to 188 property owners.

The county first adopted floodplain regulations in 1969. This established eligibility for entry into the emergency phase of the NFIP in 1972. In 1977 Cowlitz became one of the few counties to be delegated authority to issue permits under the state flood control zone program. Immediately after the 1980 disaster, the county imposed a year moratorium on development in the 500-year floodplain of the Cowlitz and in the area within the "mudline" of the Toutle. Revised USGS floodplain mapping of the Cowlitz River verified the new hydrologic conditions. Due to the sedimentation and debris in the channel and the floodplain, the post-eruption 100-year floodplain was changed to the pre-eruption 500-year floodplain.

Through cooperation with FEMA, Cowlitz County's conversion to the regular program of the NFIP was expedited, enabling threatened residents to purchase larger coverage on August 1, 1980. Most recently, the county has extended the floodplain moratorium until accurate, updated floodplain information can be computed for the Cowlitz and Toutle Rivers. The moratorium prohibits new buildings, septic tanks, and mobile homes in flood hazard areas. Rebuilding of partially damaged structures is being evaluated on a case-by-case basis.

Through its 1362 program, FEMA has acquired 16 flood-prone properties along the lower Toutle River at a cost of $950,000. The county has assumed title to preserve the properties as open space.

The Corps has underway an extensive program to clear the channel and thereby partially restore the conveyance capacity of the Cowlitz and Toutle Rivers. This will reduce future flood threats to low-lying properties. Levees have also been constructed.

Problems: Alteration of hydrologic conditions due to the volcanic eruption, the severity and unusual nature of the flood problems, continuation of flood threat due to many unknowns in such a volcanic event, development pressures.

Keys to Success: The severity of the flood problem, community (county) interest and immediate reaction, landowner awareness, and federal cooperation and monies.

General Applicability: This was a unique situation (volcanic eruption). Nevertheless, the combination of regulations and acquisition are broadly applicable.

Sources of Information:

(1) FEMA files

(2) Ed Hammersmith, Washington Floodplain Management Program

(3) Sarah Deatherage
Cowlitz County
Department of Community Development
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(206) 577-3052

King County, Washington

Innovation: Restrictive floodplain regulations have been combined with a stormwater management ordinance. Acquisition of floodplain areas is also anticipated.

Background: King County, a coastal county which includes Seattle, has an unincorporated population of approximately one million. Flooding is both riverine and coastal (Puget Sound) with principal problems in the riverine areas. Increased drainage from urban runoff is a particularly serious problem. The county entered the emergency program of the NFIP in October 1972 and the regular program in September 1978.

The county adopted floodplain regulations in 1973. These prohibit development in floodways and require that residential development be constructed on fill at or above the 100-year flood elevation. Subdivisions must be designed to provide access during floods. To enforce these regulations, the county provides careful site review. In addition the county has, since 1977, been responsible for issuing permits for state-defined flood control zones within unincorporated areas for five control zones within the county. The county has prepared its own flood maps with five-foot contour intervals and at scales of 1"=200'.

In 1975, 1976 and 1980 the county council passed stormwater management and erosion control ordinances requiring that stormwater control (retention-detention) measures be constructed in new subdivisions to maintain the rate or volume of stormwater flow at pre-development conditions. The county is considering a stormwater utility which will charge landowners for discharge into the stormwater system. The county has adopted a flood warning system and has constructed flood control works for some areas.

It has also adopted an agricultural land preservation program. The electorate approved a $50 million bond issue for acquiring agricultural lands. Some of these funds will probably be used for floodplain acquisition.

Problems: Lack of comprehensive basin plans, existing development, development pressures.

Keys to Success: Public officials interested in and committed to solving flood and drainage problems, technical expertise of staff.

General Applicability: A combination of floodplain regulations and stormwater management regulation with detailed mapping and acquisition is broadly applicable to metropolitan areas.

Sources of Information:

(1) Ed Hammersmith, Washington Floodplain Management Program

(2) George Wannamaker
Dave Aggerholm
King County Department of Public Works
Surface Water Management Division
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Brown County, Wisconsin

Innovation: Floodplain regulations which exceed NFIP standards are carefully monitored and are supplemented with restrictive wetland and shoreland zoning regulations.

Background: Brown County is an eastern Wisconsin county with an approximate population of 175,280. It has flooding problems along Duck Creek and East River and along the Lake Michigan shore. Severe lake flooding occurred in 1973. In addition, erosion problems occur along the Lake Michigan shore. Extensive wetlands are located there as well.

The county adopted shoreland and floodplain zoning in 1969 that was based on USGS and Corps maps. The county entered the emergency phase of the NFIP in March 1972 and the regular program in April 1978. Floodplain regulations exceed NFIP standards. No more than a 0.1-foot rise is permitted in delineated floodway areas. Floodplain regulations require two feet of freeboard above the 100-year base flood elevation. Fill must be one foot above that level, and houses another foot higher. A licensed engineer or architect must certify that elevation requirements have been met. In most instances, commercial structures must be elevated.

The county has been preparing its own flood maps at 1"=200' with a two-foot contour interval. Four to eight inspections are performed for each permit, including before, during, and after construction, and at the point of occupancy. Revised shoreland zoning, wetland zoning, and sanitary controls have also been in place since 1978.

The state and the county have acquired some wetland and floodplain areas. Practically a whole section (640 acres) was donated by a paper company. Through careful application of regulations, the density of some undeveloped areas has been reduced by requiring combination of lots.

Problems: Development pressures, substandard lots, inaccurate flood maps, lack of staff and budget, less restrictive state wetland regulations, need for more detailed flood maps for the eastern shore.

Keys to Success: Severe flooding along Lake Michigan in 1973 and before, good staff, concern of county board of supervisors, a sympathetic board of appeals, good public education.

General Applicability: A combination of restrictive floodplain and wetland regulations with careful enforcement is broadly applicable to other inland and coastal communities.

Sources of Information:

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Milwaukee County, Wisconsin

Innovation: Regulations that exceed NFIP standards have been combined with extensive acquisition of undeveloped floodplains for park and parkway use.

Background: Milwaukee County is the major population center in Wisconsin. It is subject to flooding along numerous small rivers and creeks as well as the Milwaukee River. The Lake Michigan shore also has flooding and erosion problems.

Milwaukee was one the first counties in the nation to adopt floodplain regulations when it adopted elevation requirements in 1936. The county regulated floodplains until 1956 when all of the county was incorporated. Regulatory power then became a municipal prerogative. All 19 of the municipalities within the county have adopted floodplain regulations. Most municipalities either prohibit new development or require fill to a height of three feet above flood elevation established on the maps. Most municipalities are in the NFIP.

Milwaukee County has been acquiring parks along riverbank areas since 1910. Since 1936 it has been acquiring and managing lands within the city of Milwaukee. Most of the county's floodplains have been acquired for parks, parkways, and open space. Acquisition has been primarily with county funds, although some state and federal monies have also been used.

The extensive floodplain park and greenway system has been developed to provide biking, picknicking, hiking, and other recreation opportunities.

Problems: Existing development, lack of acquisition funds, some development within the undeveloped floodplain permitted by cities.

Keys to Success: Careful prior planning; adoption of regulations and acquisition prior to development; high public awareness of environment values, state floodplain standards, technical assistance from the South Eastern Regional Planning Commission.

General Applicability: The long-term, foresighted approach to flood problems is applicable to urbanizing areas and towns with undeveloped or developing floodplains.

Sources of Information:

(1) Onsite visit

(2) CAPE, Region V, 1978

(3) Irving Heipel
County Landscape Architect
Room 301, Courthouse
901 West 9th Street
Milwaukee, Wisconsin 53233
(414) 278-4353

(4) John Hetzer
City of Milwaukee Department of Building Inspection
841 North Broadway
Milwaukee, Wisconsin 53202
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Prairie du Chien, Wisconsin

Innovation: State-supervised local regulations have been combined with acquisition and relocation of some flood-prone properties and voluntary floodproofing of others. This was the first ma-

jor federal (Corps of Engineers) investment in the acquisition and relocation of flood-prone properties. A comprehensive floodplain management plan was developed and is being implemented.

Background: Prairie du Chien is a small town of approximately 6,000 residents subject to recurrent and serious flooding by the Mississippi River. Flooding is of long duration and affects both residential (60%) and commercial and industrial (25%) properties. Flooding has occurred at least 16 times since 1880, with the most serious flooding in 1965 when $2,500,000 in property damages resulted.

The city entered the emergency program of the NFIP in 1970 and the regular program in 1975. Consistent with state standards, the city's regulations define floodway and flood fringe areas. New structures are prohibited within the floodway. Existing properties are regulated only where a structure is damaged more than 50% of its value or is abandoned for more than 12 consecutive months. New structures in the flood fringe must be floodproofed to the record flood protection elevation (two feet above the record flood). Flood fringe structures must be designed so as to allow access during flooding. Basements are prohibited.

As a result of the 1965 flood, the town requested that the Corps conduct a flood control study. This study, completed in 1970, concluded that flood control works were not economically justified and that evacuation and floodproofing were the only feasible alternatives. The plan, approved by the town and Congress, called for evacuation of the 10-year floodplain.

The plan calls for mandatory evacuation of 128 residences and two businesses—5% of the town's population. Properties in the floodway are to be acquired. Estimated total costs of $4,500,000 (1980 price levels) are to be paid 80% by the Corps and 20% locally. The town has received $850,000 in HUD Community Development Block Grant money to help pay its share. The Corps has appropriated $2,200,000 to date. Acquisition is now taking place.

Considerable commercial development will remain in the floodplain, including many historic properties. In order to qualify for relocation assistance, the town must require flowage easements from landowners and adopt and maintain adequate regulations.

Problems: Building-by-building cost-benefit analysis, resulting in selective evacuation of properties; piecemeal acquisition, limiting use of the floodplain for recreation or other public uses; differences between state and federal formulas for relocation payments; possible difficulty reimbursing Corps funds.

Keys to Success: Serious and recurrent flood problems, lack of structural solutions, availability of federal financial assistance; local control in the implementation stage (as a result, 80% of the parcels have been acquired without relying on condemnation).

General Applicability: The floodplain management plan developed here may serve as a useful model for other areas. However, problems with cost-benefit analysis and fragmentary property acquisition may limit its usefulness.

Sources of Information:

(1) Stuart Braman, Ralph Field Associates, Westport, Connecticut

(2) CAPE, Region V, August 9, 1978

(3) Sheaffer and Roland. *Evaluation of the Social Economic and Environmental Effects of Floodplain Regulation, Field Study Report: Prairie du Chien*, Prepared for the Department of Housing and Urban Development, Office of Policy and Research (1977)

(4) Dale Klemme
Community Development Coordinator
338 North Main
Prairie du Chien, Wisconsin 53821
(608) 326-8918

Racine County, Wisconsin

Innovation: Highly restrictive floodplain regulations and bluff setbacks for erosion areas have been combined with acquisition and citizen education and participation.

Background: Racine is an urbanizing southeastern Wisconsin county. It has flood problems along several rivers and streams, including the Root River and its tributaries, the Fox, the Pike, and the Des Plaines, and bluff erosion problems along much of its eastern boundary on Lake Michigan.

In 1969 the county adopted a highly restrictive floodplain zoning ordinance, which generally followed a model developed by the Southeastern Wisconsin Regional Planning Commission. The ordinance, which exceeds both NFIP and state standards, now prohibits all development in the floodplain. Flood storage must also be protected. The county shoreland zoning ordinance also places wetlands in "resource conservation" districts, imposing additional restrictions. This county has a 100-foot setback line for bluff erosion areas along Lake Michigan. It also requires erosion control measures in shorefront development.

The county has prepared detailed flood maps at the scale of 1″=200′ with 4-foot contour intervals. Wetlands, prime agricultural lands and other resources have also been mapped. The county entered the emergency phase of the NFIP in 1968.

The county and towns have several erosion projects to study rates and causes of erosion, including a "coastal watch" of 12 volunteers who monitor wave heights, rain, rates of erosion, and other factors. A technical advisory committee of architects, engineers, and interested citizens has been formed to advise the county board and town boards on permit applications. Floodplains are being acquired for park and open space in several parts of the county.

Problems: Development pressures, less restrictive state and federal regulations, initial problems with flood maps.

Keys to Success: Motivated and aware citizens, motivated county board, limited floodplain development, state shoreland and floodplain zoning requirements, good staff.

General Applicability: Highly restrictive floodplain and other resource-oriented regulations combined with some acquisition is broadly applicable to floodplain areas.

Sources of Information:

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Soldiers Grove, Wisconsin

Innovation: This is one of the most innovative local programs combining regulations meeting state and NFIP standards, land acquisition, floodproofing of structures, relocation, and passive solar energy systems in redevelopment.

Background: Soldiers Grove is a small southern Wisconsin town with a 1980 population of 616. Because it has been repeatedly flooded by the Kickapoo River, emergency levees were constructed in 1969. The Corps studied the flood problem and proposed construction of the La Farge Dam with a 9,500-acre reservoir, channel improvements, and levees. Due to state and local opposition, the dam was not com .eted and the community refused to go along with the levee plan.

In 1975 the town adopted floodplain regulations meeting state standards which require two feet of freeboard above the 100-year flood. The town was admitted into the emergency phase of the NFIP in 1972. In 1975 the community redevelopment office prepared a relocation plan for the downtown area which was in the floodway of the Kickapoo river. The plan was revised in 1976, but implementation did not begin until two years later.

A severe 1978 flood inundated the entire town and caused $52 million in damages. After this flood, a new relocation plan was prepared for postdisaster implementation conditions. The town began an intensive public education campaign and sought federal funds from a number of sources. Implementation is underway at an estimated total cost of $5.75 million with 60% federal and 40% nonfederal cost-sharing. The redevelopment authority acquired a 190-acre site for a new town and installed sewer and water systems.

Floodplain regulations adopted after the 1978 event prohibited rebuilding in the Kickapoo River floodway. The town also required energy conservation and passive solar heating for buildings at the new site and a village-wide solar access provision.

To date approximately $3,255,000 in federal grant funds have been committed to the redevelopment project. Funding has been provided by the Land and Water Conservation Fund, EPA, HUD, and the Economic Development Administration. Thirteen commercial structures have been constructed at the new town site. In addition, four residential structures have been elevated on fill or floodproofed in the outer flood fringe area. Floodproofing is anticipated for 11 more. The city has provided 50% of the cost as grants with the remaining 50% as low interest deferred payment loans.

Problems: Public agency apathy until the 1978 flood and the prospect of a federal dam discouraged implementation of floodplain regulations; fiscal uncertainty and slow appropriation of federal funds.

Keys to Success: Severity of the flood threat, strong leadership by the local redevelopment authority, a multiobjective approach to flood loss reduction and other community goals, education to demonstrate the cost-effectiveness of floodplain management, federal funds.

General Applicability: Many elements of this program may interest other communities, including the content and procedures for preparing the floodplain management plan, the floodplain regulations, the energy management approach, the multipurpose planning goals, the role of the local participatory planning, the leadership of the redevelopment authority, and the role of technical assistance through the state university system, state and federal agencies, and private consulting firms.

Sources of Information:

(1) Onsite visit, June 1980

(2) Larry Larson, Coordinator, Wisconsin Floodplain Management Program

(3) Thomas Hirsch
Coordinator
Office of Community Development
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Soldiers Grove, Wisconsin 54655
(608) 624-5209

Walworth County, Wisconsin

Innovation: Comprehensive floodplain, wetland, and shoreland regulations that exceed federal standards have been adopted. These have been based on town-by-town resource inventories.

Background: Walworth is a rural county in southeastern Wisconsin with a population of 70,000. The county has major flood problems along Turtle Creek, the White River, Sugar Creek, and Honey Creek. In 1974 a flood exceeding a 100-year discharge along Turtle Creek caused considerable erosion and damage to bridge structures.

In 1971 the county adopted a subdivision control ordinance and a shoreland-floodplain ordinance. In 1970 to 1972, it prepared careful resource inventories of floodplains, wetlands, prime agricultural lands, other resources, and existing land uses. In 1974 a comprehensive ordinance was adopted to implement a county-wide plan. The plan and regulations prohibit most fill and structures in flood fringe and floodway areas. Residential uses, septic tank systems, and basements are prohibited. A wetland conservancy district prohibits essentially all development and fill in wetland areas. Shoreland regulations, which apply within 1,000 feet of lakes, have also been adopted. Some of the floodplains have also been zoned for agricultural use. The county entered the emergency phase of the NFIP in June 1975.

The county uses a variety of maps including soil maps, maps from the Southeastern Wisconsin Regional Planning Agency, and Corps and FEMA flood maps. Zoning maps have been prepared on an air photo base at a scale of 1"=400'.

Problems: Inadequate budget and staff, lack of regulation in some incorporated areas.

Keys to Success: Excellence of personnel, supportive state requirements, good public education program, help from Southeastern Wisconsin Regional Planning Commission.

General Applicability: The comprehensive resource protection and public education orientation of this program is broadly applicable to other rural areas of the nation.

Sources of Information:

(1) Ron Neumeister
Environmental Technician
Courthouse Annex Building
Elkhorn, Wisconsin 53121
(414) 723-3344

Gulf Shores, Alabama

Innovation: Barrier island flood hazard regulations that consider wave heights are combined with acquisition and postdisaster planning.

Background: Gulf Shores is a small coastal community of approximately 1,500 permanent residents. It is the central business and resort area of "Pleasure Island," a 32-mile long barrier island which attracts 1.5 million tourists each year. Hurricane Frederic struck the island on September 12, 1979, causing widespread destruction of property in Gulf Shores and destroying most of the first and second tiers of development on the island. Five hundred structures were damaged or destroyed by storm surge levels of 10 to 12 feet combined with wave action.

The community entered the emergency phase of the National Flood Insurance Program (NFIP) in 1972 and the regular phase in 1974. Regulations required elevation of new structures to 10 feet—the 100-year surge elevation. After Hurricane Frederic, revised regulations required deeper pilings, bracing of pilings, and protection from wave heights. Regulations are being tightly enforced.

Through its 1362 program, FEMA is acquiring five units at an estimated cost of $1,068,400. One property owner is donating her property to the city. The property will be sold and the resulting cash used to match a Heritage Conservation and Recreation Service grant of $372,000

Problems: Substantial existing development, misunderstanding of FEMA requirements, landowner opposition, delays in obtaining federal acquisition funds.

Keys to Success: Severity of flood problems, interested local citizens, NFIP incentives, federal monies for acquisition.

General Applicability: In some respects Gulf Shores is typical of a highly developed barrier island community. Use of tight regulations, acquisition and evacuation is applicable elsewhere.

Sources of Information:

(1) FEMA files

(2) Thomas B. Norton, Mayor of Gulf Shores
P.O. Box 29
Gulf Shores, Alabama 36542
(205) 968-7571

(3) Mixon Jones, former Mayor of Gulf Shores

Pensacola Beach, Santa Rosa Island, Florida

Innovation: A comprehensive development code has been adopted which includes setback requirements, an elevation requirement, and flood resistant construction standards for buildings in wave velocity zones (V zones).

Background: Pensacola Beach is a small community of 2,500 residents, located on Santa Rosa Island, a 48-mile long barrier island off the Florida panhandle. The community lies between two sections of the Gulf Islands National Seashore. Two state parks and a portion of Eglin Air Force Base are also located on the island. Pensacola Beach is a popular resort area, and during the 1950s and 1960s many summer cottages were built there on slab foundations. Some of these cottages were heavily damaged by Hurricane Frederic in 1979.

Pensacola Beach is unique in that all land is owned by Escambia County, Florida and administered by the Santa Rosa Island Authority, which was established by the state legislature in 1947. The Authority, vested with the powers of a local government, leases land to private developers, but maintains strict codes and review boards to ensure the community's architectural and environmental integrity. The Authority is preparing a comprehensive development plan which allows for little future development. The community entered the emergency phase of the NFIP in 1970 and the regular phase in 1974. It has developed an efficient emergency plan for evacuation to the mainland.

The Authority's development code requires that all new construction be set back at least 50 feet from the primary dune crest on the Gulf shore, and at least 100 feet upland of the vegetation line on the Bay shore. The "vegetation line" is defined as "the semi-continuous line of perennial vegetation that marks the normal landward limit of high tide/storm waves." The state has also established a building construction setback line which, in most cases, is more stringent than the Authority's line and which is strictly adhered to by the Authority. Manmade structures in coastal waterways are prohibited if current and tidal flows would be modified enough to increase erosion in presently stable shoreline areas.

To qualify its leaseholders for flood insurance, in 1974 the Authority adopted a resolution requiring that new residential construction be elevated above the 100-year flood level and new nonresidential construction be either elevated or floodproofed to the 100-year flood level. Existing uses located below the 100-year flood level cannot be expanded.

Following revisions in the NFIP a 1977 resolution required that all new construction be certified as adequately anchored to pilings, and that the lowest structural members of the lowest floor be elevated to or above the base flood level (10 feet). Alteration of sand dunes in the V zone was prohibited if such alteration would increase potential flood damage.

An early 1979 resolution defined the V zone boundaries to generally follow roads and property lines; thus, some of the V zones lie inland of the actual 100-year floodmark. Structures with any portion in the V zone were considered totally within it.

After Hurricane Frederic (1979) caused unexpected damages to structures in the V zone, a new resolution required increased minimum pile dimensions, minimum pile embedment (5 feet below MSL), direct tie-ins between corner pilings and roof members, and windload protection for at least 140 mph for the entire structure. Minimum elevation for the underside of the building support structure is now set at 13 feet above MSL (10 feet base flood elevation plus three feet allowance for wave activity).

Problems: Existing development, development pressures.

Keys to Success: Severe flood threats, incentives of the NFIP, freedom and willingness of the Santa Rosa Island Authority to strictly control development as owner and lessor of all land in community.

General Applicability: Despite its unique form of land ownership, the Santa Rosa Island Authority's setback requirements and building codes may be widely applicable to other barrier island communities subject to flood and hurricane hazards.

Sources of Information:

(1) James M. Sheffer, General Manager
Santa Rosa Island Authority
Pensacola Beach, Florida
(904) 932-2257

Sanibel Island, Florida

Innovation: Comprehensive resource management regulations including floodplain regulations were based on a comprehensive carrying capacity and hazard plan prepared by the city with the help of consultants. As a result of this plan, the community was downzoned. Further restrictions are under consideration, based on hurricane evacuation problems.

Background: Sanibel Island is a barrier island off the west coast of Florida with a winter population of approximately 17,000 and a summer population of 8,000. It is a wealthy community with a large percentage of older individuals. In 1926 the island was overwashed by a hurricane, which destroyed much of its agriculture. Extensive development has occurred since 1963 when a causeway to the mainland was constructed.

Completion of the causeway led to the construction of 4,000 housing units with a peak season tourist population of 12,000 by 1974. This uncontrolled growth concerned island residents; but Lee County, which had zoning jurisdiction for the area, refused to adopt regulations. In order to control future development, the residents of Sanibel incorporated as an independent city in 1974. They established a moratorium on building permits and began preparing a development plan for the island with the help of several consultants. Interested citizens also founded a Sanibel-Captiva Conservation Foundation to assist planning and conservation efforts. After completing the plan, the city adopted natural systems carrying capacity regulations that addressed floodplains and wetlands as well as other areas. These require that structures be protected to the 100-year flood elevation. All development must meet a broad range of performance standards including density restrictions. Special requirements were adopted for mangrove and beachfront development.

At present, the city is considering additional restrictions to limit development in areas subject to wave action. Regulations have been supplemented by an active public education effort and acquisition of some wetland and floodplain areas.

Problems: Before incorporation, Sanibel lacked zoning authority. Significant development pressures, suits by developers, inadequate coastal flood hazard information, problems with evacuation to the mainland during hurricanes are other problems.

Keys to Success: Highly motivated electorate, private financial resources, local expertise, expert consulting assistance.

General Applicability: A general carrying capacity and resource protection approach has widespread applicability to other communities, particularly where there is no strong memory of a flood disaster. Nevertheless, Sanibel may be unique in its affluence and citizen commitment. Stronger state and federal technical and financial assistance may be required for other areas.

Sources of Information:

(1) Onsite visit

(2) Dick Workman, formerly of the Sanibel-Captiva Conservation Foundation

(3) John Clark, The Conservation Foundation

(4) Porter Goss, City of Sanibel Councilman and former mayor

Hilo, Hawaii

Innovation: Interim floodplain regulations adopted to prevent rebuilding of a coastal area devastated by a tsunamis were combined with governmental acquisition and redevelopment.

Background: Hilo, the Island of Hawaii's largest city, was hit by two severe and seven very severe tsunamis between 1819 and 1960. In 1946 a wave killed 96 and caused $25 million in property damage. After this, some of the waterfront business area was condemned and placed in nonvulnerable uses such as recreation, parking, and roads. However, in 1960, a 35-foot tsunamis inundated backlying areas, killing 61, severely injuring over 100, and causing damage estimated between $22 and $50 million.

Following this event, the Hawaii County Board of Supervisors adopted a 7-month moratorium on building or rebuilding where damage to previous structures was greater than 60% of market value. The legislature created the Hawaii Redevelopment Agency, made public lands available for relocation of homes and light industry, and authorized a $2.5 million bond issue to cover the local share of a proposed urban renewal project. The Redevelopment Authority prepared and implemented a plan involving a 350-acre project with a 310-acre open-space zone along the shore in the front and an elevated 40-acre intensively developed commercial zone in the rear. Three hundred eighty-eight parcels were acquired, involving the relocation of 228 families and 42 individuals and 83 businesses. Net project costs were $9,776,484 with 75% of the funds coming from a federal urban renewal grant and 25% from local sources. Interestingly, the overall tax base of the area was increased rather than decreased by the project.

The city has been participating in the regular program of the NFIP since 1975. Floodplain regulations are incorporated in various zoning subdivision control, plumbing and other codes. New structures including basements, must be elevated to the 100-year flood elevation. Protection must also be provided for attendant facilities. Regulatory protection elevations are 17 to 25 feet. A state statute requires a 40-foot setback from the wave wash area on the shoreline. In addition, the county has adopted special management area regulations for lands within 500 feet of the shore.

Problems: Not all landowners were in favor of the proposed acquisition by the Agency. Federal funding proceeded slowly. Floodplain regulations have been handicapped by lack of information on base flood elevations.

Keys to Success: Severity of the multiple flood events, lack of a satisfactory structural solution, desire for an improved and more aesthetically pleasing waterfront, availability of state and federal funding.

General Applicability: Hilo's shoreline protection and successful relocation and redevelopment are applicable to other communities, particularly in postdisaster situations.

Sources of Information:

(1) Stuart Braman, Ralph Field Associates, Westport, Connecticut

(2) CAPE, Region IX, October 20, 1977

(3) Dale Peterson, FEMA, (415) 556-3534

(4) Sid Fuke
Planning Department
25 Aupuni Street
Hilo, Hawaii 96720
(808) 961-8288

Hull, Massachusetts

Innovation: Coastal floodplain regulations adopted after a disaster incorporate wave heights. Administration and enforcement are aggressive.

Background: Hull is a coastal community 20 miles south of Boston with an approximate population of 10,500. It has an intensively developed coastal floodplain (estimated 860 structures) which has been repeatedly damaged by winter storms and hurricanes (1959, 1967, 1972, 1978). In the most recent severe storm in February 1978, approximately 2,000 structures were damaged or destroyed by high surface water elevations and severe wave action.

The community entered the emergency phase of the NFIP in December 1972. A sewage moratorium was adopted in 1977.

As a result of the coastal storm of 1978, a town disaster center was established. The Boston Regional Office of FEMA was requested to provide elevation and design standards for reconstruction that included wave heights. New state and federal regulations which are being enforced locally require elevation and protection from wave action to a height of 23 feet at the seawall. Limited flood control structures and floodproofing of a sewage treatment plant have been completed.

Problems: Initial lack of flood data including wave heights, substantial development in the floodplain.

Keys to Success: Severity of flood problems, technical assistance from FEMA and the state, overall community awareness, aggressiveness of elected officials, application of a state building code.

General Applicability: The use of task forces, incorporation of wave heights, and strict enforcement are generally applicable to coastal communities.

Sources of Information:

(1) CAPE, Region I, September 1979

(2) Stanley MacLeod
Building Commissioner, Town Hall
Hull, Massachusetts 02045
(617) 925-2000

Scituate, Massachusetts

Innovation: After the winter storm of 1978, restrictive coastal floodplain regulations were adopted, including wave heights, standards for bulkheads, and construction setbacks. The town established

a temporary moratorium on construction in the beach areas and enforces nonconforming use provisions. Regulations are being supplemented with acquisition.

Background: Scituate is a small, intensively developed town of approximately 17,000 on the coast between Boston and Plymouth. It has about 6½ miles of barrier beach along its 9-mile waterfront. Because its beach faces north, the area is subject to severe storm damage from "northeasters." The town sustained close to $2.5 million in damages from a single northeaster in 1972. The great blizzard and coastal flood of February 6-7, 1978 destroyed or seriously damaged 700 beachfront properties, many of which were summer cottages which had been converted to permanent homes.

Scituate entered the emergency program of the NFIP in 1972. Of the 649 policies in effect at the time of the 1978 flood, 479 claims were submitted.

After the storm of 1978 the town adopted a building moratorium on new buildings and reconstruction of old ones for certain areas. New restrictions were also placed on structures in wave zones. A 21-foot floor protection elevation was required for rebuilding as well as for new buildings.

Regulations are being supplemented with acquisition. Through its 1362 program, FEMA will acquire eight barrier island properties located in the velocity zone at an estimated cost of $395,000. The Massachusetts State Department of Environmental Management will assume title to the acquired land.

Problems: Extensive existing development, no feasible structural solutions, lack of funds for land acquisition immediately after the 1978 disaster, strong pressure for redevelopment, community opposition to regulations and acquisition.

Keys to Success: Severity of the flooding, federal incentives, state and federal technical assistance.

General Applicability: The partially successful efforts to deal with reconstruction after a disaster and to require protection from wave heights can serve as an example to other communities.

Sources of Information:

(1) New England River Basin Commission, *The Ocean's Reach.* (1976)

(2) Ed Thomas, FEMA Region I Office, Boston

(3) Stuart Braman
Ralph Field Associates
Westport, Connecticut

(4) Claire McDonough
Conservation Commission
Town of Scituate
Scituate, Massachusetts
(617) 545-6700

Avalon, New Jersey

Innovation: Floodplain regulations meeting NFIP standards have been combined with a beach setback (dune protection) line, dune protection regulations, acquisition of beaches and wetlands, wetland regulations, and an aggressive enforcement and public education program.

Background: Avalon is a barrier island town of approximately 2,500 residents with a summer population of about 25,000. The city has periodic flood and erosion problems. The most serious recent flooding occurred in 1962 when a "northeaster" destroyed much of the dune system. In

the mid-1960's, the city began a dune acquisition program to acquire 15-20 lots in private ownership in the dune area. By 1969 it completed the acquisition and adopted a dune ordinance that zoned all dune areas as conservation areas. In 1970 a dune line was established. In 1975 the community entered the emergency phase of the NFIP and in 1979, the regular phase.

To supplement passive measures to reduce flooding and protect the dunes, the borough embarked on a sand dune establishment program. Many feet of snow fencing have been erected (6,000 feet per year, at times) to trap sand and 500,000 American Beach Grass plants were planted. Foot traffic to the dunes was controlled and walkways over the dunes provide access to the beach. The city also undertook an active educational program, including the mailing of dune protection information with its annual property tax bills. In 1980 the environmental commission won an Outstanding Conservation Achievement Award from the New Jersey Association of Natural Resources Districts for this effort.

Extensive wetlands on the bay side of the island have been protected through conservancy zoning by the borough, state wetland regulations, and purchase of much of the area by the World Wildlife Fund and the state green acres program. The environmental commission and borough council members have taken an aggressive stance in monitoring and enforcing the program.

Problems: Extensive development in the floodplain, occasional violation of dune protection regulations by adjacent landowners and the public (such as illegal paths and fires on the dunes), and opposition to restrictions on development.

Keys to Success: Severe flood and erosion problems, aggressive and informed citizens, technical assistance and cost sharing from the Soil Conservation Service, careful monitoring by the environmental commission.

General Applicability: This combination of flood hazard, dune protection and wetland protection measures is broadly applicable to coastal communities.

Sources of Information:

(1) Robert Buzwell, Yvonne S. Ballenger
Environmental Commission
Municipal Building
Avalon, New Jersey 08202
(609) 967-7485

(2) Rachael Sloan
Councilwoman
Municipal Building
Avalon, New Jersey 08202

Beach Haven, New Jersey

Innovation: Coastal flood hazard elevation requirements meeting NFIP standards have been combined with a beach setback line and selected acquisition of beachfront properties.

Background: Beach Haven is a New Jersey barrier island community with a permanent population of approximately 1,600 and a summer population of about 25,000. Virtually the entire community lies within the 100-year floodplain. Flooding has been frequent with the most serious recent flooding in September 1962. Much of the community was inundated, the dune system was leveled by high velocity waves, and much of the first tier of development along the beach was seriously damaged or destroyed.

After the 1962 flood, the community adopted a beach setback line that prevented rebuilding in some of the most seriously damaged areas. This line was upheld against a claim that it took private property in *Spiegel v. Beach Haven*.

Because of continuing litigation and a desire to have beach areas in public ownership, the town began to acquire properties lying seaward of the beach line after the 1962 flood. State "green acres" funds have been used to acquire approximately 600 feet of ocean frontage. Total acquisition costs have been approximately $130,000. The community entered the emergency phase of the NFIP in June 1970 and the regular phase in April 1971, with a minimum construction elevation of 10 feet.

Problems: Legal challenges, pressures for development.

Keys to Success: Severity of flood problems, state green acre funds, public interest in protecting beach areas.

General Applicability: A combination of regulations establishing protection elevations, a beach setback line, and selective acquisition is broadly applicable to coastal communities.

Sources of Information:

(1) Mrs. Connor
Borough Clerk
Bay and Engleside Avenues
Beach Haven, New Jersey 08008
(609) 492-0111

Sea Isle, New Jersey

Innovation: Floodplain regulations have been combined with a beach protection ordinance, a moratorium on building in an area of the town without sewers, partial acquisition of the floodplain, and dune construction.

Background: Sea Isle is a barrier island community along the New Jersey coast with a permanent population of 2,300 and a summer population of 21,000. It is residentially developed. Virtually the entire city lies within the 100-year floodplain, and has been repeatedly subject to severe floods with the most serious damage occurring in 1962 when flooding covered most of the island inundating 2,272 dwellings, structurally damaging 668 more and completely destroying 208. The island was cut off for three days and most of the dunes were leveled.

After the 1962 storm the city passed regulations requiring that all construction be at least 14 feet above sea level but revised this ordinance in 1966 to reduce the elevation to nine feet. The community entered the emergency phase of the NFIP in June 1970 and the regular phase in December 1970. Protection is now required to 10.5 feet.

The city has adopted not only floodplain regulations but also a beach protection ordinance that prohibits all construction in beach and dune areas except walkways, sand fences, pavilions, and platforms. It also prohibits moving or displacement of sand and destruction of natural vegetation.

Regulations have been supplemented with acquisition. In 1966 the city used $600,000 in state funds to acquire an area washed away by the storm, including an area of 183 homes. The Corps rebuilt the destroyed dunes.

Problems: Extensive existing development, development pressures.

Keys to Success: Severity of flood problems, incentives of the NFIP, state funding for acquisition.

General Applicability: A combination of floodplain regulations, acquisition, and dune construction is broadly applicable to other communities.

Sources of Information:

(1) George Daly, Zoning Officer
City Hall
4416 Ladis Avenue
Sea Isle, New Jersey 08243
(609) 263-1141

East Hampton, New York

Innovation: Floodplain regulations meeting NFIP standards have been combined with restrictive wetland protection regulations; extensive acquisition of floodplain, dune, and wetland areas; a scenic easement program; and a sound monitoring and enforcement effort.

Background: East Hampton is a wealthy community at the eastern end of Long Island's southern fork. It has a year-round population of approximately 14,000. About 10% of those live within the 100-year floodplain. Houses are located along the bay side and on and behind a dune system up to 20 feet high on the Atlantic side. Substantial development pressures exist. In 1938 a hurricane breached the dunes and flooded backlying areas, causing severe flood damages and taking many lives.

The town has been in the regular phase of the NFIP since 1977. Regulatory flood protection elevations are eight feet on the bay side and 11 feet on the Atlantic side. A study is now under way to upgrade floodplain regulations.

Although the floodplain regulations are not particularly innovative, they have been supplemented by a variety of additional measures. A beach grass protection ordinance has been adopted. Tidal and inland wetland regulations have been in effect since the 1970s. The town also has adopted an environmental review act. It is updating its comprehensive plan and is now preparing revised dune setback regulations. A dune overlay district will include everything within 100 feet of the dune crestline (primary line). State wetland regulations also apply to some areas. At present the town is revising its open space zoning ordinance to require clustering in areas of unique environments.

The town has acquired between 400 and 500 scenic easements to protect wetlands, dunes, and other areas. Most easements have been donated or dedicated as a condition to town approval for subdivisions or individual lot development. Lands subject to easements are given real estate tax breaks.

The Nature Conservancy purchased about 1,300 acres of dunes and wetlands in 1968. The State of New York subsequently purchased some of this land from the Conservancy and now owns over 800 feet of beach. The Nature Conservancy has also purchased much of the "Atlantic Double Dunes" extending from Amagansett into the village of East Hampton. Other acquisitions by the Conservancy are anticipated for dune and wetland areas. By 1974 approximately 20% of the town was in public ownership. This did not include scenic easements.

Problems: Extensive existing development, development pressures, small scale of FEMA maps, lack of money for acquisition, obstruction of ocean views by elevated structures.

Keys to Success: A high level of community awareness and interest, a comprehensive resource management approach, bond issues for wetland and dune acquisition, assistance of conservation organizations, willingness of citizens to contribute financially, an enlightened planning board and expert staff.

General Applicability: A similar combination of flood hazard, wetland protection, dune protection, and comprehensive zoning regulations with acquisition is broadly applicable to other coastal areas, although funds and support for acquisition may not be so readily available in other areas.

Sources of Information:

(1) CAPE, Region II, August 16, 1978

(2) Thomas M. Thorsen
159 Pantigo Road
East Hampton, New York 11937
(516) 267-8442

Southampton, New York

Innovation: Restrictive coastal floodplain regulations have been combined with dune protection, velocity zone and wetland regulations. Considerable freeboard above the 100-year flood elevation is required for coastal structures. Coastal setbacks, wetland protection provisions, and dune protection regulations have also been adopted.

Background: Southampton is an eastern Long Island coastal community with an estimated year-round population of 30,500 and a summer population of about 125,000. It includes 27 miles of barrier beaches and an extensive system of bays. Approximately 500 acres lie in the coastal high hazard area and another 7,000 acres lie in the flood fringe. Much of the summer population lives within these areas: 3,000 dwellings are located in hazard areas (1975 estimate) with 300 along the coast, 2,000 along interior bays, and 700 along the Peconic Bays. The town is subject to severe flooding from coastal storm surges. The most severe damage resulted from a 1938 hurricane which killed 102 people. Winter storms also affect the area.

Southampton entered the regular program of the NFIP in 1973. Floodplain regulations require that coastal residential construction be elevated 15 feet above mean sea level, which is between 3 to 4 feet above the estimated level of the 100-year flood. Buildings on the bay front must be 2 to 2-1/2 feet above the 100-year flood level. Township ordinances also prohibit building in the tidal wetlands and require setbacks from ocean beaches and from the edge of tidal wetlands.

Problems: Extensive existing development, development pressures, NFIP requirements that undercut local standards.

Keys to Success: Severity of flood hazard, state tidal wetland law, incentives of the NFIP, public concern for environment.

General Applicability: A similar combined flood hazard, wetland and dune protection program is broadly applicable to other eastern and Gulf Coast communities.

Sources of Information:

(1) CAPE, Region II, October 4, 1976

(2) Sheaffer and Roland, Case Study, prepared for the Federal Insurance Administration

(3) Harold Williams
Building and Zoning Administrator
116 Hampton Road
Southampton, New York 11968
(516) 283-6000

Wrightsville Beach, North Carolina

Innovation: Floodplain elevation requirements exceeding NFIP standards have been combined with broader regulations related to dune setbacks, wetland protection, and the capacity of community services. Emphasis has been placed on careful enforcement of a flexible permitting procedure and a coordinated development review process, including a "project impact" analysis that must be completed by all developers.

Background: Wrightsville Beach is an old resort town dating from 1899. It is located on two barrier islands. Several hurricanes struck the town in the mid-1950s and severely damaged beach properties. Construction was temporarily halted, but growth pressures resumed in the 1960s. Construction peaked in a boom between 1970 and 1973. Several high-rise apartments were constructed.

Threats to groundwater supplies and sewage treatment problems resulted. Consequently, in 1974 the town board "down-zoned" the entire community to favor single-family residences and large lot sizes. In 1970 the community entered the regular phase of the NFIP. Buildings must be elevated to the 100-year flood elevation with a 1-foot free-board requirement. Buildings are ordinarily prohibited in a 150-foot-wide dune line (considered a velocity zone by the community). Wetlands are placed in a conservation zone. Sea walls and bulkheads are prohibited.

In 1974 the community prepared a comprehensive land use plan in order to comply with the requirements of the Coastal Zone Management Act. This plan was based on many of the existing policies and guidelines. Consequently, the town needed no new major ordinances or ordinance changes to implement the plan.

Problems: Inadequate flood and erosion data to determine protection elevations and coastal setbacks; severe beach erosion problems; lack of clarity in regulatory policies, procedures and standards.

Keys to Success: Strong administrative leadership by the building director and community support for his actions, flood hazard information supplied by FEMA and the Corps.

General Applicability: A general ordinance applied here with emphasis upon project review and strict enforcement may be more politically acceptable in some communities than very detailed regulatory standards.

Sources of Information:

(1) John Nesbitt, Director
Department of Public Works
200 Parmele Boulevard
Wrightsville Beach, North Carolina 28480
(919) 256-4148

Cranston, Rhode Island

Innovation: The city has adopted two-district coastal floodplain regulations combined with wetland controls. Administration is effective.

Background: Cranston is the third largest city in Rhode Island with a 1980 population of 71,922. It lies within the Patuxent River basin, which drains approximately 200 square miles south and west of Providence. A small strip borders Narragansett Bay. Consequently the town is subject to both riverine and tidal flooding. About 10% of the land in Cranston (1,700 acres) is subject

to flooding. Thirty-eight percent of all industrial acreage is located there. Severe flooding occurred in 1886, 1938, and 1954.

In 1974 Cranston joined the regular phase of the NFIP and adopted regulations requiring elevation of structures to the 100-year flood level. Prior to this, it had adopted zoning regulations prohibiting first floor building elevations below the 100-year flood elevation. Currently Cranston has strong floodplain zoning and subdivision controls which delineate floodway and flood fringe areas. Boundaries from FEMA maps have been transposed to city plat maps for use in program administration. Subdivision regulations require floodproofing, drainage and storage, and elevation of public and private facilities. Public investments must conform to these regulations. Several upstream dams have been constructed, which substantially reduce peak flows in the river. Cranston has adopted not only floodplain regulations but also identified wetlands and, according to Rhode Island law, coordinates permits for development in these areas.

Problems: Substantial existing floodplain development; increased runoff from urbanization, which in turn, increases future flood problems; development pressures; aggravation of flooding from development in adjacent communities; lack of wave heights on maps.

Keys to Success: Concern with environmental values, including wetlands, several severe floods in the last 20 years, incentives of the NFIP, active state wetland protection and coastal zone management programs, mapping and technical assistance from the Corps and other agencies.

General Applicability: This combination of floodplain regulations, wetland controls, land acquisition and flood control works has applicability in other estuarine areas.

Sources of Information:

(1) Sheaffer and Roland, Case Study, Conducted for the Federal Emergency Management Agency (1977)

(2) Frederic Vincent
Planning Department, City Hall, Park Avenue
Cranston, Rhode Island 02910
(401) 461-1000

East Providence, Rhode Island

Innovation: Two-district zoning has been used to control development in a coastal area. This has been combined with acquisition and redevelopment.

Background: East Providence, a city of 52,400, lies on the Seekonk River estuary. Flooding from hurricanes was particularly severe in 1938 ad 1954. Following recommendations of a governor's task force in 1955, the city adopted floodplain regulations restricting to open space use lands subject to hurricane flooding and lying 10 feet or less above mean sea level. Areas subject to hurricane flooding and lying between 10 and 15 feet above mean sea level may be used for human occupancy but must be protected against flooding. In 1974 the city prepared a development plan for the 14.4 miles of city waterfront, recommending additional parks.

Problems: Existing uses, enforcement.

Keys to Success: Severity of the flood hazard, recommendations of the governor's task force, an active state coastal zone program, flood protection elevations that exceed NFIP standards, an active city planning office and conservation commission.

General Applicability: A two-district coastal ordinance combined with comprehensive waterfront planning and selective acquisition is broadly applicable.

Sources of Information:

(1) Heritage Conservation and Recreation Service, Vol. 2, *Urban Waterfront Renewal*

(2) Joseph Sarvick
City Hall
East Providence, Rhode Island
(401) 434-3311

South Kingston, Rhode Island

Innovation: Protection elevations have been combined with a beach setback line and comprehensive wetland and environmental protection regulations in a zoning ordinance.

Background: South Kingston is a southwestern Rhode Island coastal community with a population of about 20,414. It has 3.7 miles of barrier beach with maximum elevations of 1.5 to about 5.0 feet at dune crest. Both erosion and flooding are problems. A severe hurricane in 1938 took eight lives. A 1954 hurricane destroyed all beach front structures. At present approximately 1,800 residences, 21 businesses, and 175 other structures are located in the floodplain. Approximately 186 are located in the wave velocity zone.

The community entered the emergency phase of the NFIP in 1970 and the regular phase in 1972. Regulations require a minimum setback of 150 feet from the mean high water mark. All new structures must be at or above the 100-year flood level, and anchored to pilings. Regulations are contained in the building code. In 1975 the town adopted a high-hazard flood zoning district. It has also adopted a far-reaching zoning ordinance which establishes a beach setback line, regulates intertidal and freshwater wetlands, provides detailed information and standards for construction in high hazard and beach setback areas, requires environmental impact statements, permits conditions to be imposed on special exceptions, and prohibits structures and construction in "high flood danger zoning districts." The danger district includes all of the area between the open water and the dune line. Occupancy or use for more than 24 hours is prohibited in this area.

Problems: Development pressures, extensive existing development, court cases.

Keys to Success: Severe and recurrent flood problems, a high degree of community environmental awareness, community leadership, state and federal technical assistance.

General Applicability: The combination of protection elevations and an open space beachfront zone with both environmental and hazard emphases is broadly applicable to other coastal communities.

Sources of Information:

(1) Crane Miller, Sheaffer and Roland, Washington, D.C.

(2) CAPE, Region I, 1978

(3) Anna Prager, Town Planner
Town of South Kingston
South Kingston, Rhode Island
(401) 789-9331

Warwick, Rhode Island

Innovation: A two-district coastal floodplain zoning ordinance includes a high velocity wave zone and an elevation requirement for backlying areas. Regulations have been combined with limited acquisition and urban renewal.

Background: Warwick is a moderate-sized city of 87,000, fronting on Narragansett Bay. Its beach area was a major summer resort during the later 1880s and 1890s but declined during the early part of this century. A 1938 hurricane destroyed 308 homes including many of the mansions. Further severe damage was caused by a 1954 hurricane. This led to the formation of a governor's task force which recommended hurricane protection measures including two hazard zones for severely impacted areas.

A 1955 zoning ordinance incorporated the two-zone approach. It prohibited rebuilding and new buildings in areas of extreme danger—defined roughly to coincide with areas devastated by the 1954 storm—but permitted new development in backlying areas, providing buildings designed for overnight residence were at least 15 feet above mean sea level.

After the community entered the NFIP, restrictions on development in the high hazard zone were relaxed somewhat. Elevated structures are permitted inside the wave velocity zone if consistent with NFIP standards. A 1964 community redevelopment program recommended a 26-acre park project for the waterfront area. This is now being implemented through a $1 million bond issue and federal funds.

Problems: Existing development, lack of funds, less restrictive federal standards.

Keys to Success: Severity of the flood threats, availability of data from the Corps and other agencies, aid of the governor's hurricane task force, availability of special legislation to aid the city in condemning land subject to hurricane damage, the need for community open space and recreation areas.

General Applicability: Warwick's two-zone regulations combined with selective acquisition are widely applicable to other communities with the prospect of hurricane, winter storm, or tsunami damage.

Sources of Information:

(1) Heritage Recreation and Conservation Service Vol. 2, Case Studies, *Urban Waterfront Renewal* (1979)

(2) George Valkoun
Deputy Planning Director
City Hall
Warwick, Rhode Island 02886
(401) 738-2000

Chesapeake City, Virginia

Innovation: Carefully enforced floodplain regulations meeting NFIP standards and state building code standards have been combined with wetland regulations for tidal wetland areas.

Background: Chesapeake is a rural community of 125,000 with only about 15% of its land developed. It is subject to tidal flooding from Chesapeake Bay. Considerable development exists in the floodplain, but most is subject to very low levels of inundation due to the natural elevation (six feet or more).

In 1970 the community adopted floodplain regulations. The city entered the regular phase of the NFIP on February 1, 1977. It has adopted floodplain zoning. It also enforces the state building code provisions which require elevation of structures to the 100-year flood elevation Wetland regulations have been adopted pursuant to a state statute.

The floodplain contains extensive wetlands but very little development has been allowed within them. A careful site review procedure has been adopted for floodplain and wetland permits. Fill permits are required throughout the city. Subdividers are required to provide drainage facilities to accommodate present and future drainage needs.

Problems: Landowner complaints about regulations, maps at inadequate scales.

Keys to Success: Incentives of the NFIP, plentiful land, state building code provisions, state and Corps support for wetland regulations, good community support.

General Applicability: A combination of floodplain and wetland regulations is broadly applicable to coastal and inland areas.

Sources of Information:

(1) CAPE, Region III, March 31, 1978

(2) Max Taback
Department of Planning
300 Cedar Road
City of Chesapeake, Virginia 23320
(804) 547-6176

Virginia Beach, Virginia

Innovation: Floodplain regulations exceeding NFIP standards have been combined with wetland protection and dune protection regulations.

Background: Virginia Beach is a southeastern Virginia coastal community of 285,000 with a large coastal floodplain and some riverine flooding. The most severe flooding of record occurred in August 1933 due to a hurricane. The "Ash Wednesday" storm of 1962 caused the most extensive damage to property and beach structures ever experienced in the city.

Floodplain regulations were adopted in October 1973. To deal with NFIP deficiencies, the community has adopted its own floodplain maps at a 1"=100' scale. Pursuant to the regulations, activities disturbing the land must receive a permit. First floors must be elevated at least one foot above the 100-year flood elevation. Development is prohibited in coastal areas below six fet above mean sea level. In one portion of the community, elevations of 18.5 feet above mean sea level for the first habitable floor are required to offset possible wave action. Proposals to develop wetlands are carefully reviewed. A coastal sand dune ordinance requires setbacks. Four coastal zone "inspectors" hired by the city effectively enforce regulations. Private citizens have also been effective in monitoring and enforcing regulations.

Problems: Initially inadequate maps which failed to show wave heights, substantial existing development, court suits.

Keys to Success: Strong public and city administration support, detailed flood maps, active wetlands board.

General Applicability: The broad wetland/floodplain approach taken here to reduce flood losses and protect resources could be effectively applied to many communities.

Sources of Information:

(1) CAPE, Region III, June 13, 1977

(2) Carl A. Thoren, Assistant City Engineer
Municipal Center
Virginia Beach, Virginia 23456
(804) 427-4131

APPENDIX IV

Selected Local Ordinances

During the 1970's some communities went beyond recommended state and federal minimum standards in regulating flood hazard areas to meet multipurpose community goals or address special situations. Examples are provided here of such innovative ordinances.

HIGH RISK EROSION AND BLUFF AREAS

Lincoln Township, Michigan

Zoning Ordinance, Article XV

HIGH RISK EROSION OVERLAY DISTRICT

SECTION 15.1. DISTRICT AND INTENT: The regulations herein contained are intended to effectively control unwise development of the shorelands where property damage during high water periods has or may result in structural property damage; actual loss of land; loss of recreational swimming beaches and/or lack of access to Lake Michigan.

It is the further intent of this district to:

1. Insure the land will support a structure for a minimum of 30 years.
2. Insure that the structure itself will not contribute to erosion problems along the shoreline.
3. Contribute to the aesthetic beauty of the shoreline.
4. Minimize the financial hardships that individuals and local governmental units suffer due to erosion.
5. Promote the public safety, health and welfare of the residents of Lincoln Township.

SECTION 15.2. LEGISLATIVE AUTHORITY: The following regulations are applicable to those areas which are generally defined as to be controlled by the Shorelands Protection and Management Act of 1970 (Act 245 of P.A. of 1970), as amended. The shorelands area consists of all lands which border on Lake Michigan in Lincoln Township situated within 1,000 feet landward from the ordinary high water mark as defined in Section 2 of Act No. 247 of the Public Acts of 1955, as amended, being Section 322.702 of the Compiled Laws of 1948.

1. Beach: Flat area from shoreline to foredune area or bluff, devoid of vegetation.
2. Bluff Areas: Shoreline areas where there is an abrupt rise from the beach areas to an elevation 30' or more above beach level. Such areas are usually characterized by a flat plateau on the top of the bluff and the soil characteristics are generally a mixture of clay, soil and

sand. The natural angle of repose for a bluff is steeper than for a foredune face composed only of sand.

3. Foredune (or Primary Dune): Gently sloping area immediately inland of the beach, generally stabilized by dune grasses and low shrub vegetation. There may or may not be a depressed area behind the foredune.

4. High Dune Shoreline Areas: Shoreline areas where the elevation above mean lake level within a distance of 300' of the shoreline exceeds 60' for a substantial portion of the shoreline frontage.

5. Inland Dune: Inland area of rising dunes inland of foredune area. Seaward slope may be forested or still exhibit vegetation characteristic of foredune area, depending upon period of stability of dune. The backside of the dune supports woody vegetation.

6. Low Dune Shoreline Areas: Shoreline areas where the maximum elevation above mean high water mark for a distance of 300' inland to the shoreline does not exceed 60'.

7. Mean Highwater Mark: (Also referred to as Ordinary High Water Mark): For Lake Michigan this has been determined to be 579.8' above sea level. For purposes of this ordinance, the juncture of the seaward edge of the foredune and the beach is a more readily identifiable location than the mean high water mark and may be used whenever mean high water is specified.

8. Shoreline Erosion Control Structure: Any structure, device or earth change operation intended to control, correct or mitigate shoreline or beach erosion.

9. Thirty Year Erosion Mark: To be set and defined by the State of Michigan. The set back distances established in this ordinance are minimum and may be altered based upon the thirty year erosion mark as established by the State of Michigan.

SECTION 15.4 PERMITTED USES: All uses permitted in the high risk erosion areas are subject to the conditions hereinafter imposed for each use and subject to site plan review provisions pursuant to Section 17.2 and 17.3 of the ordinance.

SECTION 15.5 SHORELINE SET BACK: All new construction above and below ground shall be set back a minimum as follows:

1. Low Dune Areas: 110' from the seaward edge of the foredune.

2. High Dune Areas: 110' from the seaward edge of the foredune area, plus 1' for each foot of elevation above 60'. Where such set back distance is less than the distance to the top of the inland dune facing the lake, the minimum distance shall be to the top of such inland dune. Construction shall be prohibited on the seaward slope of the dune face or in the foredune area.

3. Bluff Areas: 110' from the top of the bluff (or the seaward edge of the foredune if one exists). Distance to be measured from the top of the bluff above the mean high water mark.

4. Platted Areas: In platted areas those set backs may be reduced by the Board of Appeals depending upon the particular terrain of the area and the set back of existing neighboring properties. In no case shall the set back be less than 75' from seaward edge of the dune area.

SECTION 15.6 TREE CUTTING AND/OR REMOVAL OF SHORE COVER:

1. The natural vegetation shall not be cleared, cut nor destroyed from more than 30% of the total set back area. The cutting of the 30% shall not create clear-cut openings totaling more than 30' for each 100' of shoreline.

2. Natural vegetation shall be preserved as far as practical and where removed shall be replaced with other vegetation that is equally effective in retarding runoff, preventing erosion and preserving natural beauty.

SECTION 15.7. REMOVAL OF SAND OR SOIL: No sand or soil shall be removed or relocated within the set back area. No bluff or primary dune shall be cut down in elevation within the set back area.

SECTION 15.8. SHORELINE STRUCTURES REQUIRING A BOARD OF APPEALS SPECIAL USE PERMIT: Shoreline protection devices and all other construction not expressly exempted in Section 15.12 regardless of whether the proposed construction is temporary or permanent in nature, constructed above the mean high water mark as defined in Section 15.3 shall be subject to site plan review pursuant to Section 17.2 and 17.3 and a special use permit issued by the Planning Commission. The intent of this regulation is to alert the shoreline property owners of possible impact of such construction in high risk erosion areas.

SECTION 15.9 PROCEDURES FOR SHORELINE STRUCTURES:

1. The applicant shall submit to the Zoning Administrator a site plan prepared according to the provisions of Section 17.2.
2. The Zoning Administrator shall review the site plan pursuant to the provisions of Section 17.3 and shall forward the approved site plan to the township planning commission.
3. The township, upon receipt of the approved site plan, shall notify by first class mail the applicant and all adjacent shoreline property owners within 500 feet of subject property of date, time and location of the board of appeals hearing in which the applicants request shall be considered. Said Planning Commission hearing shall be scheduled within 30 days after receipt of the approved site plan.
4. The Planning Commission will consider the applicants request at the scheduled meeting and shall either table or render a decision upon the applicants request based upon the Planning Commission findings of fact. The board of appeals may stipulate additional conditions and/or restrictions deemed necessary to uphold the district purpose and intent as specified in Section 15.1 in granting a special use permit.
5. The Zoning Administrator upon the action of the Board of Appeals shall within 5 days issue the applicant a special use permit noting in writing all conditions specified by the Board of Appeals or notify the applicant in writing of the Planning Commissions denial.

SECTION 15.10 APPLICANTS RIGHT TO APPEAL: The applicant, pursuant to P.A. 184 of 1943 as amended, shall have the right to appeal through Circuit Court action any decision rendered by the Board of Appeals.

SECTION 15.11 HOLD HARMLESS PROVISIONS:

1. These procedures and/or the issuance of special use permit shall not be construed as to pose any legal or moral obligation upon Lincoln Township or its elected or appointed officials.
2. Issuance of the special use permit does not relieve the property owner from civil liability claims by other property owners.
3. Issuance of the permit does not imply approval of the need for, design of, or benefits of the proposed construction.

SECTION 15.12. EXCEPTIONS: No special use permit shall be required for the following:

1. Wooden stairways (but not steel or concrete) which provide beach access.
2. Wells (but not pumphouses), where alternate sources of water are not satisfactory or where such location is necessary to avoid contamination by septic tanks and drainage fields. (Note: Septic tanks and drainage fields are not permitted within required set back area).

3. Fences of wire or wooden construction, providing that such fences do not detract from natural appearances of the shoreline.

DUNE PROTECTION

Virginia Beach, Virginia

ARTICLE 16. COASTAL PRIMARY SAND DUNE ORDINANCE

1600. LEGISLATIVE INTENT

The governing body of the City of Virginia Beach, acting pursuant to Chapter 2.2 of Title 62.1 of the Code of Virginia, for the purposes of fulfilling the policy and standards set forth in such chapter, adopts this ordinance regulating the use and development of coastal primary sand dunes.

1601. DEFINITIONS

For the purpose of this ordinance:

(a) "Commission" shall mean the Virginia Marine Resources Commission.

(b) "Commissioner" shall mean the Commissioner of the Virginia Marine Resources Commission.

(c) "County or city" shall mean the governing body of such county or city.

(d) "Coastal primary sand dune" hereinafter referred to as "dune", shall mean a mound of unconsolidated sandy soil which is contiguous to mean high water, whose landward and lateral limits are marked by a change in grade from ten per centum or greater to less than ten per centum, and upon any part of which is growing on July one, nineteen hundred eighty, or grows thereon subsequent thereto, any one or more of the following: American beach grass (Ammophilla breviligulata); beach heather (Hudsonia tometosa); dune bean (Strophostylis umbellata var, paludigena); dusty miller (Artemisia stelleriana); salt meadow hay (Spartina patens); seabeach sandwort (Arenaria peploides); sea oats (Uniola paniculata); sea rocket (Cakile edentula); seaside goldenrod (solidago sempervirens); and short dune grass (Panicum ararum). For purposes of this ordinance, "Coastal Primary Sand Dune" shall not include any mound of sand, sandy soil or dredge spoil which has been deposited by man for the purpose of the temporary storage of such material for later use.

(e) "Governmental activity" shall mean any or all of the services provided by the Commonwealth or a county or city to its citizens for the purpose of maintaining public facilities and shall include but not be limited to such services as construction, repairing and maintaining roads, sewage facilities, supplying and treating water, street lights and constructing public buildings.

(f) "Wetlands Board" or "board" means the board created as provided for in Section 62.1-13 of the Code of Virginia.

1602. USES

The following uses of and activities on dunes are permitted if otherwise permitted by law:

(a) The construction and maintenance of noncommercial walkways which do not alter the contour of the coastal primary sand dune;

(b) The construction and maintenance of observation platforms which are not an integral part of any dwelling and which do not alter the contour of the coastal primary sand dune;

(c) The planting of beach grasses or other vegetation for the purpose of stabilizing coastal primary sand dunes;

(d) The placement of sand fences or other material on or adjacent to coastal primary sand dunes for the purpose of stabilizing such features, except that this provision shall not be interpreted to authorize the placement of any material which presents a public health or safety hazard;

(e) Sand replenishment activities of any private or public concern provided no sand shall be removed from any coastal primary sand dune unless authorized by lawful permit;

(f) The normal maintenance of any groin, jetty, riprap, bulkhead or other structure designed to control beach erosion which may abut a coastal primary sand dune;

(g) The normal maintenance or repair of presently existing roads, highways, railroad beds and facilities of the United States, this State, or any of its counties or cities, or those of any person, firm, corporation, or utility, provided no coastal primary sand dunes are altered;

(h) Outdoor recreational activities, provided that such activities do not alter the natural contour of the coastal primary sand dune or destroy its vegetation;

(i) The conservation and research activities of the Virginia Marine Resources Commission, Virginia Institute of Marine Science, Commission of Game and Inland Fisheries and other related conservation agencies;

(j) The construction and maintenance of aids to navigation which are authorized by governmental authority;

(k) Activities pursuant to any emergency declaration by the governing body of any local government or the Governor of the Commonwealth or any public health officer for the purposes of protecting the public health or safety; and

(l) Governmental activity on coastal primary sand dunes owned or leased by the Commonwealth of Virginia or a political subdivision thereof.

1603. APPLICATIONS

Any person who desires to use or alter any coastal primary sand dune within the City of Virginia Beach, other than for those activities specified in Section 1602 herein, shall first file an application with the Wetlands Board at the office of the City Engineer in accordance with Section 4 of Section 62.1-13.5 of the Code of Virginia. The Wetlands Board may establish a processing fee in accordance with Section 4 of Section 62.1-13.5 of the Code of Virginia. No person shall be required to file two separate applications for permits if the project to be undertaken would require that a permit be filed in accordance with Section 62.1-13.5 as well as this ordinance. Under such circumstances the fee accompanying the application required by Section 62.1-13.5 shall also be the fee for the purpose of this ordinance.

1604. PUBLIC INSPECTION OF APPLICATIONS

All applications and maps and documents relating thereto shall be open for public inspection at the office of the City Engineer.

1605. PUBLIC HEARING PROCEDURE

Not later than sixty days after receipt of such application, the Wetlands Board shall hold a public hearing on such application. The applicant, the local governing body, the Com-

missioner, the owner of record of any land adjacent to the coastal primary sand dunes in question, known claimants of water rights in or adjacent to the coastal sand dunes in question, the Virginia Institute of Marine Science, the Department of Game and Inland Fisheries, the Water Control Board, the Department of Highways and Transportation and governmental agencies expressing an interest therein shall be notified by the board of the hearing by mail not less than twenty days prior to the date set for the hearing. The Wetlands Board shall also cause notice of such hearing to be published at least once a week for two weeks prior to such hearing in the newspaper having a general circulation in the City of Virginia Beach. The costs of such publication shall be paid by the applicant.

1606. ACTION OF BOARD

In acting on any application for a permit, the board shall grant the application upon the concurring vote of three members of the board. The chairman of the board, or in his absence the acting chairman, may administer oaths and compel the attendance of witnesses. Any person may appear and be heard at the public hearing. Each witness at the hearing may submit a concise written statement of his testimony. The board shall make a record of the proceeding, which shall include the application, any written statement of witnesses, a summary of statements of all witnesses, the findings and decision of the board, and the rationale for the decision. The board shall make its determination within thirty days from the hearing. If the board fails to act within such time, the application shall be deemed approved. Within forty-eight hours of its determination, the board shall notify the applicant and the Commissioner of such determination and if the board has not made a determination, it shall notify the applicant and the Commission that thirty days has passed and the application is deemed approved. The board shall transmit a copy of the permit to the Commissioner. If the application is reviewed or appealed, then the board shall transmit the record of its hearing to the Commissioner. Upon a final determination by the Commission, the record shall be returned to the board. the record shall be open for public inspection at the office of the City Engineer.

1607. BONDING REQUIREMENTS

The board may require a reasonable bond or letter of credit in an amount and with surety and conditions satisfactory to it securing to the City of Virginia Beach compliance with the conditions and limitations set forth in the permit. The board may, after hearing as provided herein suspend or revoke a permit if the board finds that the applicant has failed to comply with any of the conditions or limitations set forth in the permit or has exceeded the scope of the work as set forth in the application. The board after hearing may suspend a permit if the applicant fails to comply with the terms and conditions set forth in the application.

1608. REVIEW PROCEDURE

(a) In making its decision whether to grant, to grant in modified form or to deny an application for a permit the board shall base its decision on the following factors:

(1) Such matters raised through the testimony of any person in support of or in rebuttal to the permit application.

(2) Impact of the development on the public health and welfare as expressed by the policy and standards of Chapter 2.2 of Title 62.1 of the Code of Virginia and any guidelines which may have been promulgated thereunder by the Commission.

(b) If the board, in applying the standards above, finds that the anticipated public and private benefit of the proposed activity exceeds the anticipated public and private detriment and that the proposed activity would not violate the purposes and intent of Chapter

2.2 of Title 62.1 of the Code of Virginia and of this ordinance, the board shall grant the permit, subject to any reasonable condition or modification designed to minimize the impact of the activity on the ability of the City of Virginia Beach to provide governmental services and on the rights of any other person and to carry out the public policy set forth in Chapter 2.2 of Title 62.1 of the Code of Virginia and in this ordinance. Nothing in this section shall be construed as affecting the right of any person to seek compensation for any injury in fact incurred by him because of the proposed activity. If the board finds that the anticipated public and private benefit from the proposed activity is exceeded by the anticipated public and private detriment or that the proposed activity would violate the purposes and intent of Chapter 2.2 of Title 62.1 of the Code of Virginia and of this ordinance, the board shall deny the permit application with leave to the applicant to resubmit the application in modified form.

1609. PERMITS

The permit shall be in writing, signed by the chairman of the board and notarized.

1610. EXPIRATION DATE AND EXTENSIONS

No permit shall be granted without an expiration date and the board, in the exercise of its discretion, shall designate an expiration date for completion of such work specified in the permit from the date the board granted such permit. The board, however, may, upon proper application therefore, grant extensions.

1611. ISSUANCE OF PERMITS BY COMMISSION

No person shall conduct any activity which would require a permit under a coastal primary sand dune ordinance unless he has a permit therefore.

1612. ADMINISTRATIVE, APPELLATE AND ENFORCEMENT PROVISIONS

In administering the provisions of this article and in order to provide for enforcement, the Wetlands Board shall bear all those duties and responsibilities and follow those procedures specified in Sections 62.1-13.7 through 62.1-13.19 of the Code of Virginia in the same manner and on the same basis as it administers and enforces the Wetlands Zoning Ordinance.

1613. INVESTIGATIONS AND PROSECUTIONS

The Wetlands Board shall have the authority to investigate all projects whether proposed or ongoing which alter a coastal primary sand dune located within the City of Virginia Beach. The Wetlands Board shall have the power to prosecute all violations of any order of such board, or any violation of any provision of the Wetlands Zoning Ordinance contained in Section 62.1-13.20:5 of the Code of Virginia or of the Coastal Primary Sand Dune Zoning Ordinance contained in Title 1, Article 16 of the Zoning Ordinance of the City of Virginia Beach, Virginia.

1614. VIOLATION OF ORDERS, RULES AND REGULATIONS

Any person who knowingly, intentionally, negligently or continually violates any order, rule or regulation of the Commission or of the Wetlands Board or violates any provision of Title 62.1, Chapter 2.2 of the Code of Virginia or Title 1, Article 16, of the Zoning Ordinance of the City of Virginia Beach, Virginia, or any provision of a permit granted by the Wetlands Board or the Commission pursuant to Title 62.1, Chapter 2.2 of the Code of Virginia or Title 1, Article 16, of the Zoning Ordinance of the City of Virginia Beach, Virginia, shall be guilty of a misdemeanor. Following a conviction, every day the violation continues shall be deemed a separate offense.

1615. INJUNCTIONS

In addition to and notwithstanding the provisions of Section 62.1-13.20:7 of the Code of Virginia and Section 1614 herein, upon petition of the Wetlands Board to the Circuit Court of the City of Virginia Beach, the court may enjoin such unlawful act and may order the person so acting unlawfully to take such steps as are necessary to restore, protect and preserve the wetlands involved.

1616. EXEMPTIONS

Nothing in this Article shall affect any project or development (i) for which a valid building permit or final site plan approval has been issued prior to July one, nineteen hundred eighty; or (ii) which, if no building permit is required for such project including a locally approved mining operation, has been otherwise commenced prior to July one, nineteen hundred eighty and certified as exempt by the Commission or the Wetlands Board; or (iii) approved by the Council of the City of Virginia Beach pursuant to Ordinance No. 931 which was the Coastline Management Ordinance in effect from March 26, 1979 to July 1, 1980. Nothing in this section shall be deemed to exclude from regulation any activity which expands or enlarges upon a project already in existence or under construction.

COASTAL HIGH VELOCITY ZONES AND WAVE HEIGHTS

South Kingston, Rhode Island

Zoning Ordinance, Article 12

FLOOD DANGER ZONING DISTRICTS

Section 1200
STATUTORY AUTHORIZATION

The General Assembly of the State of Rhode Island has in Chapter 101 of the Public Laws of 1973, provided that an ordinance adopted pursuant thereto may include provisions for designating areas, and controlling and limiting development in such areas subject to periodic or seasonal flooding utilizing standards, charts, contour maps, elevations or other data showing prior or anticipated flood levels; and for designating areas and restricting development in areas which are deemed to be irreplaceable natural resources or areas of outstanding ecological value to the Town.

Therefore, the provisions of this Article are set forth in accordance with the aforementioned purposes as follows:

Section 1210
FINDINGS OF FACT

Portions of the Town of South Kingstown, Rhode Island are flood danger areas subject to storm damage and flooding, and are areas of unique ecological significance.

The flood danger areas of South Kingstown are subject to periodic inundation which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, and extraordinary public expenditures for flood protection and relief, all of which adversely affect the public health, safety and general welfare. Flood and associated losses are caused by the occupancy of flood danger areas by uses which are vulnerable to floods or erosion because they are inadequately elevated or otherwise protected or which increase flood or erosion damage to other property.

The flood danger areas of the Town of South Kingstown are exceptionally vulnerable to hurricane damage and erosion. Records kept by the U.S. Army Corps of Engineers and others, document severe damage from prior hurricanes and other severe storms resulting in loss of life and excessive property damage.

In particular, the barrier beaches are low in profile and highly vulnerable to wind and wave erosion particularly during hurricanes, and as such are particularly dangerous to the those people who inhabit them.

Section 1220
ESTABLISHMENT OF A HIGH FLOOD DANGER ZONING DISTRICT

There is hereby created within the flood danger areas of the Town of South Kingstown, a High Flood Danger District (HFD), the boundaries of which are shown on the Official Zoning Map.

The areas of High Flood Danger District are the areas between the Atlantic Ocean and the Dune Line as defined herein. The provisions of this Ordinance with regard to HFD Districts shall apply to all lands located in the Town of South Kingstown shown on the Official Zoning Map as being located within the boundaries of the High Flood Danger District.

Section 1221
DEFINITION OF DUNE LINE

The Dune Line is defined as the line marking the landward limit of the area between the Atlantic Ocean and the landward limits of sand dunes, salt marsh, or any other land feature of the barrier beach complex within the HFD Zoning District. The Dune Line is described on the Official Zoning Map and is the landward boundary of the HFD Zoning District.

Section 1222
PURPOSE OF THE DUNE LINE

A Dune Line is hereby established to describe the limits of the HFD Zoning District in order to protect and preserve natural barrier dunes and physical features associated with barrier beaches which provide a protective barrier from the actions of the Atlantic Ocean and Storms thereon for adjacent lands and inland waters and land. The practice of destroying said dunes and barrier beach features by development thereon and by other destructive practices constitutes a serious threat to the safety of adjacent properties, and to the health and safety of persons who might be living on or visiting these barrier beach areas.

Section 1223
WARNING AND DISCLAIMER OF LIABILITY

The degree of flood and erosion protection required by this Article is considered reasonable for regulatory purposes and is based on scientific methods of study. Larger floods may occur. This Ordinance does not imply that areas outside the High Flood Danger District boundary or land use permitted within such district will be free from flooding or flood damages. This Ordinance shall not create liability on the part of the Town of South Kingstown or any officer or employee thereof for any flood damages that result from reliance on this Ordinance or any administrative decision lawfully made thereunder.

Section 1230
REGULATIONS WITHIN THE HFD ZONING DISTRICT

Except as provided in Article 2, Section 220, no structure or use shall be allowed and no construction of any kind shall be allowed within the HFD Zoning District except the following:

A. Boardwalks and steps to permit access across the dunes or berms to the Ocean beach, without damage to the dunes themselves;

B Sand fences to encourage the accumulation of sand;

C Individual lifeguard stations.

Section 1231
INDIVIDUAL BEACH CABANAS, DRESSING ROOMS OR BATHHOUSES - LIMITATIONS

Individual beach cabanas, dressing rooms or bathhouses permitted by special exception under the provisions of Article 2, Section 220 shall be:

A No larger than 100 square feet in floor area;

B No more than fifteen (15) feet in height;

C Used for daytime occupancy only;

D Not designed for use as dwellings;

E Limited to one such individual beach cabana or dressing room or bathhouse per lot.

In addition to satisfying the requirements relating to special exceptions set forth elsewhere in this Ordinance, the applicant for a special exception authorizing an individual beach cabana, dressing room or bathhouse on a lot in an HFD Zoning district shall be required to show to the satisfaction of the Zoning Board of Review that the granting of the special exception will not result in conditions which will:

A. Unreasonably disturb the existing dunes:

B. Be likely to create wind or water currents detrimental to the existing dunes; and

C. Be likely to create, increase or prolong any other hazard.

UPDATING A COMPREHENSIVE PLAN FOR A BARRIER ISLAND TO CONSIDER HURRICANE EVACUATION

Sanibel Island, Florida

City of Sanibel Resolution No. 79-40

A RESOLUTION ESTABLISHING A NEED FOR AND ARRANGING FOR THE SERVICES OF PROFESSIONAL CONSULTANTS TO REVISIT THE COMPREHENSIVE LAND USE PLAN ELEMENTS DEALING WITH HURRICANE EVACUATION AND HAZARD MITIGATION.

WHEREAS, the Sanibel Comprehensive Land Use Plan, adopted July 1976, recognizes and deals with the problems of hurricane evacuation and hazard mitigation as essential elements of ensuring the public health, safety and welfare; and

WHEREAS, since the adoption of the Comprehensive Land Use Plan, new and meaningful information and evidence have been developed which would appear to be of particular consequence, TO WIT:

The adoption in 1979 by Lee County of a Comprehensive Land Use Plan which incorporates land use and traffic policies which directly impact on Sanibel's evacuation routes;

The adoption in 1979 by the Fort Myers Metropolitan Planning Organization of a 20 year road program which portends certain weaknesses in the present evacuation plans;

The completion of a U.S. Army Corps of Engineers/Southwest Florida Regional Planning Council pilot project on the hurricane evacuation capacities of Lee County;

The impact of Hurricane Frederic in September, 1979, on Dauphin Island, Alabama, a barrier island which bears many striking similarities to Sanibel Island;

The experience of more than 3 years growth on Sanibel under the provisions of the Comprehensive Land Use Plan, including especially information on density and degrees of intensity of land use and;

WHEREAS, Lee County has now established a Department of Disaster Preparedness which has developed an evacuation and shelter plan for all of Lee County, including the City of Sanibel and Captiva Island, and;

WHEREAS, The President of the United States has expressed specific concerns about barrier island development and has requested the Department of Interior to formulate policy to reduce encouragement of barrier island development to minimize hazards and unnecessary disaster-related costs; and

WHEREAS, these new policies discouraging barrier island development are to be available from the Department of the Interior in the immediate future; and,

WHEREAS, Public Law 93-288 May 22, 1974, Section 406 states that as a condition of any federal loan or grant for disaster relief, a "local government shall agree that the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land-use and construction practices . . ."; and,

WHEREAS, The County of Lee has failed to take action requested in City of Sanibel Resolution 79-33 relating to specific temporary public safety and welfare measures in areas particularly vulnerable to hurricane impact.

NOW, THEREFORE, BE IT RESOLVED by the Council of the City of Sanibel, Lee County, Florida, that:

Section 1. The City Manager arrange for professional planning consultants, the final binding commitment not to be entered into without prior council approval, including specifically an evacuation expert, to review, analyze and report with recommendations to Council and the Planning Commission on the adequacy of the Sanibel Comprehensive Land Use Plan to meet public health, safety and welfare needs involving evacuation and hazard mitigation in light of new information available.

Section 2. The City Planning Department and the Sanibel Planning Commission provide assistance and cooperation to the professional consultants in order to achieve a timely, coordinated report.

Section 3. The professional consultants shall visit the Mobile, Alabama, area, particularly Dauphin Island, to assess the impact of Hurricane Frederic (Sept. '79) as it specifically relates to Sanibel's evacuation, hazard mitigation and hurricane recovery plans.

Section 4. The professional consultant's report shall address not only the problems of the evacuation itself (such as lead times, numbers of persons to be moved, route and shelter availabilities, property protection measures) but also it shall address the consequences confronting this community, including potential economic dislocations, should the Sanibel Causeway be rendered unuseable for a short or longer period of time.

Section 5. Professional consultants should take into consideration in their report the findings of the Planning Commission's current Commercial Uses Study as well as the implications of hazard mitigation (including land-use and construction practices) on the Economic Assumptions of the Comprehensive Land Use Plan.

Section 6. This Resolution shall take effect immediately upon adoption.

DULY PASSED AND ENACTED by the Council of the City of Sanibel, Lee County, Florida this 20 day of November, 1979.

TRANSFER OF DEVELOPMENT RIGHTS FOR SPECIAL TREATMENT OVERLAY DISTRICTS

Clearwater, Florida

Zoning ordinance, (excerpt)

Authorizing Transfer of Development Rights for
Special Treatment Overlay Districts

* * * * *

D. Fences and walls: A fence or wall shall be required as a separation between the play area and an abutting lot.

A fence or wall may be constructed of wood, chain link or decorative concrete block, provided it allows the free flow of air through the play area and provides an eighty (80) percent opacity when viewed from an abutting lot.

All fences and walls shall be subject to the following restrictions unless approved otherwise by the Board:

1. In any residential district no closed wall or fence shall be erected or maintained within twenty (20) feet from the corner intersection of street right-of-way.
2. Fences or walls outside of front building line shall be limited to a maximum height of four (4) feet. A fence or wall shall be limited to a minimum of 5′ and a maximum of six (6) feet in the rear and side yards unless the rear and/or side yard is on a canal or waterfront in which case the maximum height shall be four (4) feet.
3. No barbed wire, spire tips, sharp objects, or electrically charged fences shall be erected in any residential area or district.
4. Fences shall be treated as a structure for building permit purposes, and a permit shall be obtained prior to erection. Setbacks shall remain measured from the principal structure.
5. A vegetative planting shall be allowed within the setback area between the fence or wall and the property line of the subject property.

E. The playing of music or the use of any type of broadcasting outside of the buildings shall be prohibited.

F. Supplementary conditions, as deemed appropriate, may be prescribed by the Board.

SECTION 9. "ST" SPECIAL TREATMENT OVERLAY DISTRICT-SPECIAL REGULATIONS FOR AREAS OF ENVIRONMENTAL SENSITIVITY AND LANDS AND STRUCTURES OF HISTORICAL AND ARCHEOLOGICAL SIGNIFICANCE.

1. INTENT AND PURPOSE:

Within Collier County there are certain areas, which because of their unique assemblages of flora and/or fauna, their esthetic appeal, historical or archeological significance or their contribution to their own and adjacent ecosystems, make them worthy of special regulations. Such regulations are directed toward the conservation, protection, and preservation of ecological, commercial, and recreational values for the greatest benefit to the people of Collier County. Such areas include, but are not necessarily limited to mangrove and fresh water swamps, barrier islands, coastal beaches, estuaries, cypress domes, natural drainage ways, aquifer recharge areas and lands and structures of historical and archeological significance.

The purpose of this overlay district regulation is to assure the maintenance of these environmental and cultural resources and to encourage the preservation of the intricate ecological relationships

within the systems and at the same time permit those types of developments which will hold changes to levels determined acceptable by the board of County Commissioners after public hearing.

8. TRANSFER OF RESIDENTIAL DEVELOPMENT RIGHTS.:

A. The residential development rights shall be considered as interests in real property and may be transferred in portions or as a total as provided in this Section. Once used, the residential development rights shall not be used again and the residential development rights of the subject "ST" lands providing them shall be considered severed forever.

B. The transfer of residential development rights to be used for non-"ST" land shall be from "ST" designated land to non-"ST" land located in TDR-1, RM-1, RM-1A, RM-2, and RT Zoning Districts and shall be subject to all of the requirements of the basic zoning district unless specifically approved otherwise as provided by law. (Rev. ORD. 78-71 - 12/5/78)

(1) The Zoning director is hereby directed to waive the land area requirement for the landscaping, off-street parking or open space to the extent necessary to accommodate the number of residential units permitted in 8, F, (1) of this section.

C. The minimum area of "ST" land eligible for the transfer of development rights shall be two (2) acres of land excluding submerged land.

D. Upon the approval of the transfer of residential development rights for an "ST" land by the Director, the property owner of the "ST" land is strongly encouraged to donate the land to the county; however, if the owner chooses otherwise, the approval may be conditioned upon an agreement by the county which will guarantee that said "ST" lands will be forever retained in its natural condition and will never be developed in any manner whatsoever by anyone except as stipulated in the agreement.

E. The maximum number of residential units which may be transferred from "ST" land to non-"ST" land shall be compiled on the basis of each acre of "ST" land at the following rate: One half (0.5) of a residential unit for each one (1) acre of "ST" land.

F. Maximum number of residential units which eligible non-"ST" lands may receive.

(1) Non-"ST" lands in RM-1, RM-1A, RM-2, and RT zoned districts are eligible to receive residential development units provided that the maximum number of residential units which may be transferred to the non-"ST" land does not exceed 20% of the maximum number of residential units permitted under the basic zoning of the RM-1 and RM-1A district or 10% of the maximum number of residential units permitted under the basic zoning of the RM-2 and RT district as the case may be. For the purpose of determining the number of residential units which non-"ST" land is capable of receiving, the following formula shall apply:

RM-1 District
6.22 units × 20% = 1.24 units per acre

RM-1A District
6.22 units × 20% = 1.24 units per acre

RM-2 District
16 units × 10% = 1.6 units per acre or 10% × units permitted under basic zoning, whichever is the greater.

RT District
20 units × 10% = 2.00 units per acre[1]
30 units × 10% = 3.00 units per acre[2]

[1]With cooking facilities.
[2]Without cooking facilities.

(2) Non-"ST" lands in the TDR-1 zoned districts are eligible to receive residential development units provided that the maximum number of residential units which may be transferred to the non-"ST" land do not exceed a maximum number of three (3) units per acre of non-"ST" land.

(3) For the purpose of calculating the final fractional residential unit as the total number of residential units eligible for transfer to a non-"ST" property, the following shall apply: Any fractional residential unit shall be converted upward, if 1/2 or more of a whole unit, or downward, if less than 1/2 of a whole unit, to the nearest whole unit value. (Rev. ORD. 78-71)

9. PROCEDURE FOR OBTAINING TRANSFER OF RESIDENTIAL DEVELOPMENT RIGHTS.

A. Any owner of "ST" land may apply for a transfer of residential development rights either separately or concurrently with a building permit for their use in connection with the construction of the transferred residential units on non-"ST" land as provided in this section.

Prior to the approval of any transfer of residential development rights or the issuance of any building permits in connection with the use of any transfer of residential development rights, the petitioner shall submit the following information and data, as applicable to the petition, to the Director for his review and action.

(1) Name and address of "ST" property owner.

(2) Name and address of non-"ST" property owner.

(3) Legal description of "ST" land from which transfer of residential development rights is petitioned.

(4) Survey of "ST" property from which transfer of residential development rights is requested.

(5) Legal description of non-"ST" land which receives the transfer of residential development rights.

(6) Survey of the non-"ST" land which receives the transfer of residential development rights.

(7) Three copies of an executed deed of transfer of ownership of the "ST" property to the county in a form approved by the County Attorney, or, if the owner elects not to deed the "ST" land to the County, the "ST" owner shall provide a guarantee, agreeable to and approved by ordinance of the Board of County Commissioners, that the "ST" land will be forever retained in its natural condition and will never be developed in any manner whatsoever by anyone. For the purpose of this requirement, natural conditions shall include minor nature related improvements such as nature paths, boardwalks, outdoor educational learning areas, and removal of exotic vegetation.

Such a guarantee shall be recorded with the Clerk of the Circuit Court of Collier County, Florida as a recorded restriction of the use of such land and shall be binding to all present and subsequent owners, heirs, or assigns of such property. Such restrictions may not be amended, deleted, or otherwise altered except by affirmative vote of all members of the Board of County Commissioners.

10. TIME LIMITATIONS ON DIRECTOR'S APPROVAL OF TRANSFER OF RESIDENTIAL DEVELOPMENT RIGHTS OR AUTHORIZATION TO PROCEED WITH THE PROCESSING OF A BUILDING OR CONSTRUCTION PERMIT.

A. The Director's approval of a transfer of residential development rights or authorization to proceed with the processing of a building or construction permit shall be valid so long as such approval is permitted by law.

The failure to act on the part of the petitioner to exercise the transfer of residential development rights or obtain and culminate an authorized building or construction permit within the time period provided by law shall automatically terminate such approval and the County shall be held harmless for any damages arising out of the petitioner's failure to act.

11. SEQUENTIAL USE OF RESIDENTIAL UNITS APPROVED FOR TRANSFER BY THE DIRECTOR.

A. Upon the issuance of any permit for the construction of residential unit(s) upon a non-"ST" receiving land, the first residential units built thereon shall be considered to be the residential units approved for transfer by the Director. Upon completion of all eligible residential units approved by the director for transfer, the succeeding residential units constructed shall be considered the residential units permitted under the basic zoning district regulations.

COMBINED WETLAND AND FLOODPLAIN REGULATIONS

Hopkinton, Massachusetts

Town of Hopkinton Wetlands and Flood Plain Protection By-Law

I. PURPOSES

The purposes of the wetlands and flood plain protection district are:

A. To protect the health and safety of persons against hazards and pollution which may result from unsuitable development in marshlands, lowlands, and bogs, areas with poorly drained soils, and along the banks of streams and watercourses and all areas subject to flooding or seasonal inundation.

B. To protect the value of lands and buildings in such wetlands and flood prone areas.

C. To protect, preserve, and maintain the water table and water recharge areas within the Town so as to preserve present and potential water supplies.

II. LOCATION

The locations and boundaries of all wetlands and flood plains included within the scope of this by-law are shown on a map entitled "Town of Hopkinton Natural Resources Map" on file at the Town Clerk's office, Hopkinton Town Hall. Said map is hereby, by this reference, made a part of this zoning by-law.

III. USE REGULATIONS

A. The Wetlands and Flood Plain District shall be considered as overlying other districts included in the Town's Zoning By-Laws. Any uses permitted in the portions of the Districts so overlayed shall be permitted; where there is a conflict between provisions of this by-law and other zoning by-laws, the more restrictive regulation shall take precedence.

B. In the Wetlands and Flood Plain District, no building or structure shall be erected, constructed, moved, or enlarged except for not more than 30% of the existing structure; no dumping, filling, or earth removal or transfer shall be permitted, nor shall the land be used for any purpose except:

1. Conservation of soil, water, plants and wildlife, including wildlife management shelters.
2. Outdoor recreation, including (but not limited to) play areas, nature study, boating and fishing and hunting where otherwise legally permitted.
3. Foot, bicycle and horse paths and bridges, provided such uses do not effect the natural flow pattern of any water course.
4. Forestry, grazing, crop farming, nurseries, truck gardening and harvesting of crops.
5. Flower or vegetable gardens, lawns, fences, and non-commercial signs as referred to in Article Two, section I (District Regulations), A. (Residence A), subsection 4. 1.
6. Municipal parks and municipal water supply facilities including wells, reservoirs and pumping stations.
7. Any of the following uses, if permission is obtained in each case from the Board of Appeals:
   a. Driveways and upgrading of existing roads if necessary for access to unrestricted land.
   b. Barns, garages and other accessory residential uses.
   c. Fairs, carnivals, circuses, pony rides and similar events.
   d. Municipal waste water facilities.
   e. Dams, excavations or changes in water courses for agricultural, fishing or recreational purposes, or for drainage improvements or mosquito control activities.

IV. EXCEPTIONS

The Board of Appeals may grant permission for any use and/or structure, subject to the following:

A. The application has been referred to the Planning Board, the Board of Health, and the Conservation Commission and reported upon by all three Boards or 60 days shall have elapsed following such referral without receipt of such reports.

B. The land is proven by the applicant to be either (1) not subject to flooding or (2) not unsuitable for the proposed use because of hydrological and/or topographic conditions.

C. The proposed use will not be detrimental to the public health, safety and welfare and will not derogate from the purposes of this by-law.

D. The proposed use will comply in all respects to the provisions of the underlying District or Districts within which the land is located.

V. BUILDING PERMITS

Whenever an application is made for a building permit on land which the building inspector believes may involve the use of land in the Wetlands and Flood Plain district, the applicant shall be required to provide as part of such application a plan of the lot on which such building is intended to be built, showing elevations of the land contours at one-foot intervals, referred to mean sea level datum indicating all wetlands and certified by a registered land surveyor. This plan shall be referred to the Conservation Commission and Board of Health and reported upon or 30 days shall have elapsed following such referral without receipt of such reports. No building permit shall be issued unless it is demonstrated by the applicant that the proposed use is in conformance with the purposes of this by-law.

MUDFLOW AREAS

Burbank, California

Resolution No. 19,541

A RESOLUTION OF THE COUNCIL OF THE CITY OF BURBANK ESTABLISHING REGULATIONS FOR CITIZEN PARTICIPATION IN THE FEDERAL FLOOD INSURANCE PROGRAM.

WHEREAS, the Federal Emergency Management Agency (Agency) has determined that certain areas of the City of Burbank (City) are subject to Special Flood Hazards and Mudflow Hazards; and

WHEREAS, the Agency has adopted Flood Hazard Boundary Maps (FHBM) and after detailed examination will adopt a Flood Insurance Rate Map (FIRM) designating such flood hazard and mudflow hazard areas; and

WHEREAS, Section 7-13 of the Burbank Municipal Code defines Flood Hazard areas and provides standards and regulations for the grading of land and the construction and maintenance of buildings and structures within said areas of the City of Burbank;

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF BURBANK as follows:

Section 1. That a permit shall be obtained before construction or development begins within any area of Special Flood Hazards or Mudflow hazards shown on the FIRM, the Flood Hazard Areas being designated as Zones A, AO, AH & B, on the FIRM and the Area of Mudflow hazard being designated as Zone M on the FIRM.

Section 2. That the application for a permit shall include, but not be limited by the following:

A. A topographic map identifying existing conditions on the project site and all adjacent properties, as well as the area of inundation by water or mudflow;

B. A complete grading plan for the project site showing final elevation of all lots and parcels prior to development and the proposed elevation in relation to mean sea level of the lowest habitable floor of all structures.

C. A soils engineering and geology report examining data on the distribution, nature and strengths of existing soils. Conditions and recommendations for development must be certified by a registered civil engineer experienced in soils engineering.

D. Description of the extent to which any water course or mudflow area will be altered or relocated as a result of the proposed development.

E. Proposed elevation in relation to mean sea level by which any structure will be floodproofed and certified by a registered civil engineer that the floodproofing method will meet the floodproofing requirements of this resolution.

Section 3. That the Building Director shall obtain and maintain the following information.

A. Obtain and maintain for public inspection and make available as needed for Flood Insurance Policies:

1. The certified elevation required in Section 4.C.1. of this Resolution;

2. The certification required in Section 4.C.2. of this Resolution;

3. The floodproofing certification required in Section 4.C.3. of this Resolution; and

4. The certified elevation required in Section 4.F.2. of this Resolution.

Section 4. That the following standard of construction shall be required in the special flood hazard areas:

A. Anchoring.

1. All new construction and substantial improvements shall be anchored to prevent flotation, collapse or lateral movement of the structure.

B. Construction Materials and Methods.

1. All new construction and substantial improvements shall be constructed with materials and utility equipment resistant to flood damage.

2. All new construction and substantial improvements shall be constructed using methods and practices that minimize flood damage.

C. Elevation and Floodproofing.

1. New construction and substantial improvement of any structure shall have the lowest habitable floor, including basement, elevated to or above the base flood elevation. Nonresidential structures may meet the standards in Section 4.C.3. Upon completion of the structure the elevation of the lowest habitable floor, including basement, shall be certified by a registered professional engineer or surveyor and provided to the official set forth in Section 3.A.

2. New construction and substantial improvement of any structure in zone AO shall have the lowest floor, including basement, elevated to or above the depth number specified on the FIRM. If there is no depth number on the FIRM, the lowest floor, including basement, shall be elevated one foot above the crown of the nearest street. Nonresidential structures may meet the standards in Section 4.C.3. Upon completion of the structure a registered professional engineer shall certify that the elevation of the structure meets this standard and provide to the official as set forth in Section 3.A.

3. Nonresidential construction shall either be elevated in conformance with Section 4.C.2. or 3. or together with attendant utility and sanitary facilities:

   (a) be floodproofed so that below the base flood level the structure is watertight with walls substantially impermeable to the passage of water;

   (b) have structural components capable of resisting hydrostatic and hydrodynamic loads and effects of buoyancy, and

   (c) be certified by a registered professional engineer or architect that the standards of this subsection are satisfied. Such certifications shall be provided to the official as set forth in Section 3.A.

4. Mobile homes shall meet the above standards.

D. Standards for Storage of Materials and Equipment.

1. The storage or processing of materials that are in time of flooding buoyant, flammable, explosive, or could be injurious to human, animal or plant life is prohibited.

2. Storage of other materials or equipment may be allowed if not subject to major damage by floods and firmly anchored to prevent flotation or if readily removable from the area within the time available after flood warning.

E. Standards for Utilities.

1. All new and replacement water supply and sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the system and discharge from systems into flood waters;

2. On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

F. Standards for Subdivisions.

1. All preliminary subdivision proposals shall identify the flood hazard area and the elevation of the base flood.
2. All final subdivision plans will provide the elevation of proposed structure(s) and pads. If the site is filled above the base flood, the final pad elevation shall be certified by a registered professional engineer or surveyor and provided to the official as set forth in Section 3.A.
3. All subdivision proposals shall be consistent with the need to minimize flood damage;
4. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage;
5. All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage.

Section 5. That the following standards shall be required for development in Mudflow Hazard Areas:

A. Subdivision Proposals.

1. Siting, orientation and design of any improvement shall be to minimize mudflow damage.
2. Lot designs and the location of proposed improvements shall permit accommodation of debris from mudflow without damage to improvements and with access to a street to provide for clean up and removal.
3. An overflow route for mud and debris associated with the mudflow shall be provided in order to direct overflow away from slopes and improvements and toward safe points of discharge.
4. Accommodation of Mudflow.
   (a) Design of streets shall provide for conveyance of mudflow unless other channel or debris basin is provided.
   (b) If a channel is proposed as part of development its design will provide for the conveyance of the 100 year mudflow, its design will be open and it will collect and distribute flow in a manner that does not endanger properties above or below the project site.
   (c) If a debris basin is proposed as part of development its design will accommodate the 100 year mudflow plus freeboard. Access will be provided for removal of material.

PASSED and ADOPTED this *16th* day of *December*, 1980.

FLOOD-RELATED EROSION AND DEBRIS

Palm Desert, California

City of Palm Desert Municipal Code, Title 28 (excerpts)

AN ORDINANCE OF THE CITY COUNCIL OF THE CITY OF PALM DESERT, CALIFORNIA, ADDING TITLE 28 TO THE PALM DESERT MUNICIPAL CODE, RELATING TO THE PREVENTION OF FLOOD DAMAGE.

CHAPTER 28.10
STANDARDS

28.10.010 FLOOD HAZARD REDUCTION. In all areas of special flood hazards, the following standards are required:

A. Anchoring:

1. All new construction and substantial improvements shall be anchored to prevent floatation, collapse, or lateral movement of the structure.

2. . . .

B. Construction Materials and Methods:

1. All new construction and substantial improvements shall be constructed with materials and utility equipment resistant to flood and flood related erosion and debris damage.

2. All new construction and substantial improvements shall be constructed using methods and practices that minimize flood and flood related erosion and debris damage.

C. Utilities:

1. All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the system;

2. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of flood waters into the systems and discharge from the systems into flood waters: and

3. On-site waste disposal systems shall be located to avoid impairment to them or contamination from them during flooding.

D. Subdivision Proposals:

1. All subdivision proposals shall be consistent with the need to minimize food damage and flood related erosion and debris damage;

2. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood and flood related erosion and debris damage;

3. All subdivision proposals shall have adequate drainage provided to reduce exposure to flood and flood related erosion and debris damage: and

4. Base flood elevation data shall be provided for subdivision proposals and other proposed development which contain at least 50 lots or 5 acres (whichever is less).

E. Encroachments:

-The cumulative effect of any proposed development, when combined with all other existing and anticipated development, shall not increase the water surface elevation of the base flood more than one foot at any point.

28.10..030 FLOODWAYS. Located within areas of special flood hazard are areas designated as floodways. Since the floodway is an extremely hazardous area due to the velocity of flood waters which carry debris, potential projectiles, and erosion potential, the following provisions apply:

A. Prohibit encroachments, including fill, new construction, substantial improvements and other development unless certification by a registered professional engineer or architect is provided demonstrating that encroachments shall not result in any increase in flood levels during the occurrence of the base flood discharge.

B. All new construction and substantial improvements shall comply with all applicable flood hazard reduction provisions of this Title.

C. Prohibit the placement of any mobile homes, except in an existing mobile home park or existing mobile home subdivision.

28.10.040 SHALLOW FLOODING. Located within the areas of special flood hazard are areas designated as shallow flooding and include areas designated AO on the Flood Insurance Rate Map (FIRM). These areas have special flood hazards associated with base flood depths of 1 to 3 feet where a clearly defined channel does not exist and where the path of flooding is unpredictable and indeterminate: therefore, the following provisions apply:

A. All new construction and substantial improvements of residential structures have the lowest floor, including basement, elevated above the crown of the nearest street to or above the depth number specified on the community's FIRM.

B. All new construction and substantial improvements of nonresidential structures shall:

1. Have the lowest floor, including basement, elevated above the crown of the nearest street to or above the depth number specified on the FIRM; or

2. Together with attendant utility and sanitary facilities, be completely floodproofed to or above that level so that any space below that level is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy.

APPENDIX V

List of Cases, 1970-1981

A. H. Smith Sand and Gravel Co. v. Dept. of Water Resources, 270 Md. 652, 313 A.2d 820 (1974). Court upheld order of Maryland Department of Natural Resources prohibiting filling on land within 50-year floodplain but redefined floodplain boundaries in light of new flood information.

American Dredging Co. v. State Dept. of Environmental Protection, 169 N.J. Super. 18, 404 A.2d (1979). Court held an entire 2,500-acre tract which included a floodplain/wetland area was to be viewed in its entirety in determining whether a wetland restriction on 80 acres was reasonable.

American National Bank and Trust Co. v. Village of Winfield, 1 Ill. App.3d 376, 274 N.E.2d 144 (1971). Court sanctioned general concept of floodplain regulations but held that regulations limiting a flood area to single family use to preserve flood storage and for recharge area were invalid because of the costs of individual flood protection and conflicting testimony concerning the need for such single family use.

Bauer v. City of Wheat Ridge, 513 P.2d 203 (Colo. 1973). Court held city could not deny special exception permit for apartment buildings in floodplain where proposed building met all floodplain ordinances and general zoning criteria.

Beckendorff v. Harris-Galveston Coastal Subsidence District, 558 S.W.2d 75 (Tex. 1977). Court held State Coastal Subsidence Act requiring permits for water withdrawal constitutional and that purpose of statute is not only to control subsidence but also to control flooding and inundation.

Cappture Realty Corp. v. Board of Adjustment, 126 N.J. Super. 200, 313 A.2d 624 (1973). Court upheld interim zoning ordinance declaring a moratorium on construction in flood-prone area unless special exception permits were obtained.

Cinelli v. Whitfield Transportation, Inc., 83 N.M. 205, 490 P.2d 463 (1971). Court held that board of county commissioners may have committed error in refusing to consider flood or drainage problems which could result from issuance of a special use permit.

Citizens for Sensible Zoning, Inc. v. Dept. of Natural Resources, 90 Wis.2d 804, 280 N.W.2d (1974). Court held that adoption of a floodplain zoning ordinance by the Wisconsin Department of Natural Resources was subject to the Wisconsin Administrative Review Act.

County of Ramsey v. Stevens, 283 N.W.2d 918 (Minn. 1979). Court indirectly but strongly endorsed Minnesota state floodplain management statute requiring communities on a list prepared by the Commissioner of Natural Resources to adopt floodplain regulations in order to qualify for the Natural Flood Insurance Program. The court sustained the decision of a lower court ordering the city council of Lilydale, Minnesota to adopt regulations within 24 hours.

Creton v. Board of County Commissioners, 204 Kan. 782, 466 P.2d 263 (1970). Court sustained denial of permit for mobile home park in an industrial area subject to odor nuisances and flooding.

Dur-Bar Realty Co. V. City of Utica, 57 A.D.2d 51, 394 N.Y.S.2d 913. Court held that floodplain zoning ordinance permitting no use of right while requiring special permits for specified uses and enumerating criteria for issuance of permits did not constitute an improper delegation of legislative authority to zoning boards of appeal or a taking of property.

Falcone v. Zoning Board of Appeals, 389 N.E.2d 1032 (Mass. 1979). Court held that zoning board of appeals did not exceed its authority in denying subdivision application for failure to comply with floodplain ordinance. Ordinance had been adopted after initial plat approval but before building permit was submitted.

Famularo v. Board of County Commissioners, 505 P.2d 958 (Colo. 1973). Court held that counties may establish flood control districts by resolution under state statute.

Foreman v. State Dept. of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979). Court sustained an injunction prohibiting defendants from making deposits on a floodway and compelling removal of deposits previously made in violation of a statute requiring a permit from a state agency for such deposits. The court refused to consider this a taking of property although the state agency had the statutory power to acquire flood easements.

Gaebel v. Thornbury Township, Delaware County, 8 Pa. Commw. Ct. 379, 303 A.2d 57 (1973). Court held that proper approach for contesting validity of floodplain zoning was to challenge its constitutionality as an exercise of police power rather than through inverse condemnation; but court did not pass upon the basic constitutionality.

Green's Bottom Sportsmen, Inc. v. St. Charles County Board of Adjustment, 553 S.W.2d 721 (Mo. 1977). Court held that zoning board of adjustment could revoke a permit incorrectly issued by zoning commission for a gun club on a 49-acre tract of floodplain near the Missouri River where county floodplain regulations did not permit such uses.

Hamlin v. Matarazzo, 120 N.J. Super. 164, 293 A.2d 450 (1972). Court held that state statutes require a planning board to evaluate and make findings as to the impact of a proposed subdivision upon drainage and erosion before giving tentative plat approval.

Holt-Lock, Inc. v. Zoning and Planning Commission, 161 Conn. 182, 286 A.2d 299 (1971). Court held that landowner could not claim a "taking" of property due to refusal of a permit for sand and gravel operations in a floodplain until he had exhausted administrative remedies.

Jefferson County v. Johnson, 333 So.2d 143 (Ala. 1976). Court held that county building code and a resolution adopted by the county to qualify for the National Flood Insurance Program did not authorize the county engineer to deny a permit for construction in a floodway area.

Just v. Marinette County, 56 Wis.2d 7, 201 N.W.2d 761 (1972). Court upheld state-supervised shoreland zoning for a wetland area despite very restrictive nature of controls on the theory that a landowner has no inherent right to destroy the natural suitability of the land. Note, this is not a floodplain zoning case *per se* but involves somewhat analogous circumstances.

Kessler v. Town of Shelter Island Planning Board, 40 A.D.2d 1005, 338 N.Y.S.2d 778 (1972). Court held that a planning board's refusal to approve subdivision subject to flooding was invalid in light of the willingness of the subdivider to fill the area to protect against flooding as required by the planning board and the intention of the planning board to preserve the entire subdivision area for recreational purposes.

Kraiser v. Zoning Hearing Board, 406 A.2d 577 (Pa. Commw. Ct. 1979). Court upheld decision of zoning hearing board of township denying a variance for a duplex residential dwelling in a 100-year floodplain conservation zone based upon substantial evidence of drainage and flooding problems and the possibility of increasing hazard to buildings both on and away from the zoned area.

Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979). The Minnesota Supreme Court held that watershed district's floodplain encroachment regulations affecting 2/3 of an 11-acre tract were not an unconstitutional taking of property.

Lemp v. Town Board, 90 Misc.2d 360, 394 N.Y.S.2d 517 (1977). Court held denial of a permit for a dwelling on a dune might be a "taking of property".

Lindquist v. Omaha Realty, Inc., 247 N.W.2d 684 (S.D. 1976). Court held that resolution of the city council of Rapid City prohibiting the issuance of building permits for one block on either side of Rapid Creek after the devastating flood of June 12, 1972, until a study was completed by the planning commission, was a valid exercise of police powers and not a taking.

MacGibbon v. Board of Appeals, 340 N.E.2d 487 (Mass. 1976). Court held that a permit to excavate and fill portions of a coastal marshland had been invalidly denied based upon erosion and flood arguments due to lack of evidence of such problems.

Maple Leaf Investors, Inc. v. State Dept. of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977). Court upheld a denial of a state permit for proposed houses in the floodway of the Cedar River. The court held that both the statute and regulations adopted pursuant to them were valid.

Metropolitan St. Louis Sewer District v. Zykan, 495 S.W.2d 643 (Mo. 1973). Court upheld regulations of the Metropolitan Sewer District requiring construction of drainage facilities in subdivisions and ordered both specific performance and payment of damages.

Moreland Development Co. v. City of Tulsa, 596 P.2d 1255 (Okla. 1979). Court held that city floodplain zoning was invalid because the city failed to follow statutory procedures.

Moskow v. Commissioner of the Dept. of Environmental Management, 427 N.E.2d 750 (Mass. 1981). Court upheld a state restrictive order for a wetland area important in preventing floods in the Charles River Watershed against claims of taking.

National Merritt, Inc. v. Weist, 41 N.Y.2d 438, 393 N.Y.S.2d 379, 361 N.E.2d 1028 (1977). Court held that flooding and drainage problems that would result from shopping center were proper considerations in evaluating variance application.

Parkway Mall Associates v. Water Policy and Supply Council, 157 N.J. Super. 169, 384 A.2d 857 (1978). Court held that the Water Policy and Supply Council had authority to impose three-year time limitation to comply with requirements of conditional stream encroachment permit.

Pima County v. Cardi, 123 Ariz. 424, 600 P.2d 37 (1979). Court held that no permit was required under Floodplain Management Act for combination of sand and gravel operation on floodplain where such use existed on or before enactment of the Act, except on a showing that waters were being diverted, retarded or obstructed and that such conduct created hazards.

Pope v. City of Atlanta, 240 Ga. 177, 240 S.E.2d 241 (1977). Court held the Georgia River Protection Act, designed in part to address flooding and erosion problems, served valid objectives and did not violate home rule powers.

Pope v. City of Atlanta, 242 Ga. 331, 249 S.E.2d 16 (1978). Court again endorsed the River Protection Act but this time more specifically addressed the application of standards to a special permit.

Pope v. City of Atlanta, 243 Ga. 577, 255 S.E.2d 63 (1979), *cert. denied*, 440 U.S. 936 (1979). The Georgia Supreme Court again endorsed the River Protection Act, holding the state justified in considering the cumulative effects of development when it makes land use plans. However, it held that denial of a permit for a tennis court based upon an argument of cumulative effect on flooding was invalid because of insufficient evidence and because too much weight had been given to cumulative effect.

Rains v. Washington Dept. of Fisheries, 89 Wash.2d 740, 575 P.2d 1057 (1978). Court held that landowner had no claim of inverse condemnation against the state for denial of a permit to rechannel the bed of a creek resulting in further flooding.

S. Kemble Fisher Realty Trust v. Board of Appeals, Mass. App. Ct. Adv. Sh. (1980) 637. Court upheld a board of appeals denial of permit to fill land in a Flood Plain Conservancy District due to increased runoff and possible stagnation.

Scheff v. Maple Shade Tp., 149 N.J. Super. 448, 374 A.2d 43 (1977). Court held that a variance was justified for liquified petroleum gas tanks on pilings in a wetland subject to periodic flooding.

Solomon v. Whitemarsh Tp., 92 Montgomery Co. L.R. 112 (Pa. 1970). Court held that floodplain zoning ordinance was validly designed to promote public health, safety, and welfare.

Spiegle v. Borough of Beach Haven, 116 N.J. 148, 281 A.2d 377 (1971). Court found that differing beach setbacks were needed for coastal property and held that certain setbacks were valid and others not.

Sturdy Homes, Inc. v. Tp. of Redford, 30 Mich. App. 53, 186 N.W.2d 43 (1971). Court held that floodplain zoning ordinance which prohibited dwellings was unreasonable and a taking as applied to plaintiff's land in part because there was no evidence that the specific site was subject to flooding.

State v. Crown Zellerbach Corp., 92 Wash.2d 894, 602 P.2d 1172 (1979). Court upheld state permit requirements for hydraulic projects and state conditions attached to permits for such projects.

State v. Capuano Bros., Inc., 384 A.2d 610 (R.I. 1978). Court held that two landowners prosecuted under the inland wetlands act (under which wetlands were defined to include the 50-year floodplain) received adequate notice that they were in fact located in wetlands and that the regulations did not take property.

Subaru of New England, Inc. v. Board of Appeals, 395 N.E.2d 880 (Mass. App. Ct. 1979). Court upheld denial of permit for construction in flood district based upon possible loss of flood storage and subsequent increase in flood damages.

Town of Salem v. Kenosha, 57 Wis.2d 432, 204 N.W.2d 467 (1973). Court held that a county may adopt a shoreland and floodland ordinance to protect navigable waters and to protect public health, safety and general welfare.

Turner v. County of Del Norte, 24 Cal. App.3d 311, 101 Cal. Rptr. 93 (1972). Court held county floodplain zoning ordinance limiting area subject to severe flooding to parks, recreation and agricultural uses was valid exercise of police power rather than a taking despite the fact that area had been zoned in part to comply with Corps of Engineers requirements for construction of flood control works.

Turner v. Town of Walpole, 409 N.E.2d 807 (Mass. App. Ct. 1980). Court held that restrictive floodplain zoning did not confiscate private property.

Turnpike Realty Co. v. Town of Dedham, 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied.* 409 U.S. 1108 (1973). Court upheld zoning regulations essentially limiting the floodplain to open space uses despite testimony that the land was worth $431,000 before regulations and $53,000 after regulations and evidence that several hills above the regulatory flood elevation had been included in the floodplain district.

Usdin v. State Dept. of Environmental Protection, 173 N.J. Super. 311, 414 A.2d 280 (1980). Court upheld state floodway regulations prohibiting structures for human occupancy, storage of materials, and depositing solid wastes.

Wolfram v. Abbey, 55 A.D.2d 700, 388 N.Y.S.2d 952 (1976). Court upheld a floodplain zoning ordinance which required that for areas determined by the Ordinance Administrator as subject to flood conditions the "elevation of the lowest floor to be used for any dwelling purpose in any residential structure shall be equal to or higher than the elevation of the high water level as determined by the enforcement officer in accordance with previous flood records."

Wright v. Town of Shirley, 359 N.E.2d 64 (Mass. 1977). Court held that storage of tires adjacent to stream did not violate statute governing removal, fill, dredging or altering land bordering waters.

Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979). Court sustained denial of a state permit for a condominium in a floodway where such a structure would have raised the level of flood waters on property on the other side of the creek. The concept of "equal degree of encroachment" was strongly endorsed as well as efforts to anticipate future watershed conditions.

Zisk v. City of Roseville, 56 Cal. App.3d 41, 127 Cal. Rptr. 896 (1976). Court held that no taking occurred when Roseville adopted a "park and streambed element" to its general plan recommending acquisition of elected floodplain areas and subsequently adopted a floodway and flood fringe ordinance controlling this area.