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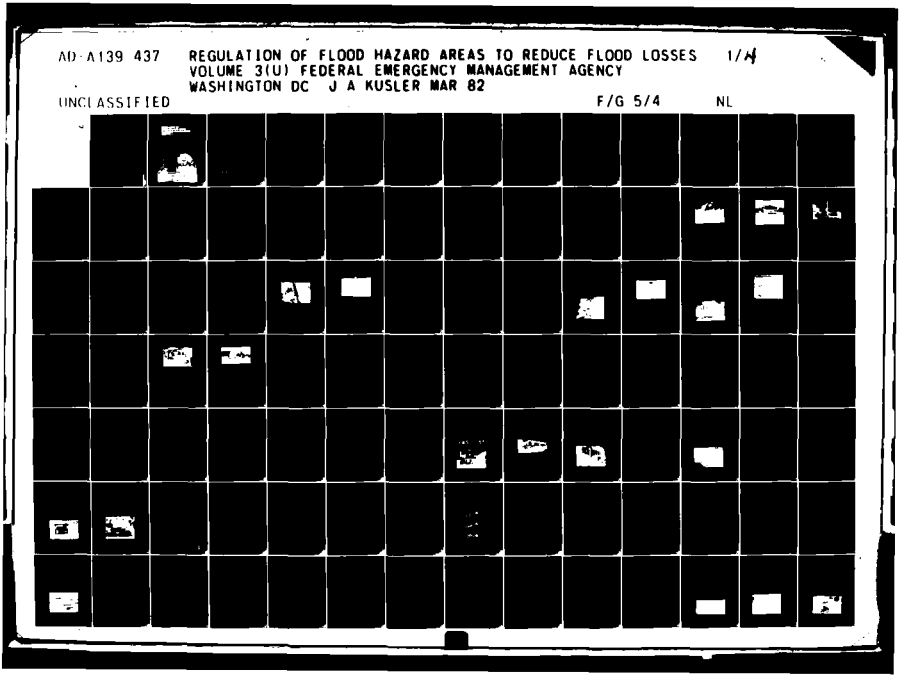

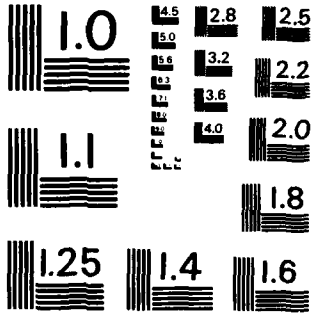

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REGULATION OF FLOOD HAZARD AREAS TO REDUCE FLOOD LOSSES VOLUME 3

John A. Kusler
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Prepared for the U.S. Water Resources Council

REGULATION OF FLOOD HAZARD AREAS TO REDUCE FLOOD LOSSES, VOLUME 3

Prepared for

The U.S. Water Resources Council
Washington, D.C.

The opinions contained herein are those of the author and do not necessarily reflect the views of the U.S. Water Resources Council or its member agencies.

A preliminary version of **Regulation of Flood Hazard Areas to Reduce Flood Losses, Volume 3** was published in 1982 by the Natural Hazards Research and Applications Information Center, University of Colorado, as Special Publication #2. Its appendices, documenting the state and local floodplain management programs that were surveyed as background for the main report, were released separately in 1982 as Special Publication #3, **Strengthening State Floodplain Management**, and Special Publication #4, **Innovation in Local Floodplain Management**.

To prepare this final version, those three volumes were reviewed, revised and consolidated in cooperation with the Natural Hazards Information Center, and supplemented by a compilation of court cases decided during the 1970s and examples of state statutes and local ordinances. This portion of the project was managed by the Tennessee Valley Authority pursuant to a contract with the U.S. Water Resources Council.

FOREWORD

The U.S. Water Resources Council contracted for this report to update and supplement Volumes 1 and 2 of **Regulation of Flood Hazard Areas to Reduce Flood Losses** which were prepared and published by the Council between 1968 and 1971. Volume 3 reviews accomplishments and problems of the decade of the 1970s in the use of floodplain regulations as one element of floodplain management. It suggests strategies for the 1980s for improving the quality of regulations and for combining regulations with other management tools to serve multipurpose state and local goals.

As a supplement to Volumes 1 and 2, this report does not repeat earlier materials. The reader is assumed to be familiar with basic floodplain management concepts. Emphasis in this volume is on conclusions drawn from the experience of the 1970s and new directions for the 1980s.

The report was prepared for the Council by Dr. Jon A. Kusler, an attorney and specialist in water resources systems, working under the guidance of an interagency task force. He is uniquely qualified to carry out this task, having been principally responsible for the research and writing of Volumes 1 and 2, and as the author of many studies on floodplain management during the last decade. The opinions expressed herein are those of Dr. Kusler.

We hope you find the report useful and interesting.

Frank Thomas
Acting Director,
U.S. Water Resources Council

March, 1982

PREFACE

Volume 3 documents progress and problems with floodplain regulations in the 1970s and suggests strategies for the use of regulations as part of broader floodplain management efforts in the 1980s. Its focus is on state and local programs, including innovations that can serve as examples for effective flood loss reduction in the 1980s.

Preparation of Volume 3 began with surveys of state and local floodplain regulations and court decisions during the 1970s to document progress and to identify problems. The surveys revealed that the materials contained in Volumes 1 and 2 of **Regulation of Flood Hazard Areas to Reduce Flood Losses** including model statutes and ordinances and legal analyses, are generally applicable to the 1980s. Volume 3, therefore, is designed to supplement and update rather than replace earlier materials, with an emphasis on increasingly effective floodplain management.

The report and appendices are based upon both primary and secondary sources of information. Preparation began with the review of papers and presentations from a series of eight floodplain and wetland seminars conducted by the U.S. Water Resources Council during the winter of 1978 and the spring of 1979. The seminars dealt with problems, issues and opportunities in floodplain and wetland management. See Kusler (1979). This assimilation was followed by a review of other publications issued since 1970 dealing with floodplain management. (See the bibliography of this report and the appendices for a partial listing.) Contacts were also made with other studies underway including one conducted by the National Science Foundation for Congress in 1980 which produced an excellent document, **A Report on Flood Hazard Mitigation**. Since the goal of the present report was to distill a decade of research and experience concerning the status, problems and possible new approaches for floodplain regulations, considerable use was made of this and other studies. Not surprisingly, conclusions of the present study closely parallel those of the National Science Foundation.

After completing the literature review, several independent surveys were conducted. These included (1) a survey of all state floodplain programs, carried out by the Association of State Floodplain Managers; (2) interviews with approximately 300 local government officials, state program personnel, regional personnel of FEMA, and the Corps of Engineers; (3) a search and analysis of court cases since 1970 that have litigated federal, state and local floodplain regulations; and (4) preparation of case study profiles for 150 communities with innovative floodplain management programs.

These surveys helped test conclusions and recommendations from other studies and provided new information concerning innovative approaches but fell short of field documentation of flood hazard mitigation approaches. Limited data concerning the type and characteristics of new and existing floodplain structures; flood losses to unprotected, partially protected structures; the effectiveness of specific types of flood mitigation measures; and compliance of new structures with regulations prevented a thorough analysis of regulations. It is hoped that the Federal Emergency Management Agency, the U.S. Army Corps of Engineers, the National Science Foundation, the states, and other organizations will help gather such data over the next decade to test the conclusions of this and other reports.

In the synthesis of material, several conclusions were particularly compelling:

1. The overall floodplain mapping, regulatory, acquisition, insurance, and other management approaches applied at the state and federal levels during the 1970s have stimulated large numbers of strong community floodplain management programs. Now the challenge is to address the more unique flood problems which face thousands of additional communities.
2. Flooding will continue to be a major national problem with periodic losses of hundreds of lives and billions of dollars in property damage when major hurricanes and inland storms occur. Despite the substantial progress in nonstructural floodplain management made during the 1970s, full implementation of flood loss mitigation measures is still far away, particularly for existing uses. Implementation will require continued federal leadership through partially subsidized insurance, disaster assistance conditioned upon mitigation measures, and floodplain acquisition and flood control measures on a cost-sharing basis. This should take place within a framework of consistent overall federal standards. States, communities and the private sector may bear a larger burden but the shift from total federal responsibility to greater state, local and private responsibility will take time. A careful system of incentives and disincentives is needed.
3. Floodplain management has become a technical subject as the approaches for floodproofing, flood warning systems, postdisaster mitigation, specialized regulation, and acquisition and relocation have been perfected. Increased expertise and education at all levels of government and in the private sector are needed to apply the lessons of the 1970s to the 1980s and to develop still more new approaches.

ACKNOWLEDGMENTS

Appreciation is expressed to all who participated in these efforts with particular attention to Pat Bloomgren, Larry Larson, and Marguerite Whilden, who provided information on state programs; Rutherford Platt for the excellent overall advice and discussion of legal issues; Frank Thomas and Tim Maywalt of the U.S. Water Resources Council for their help and guidance throughout the study; and Jacquelyn Monday of the Natural Hazards Research and Applications Information Center, University of Colorado, for her editorial assistance and patience in supervising publication of the manuscript. Special thanks is also due the Water Resources Council Work Group which provided able guidance throughout the project, including:

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EXECUTIVE SUMMARY

Progress in Floodplain Management

During the 1970s, many factors contributed to the growth and testing of floodplain management at all levels of government. Record floods took over two thousand lives and cost billions of dollars in property damage and government flood relief. Inflation soared and tax revenues dwindled. Courts increasingly held landowners, developers, subdividers and local governments liable for flood damages. This combination of losses, diminished revenues, and growing liability prompted Congress, the states and local governments to develop a federal/state/local partnership to cost-effectively reduce flood losses. Floodplain management took its lead from the fiscally sound recommendation of the 1966 Federal Flood Control Task Force: "Those who occupy the floodplain should be responsible for the results of their actions." Federal, state, and local governments strengthened their programs to assist disaster victims while redoubling their efforts to break the cycle of loss, repair, and subsequent loss. Programs were redirected to prevent losses from future uses of the floodplain and to reduce the flood damage potential of existing uses after the disaster.

Governments made substantial progress in establishing coordinated minimum flood standards for new development in floodplains and for redevelopment in damaged areas. The 100-year flood standard helped to coordinate federal, state and local mapping, standard-setting, floodproofing, regulation, and other programs. Floodplain management programs were designed in many instances not only to reduce flood losses within the 100-year floodplain but also to serve broader goals. Implementation was often achieved through a combination of public education, regulation, acquisition, public facilities planning, and flood insurance. Regulations were adopted to prevent floodplain occupants from increasing flood heights and velocities on other lands, victimizing unwary buyers, or constructing damage-prone structures. The reduction of public expenditures for federal and state disaster assistance and flood control measures was another goal. These regulations were overwhelmingly endorsed by the courts.

FEDERAL ACTIONS

Congress and federal agencies such as the Water Resources Council (WRC), the Federal Emergency Management Agency (FEMA), and the Office of

Management and the Budget (OMB) made considerable progress in developing a coordinated federal policy to reduce future flood losses to public and private land uses. Nonstructural solutions were one component of that policy. Important federal actions during the decade were:

- The National Flood Insurance Program was expanded to almost two million policies and its coordination with disaster assistance programs was improved. Local governments were required to adopt land use control measures to reduce potential flood losses as a condition to obtaining federally subsidized flood insurance.
- Planning for disaster preparedness and postdisaster response increased. Disaster assistance benefits were increased, on condition that the recipients apply for flood insurance and adopt flood hazard mitigation measures.
- Guidelines for public uses and coordination of federal floodplain management were strengthened by adoption of the Floodplain Management and Wetland Protection Executive Orders (E.O. 11988 and 11990). These require that federal and federally sponsored projects avoid floodplains unless no alternative exists.
- Approximate flood hazard maps were developed for the entire nation. More detailed maps were developed (or are being developed) for 11,000 of approximately 20,000 flood-prone communities.
- The U.S. Army Corps of Engineers, the Soil Conservation Service, FEMA, and other agencies enhanced their provision of technical assistance to states, localities, and private landowners.
- State floodplain management was strengthened by financial and technical assistance from FEMA and WRC and through the Coastal Zone Management Program.
- Congress adopted new resource management programs with hazard reduction as a part of broader goals. The Coastal Zone Management Act of 1972 includes a system of grants in aid to the states. Section 404 of the Water Pollution Control Act Amendments of 1972 and 1977 provided more comprehensive federal control of discharges into rivers, lakes, and streams, including adjacent wetlands. The Coastal Barrier Resources Act of 1982 prohibits most new federal expenditures and assistance for activities on specified undeveloped coastal barriers. Other resource protection measures that include hazard reduction components are grants in aid to states and communities for open space protection, wetland acquisition, and urban renewal.
- Congress and the agencies placed greater emphasis on nonstructural solutions including acquisition, regulations, floodproofing, and flood warning systems. More consistent cost-sharing policies were also developed.

STATE PROGRAMS

States assumed a pivotal role in coordination, education, technical assistance, and setting standards in the 1970s.

- All 50 states appointed a flood insurance program coordinator to help communities enroll in the NFIP and to provide technical assistance on flood loss reduction.
- Seven states adopted new floodplain regulation programs, adding to the 24 states that had regulatory statutes in 1970. Others strengthened existing programs to establish standards for local regulations or to regulate directly flood hazard areas through permit systems, subdivision review requirements, or building codes.
- State legislatures increased the staff size and budgets of some state programs to accelerate mapping, increase technical assistance, and facilitate evaluation of permits.
- Many states adopted resource conservation statutes with hazard reduction as one objective. Four inland states and 11 coastal states adopted wetland protection legislation. Most coastal states established coastal zone management programs, some stressing hazard mitigation. Hazard mitigation was emphasized also in some wild and scenic river and subdivision review programs.
- Many states combined regulatory and nonregulatory floodplain management measures to serve multipurpose goals, including urban renewal and resource management as well as flood loss reduction. These measures included acquisition, flood warning systems, marking of flood hazard areas, and education.

LOCAL PROGRAMS

In one sense, the most important nonstructural floodplain management programs of the 1970s were adopted by cities, counties, villages, and towns. Most nonstructural measures were implemented at the local level.

- At least 17,000 communities adopted floodplain regulations or expressed the intent to adopt such regulations in order to enroll in the National Flood Insurance Program. Most local programs were consistent with minimum NFIP standards, and some went beyond them. Community awareness of flood problems and expertise to deal with the problems generally increased, although some communities are still deficient in both.
- Several thousand communities adopted wetland protection regulations, shoreland zoning, coastal zone management, prime agricultural land zoning, or other water and land resource management programs incorporating flood loss reduction as one objective.

- Many communities combined regulations with acquisition, flood warning systems, public education, and flood control works to reduce losses to both existing and new uses and to serve broader community objectives. Communities often adopted these innovative programs as part of multipurpose land management programs.

Problems with Implementation

Despite progress in guiding new structures to flood-free sites and establishing standards for new and existing structures in hazard areas, problems in implementing consistent flood loss reduction policies occurred at all levels of government. Few measures initiated in the 1970s were used to their full potential.

Major problems included:

- Regulations were only partially effective in many of the 12,000 "emergency program communities" that adopted or stated the intent to adopt regulations to qualify for the NFIP. The problem was due to lack of maps showing 100-year flood elevations, of ordinances that were legally enforceable, and of administrative staff in numbers sufficient to enforce compliance. These problems were particularly severe in rural areas.
- NFIP flood studies and map scales, levels of accuracy, and types of data were often partially inadequate for regulation, acquisition, and other site-specific floodplain management because they were developed to meet insurance rather than land use management needs. Maps failed to account for waves, water velocities, erosion, and watershed development, thereby showing underestimated hazards. Flood studies identifying the 100-year flood evaluation were available for only one-half of the communities. Moreover, flood maps showing floodways and coastal wave impact areas were available for a smaller number. Procedures for storing map data were thoroughly inadequate and, unless revised, threaten much of the federal investment of over $500 million in mapping.
- Local governments and some state agencies lacked staff expertise to evaluate how individual permits would affect flood flows. Neither were agency personnel able to monitor or enforce state and local floodplain regulations.
- State and local regulations were relatively ineffective in reducing losses to existing uses except immediately after flood disasters.
- Some floodplain regulations were insufficiently tailored to flood characteristics such as fluctuations of water levels along lakes, high velocity flow areas in mountains, and combined storm surge and wave action in coastal areas.

- Floodplain regulations were often poorly coordinated with other resource protection regulations and comprehensive zoning and planning.
- Federal subsidies for flood control works, disaster assistance, flood insurance, and public works sometimes encouraged continued floodplain development or discouraged local government control of floodplain development and private damage reduction measures such as floodproofing.
- Court challenges to regulations continued, although very few were successful.

Strategies for the 1980s

The challenge for the 1980s will be the cost-effective implementation of flood loss reduction measures tailored to specific facts and circumstances within a continued overall set of national standards such as the 100-year flood standard. These measures should include preflood and postflood planning and incorporate regulations as one component. Implementation will require a federal and state political and financial climate that encourages local government and landowners to assume responsibility for flood loss reduction, and provides incentives for hazard mitigation tailored to local problems and needs. In addition to flood loss reduction, program emphasis, for cost effectiveness, should be on the protection of the quality and quantity of the nation's waters and on conservation of critical floodplain resources such as farm lands. Tight budgets at all levels of government will complicate implementation, but by careful allocation of resources, state and local groups can innovatively combine regulation, acquisition, flood warning systems, and other measures to serve multipurpose community goals. The federal government should continue to point the way, support, and assist state and local governments to develop or to continue and strengthen the programs they have already initiated.

Major strategies should include:

1. All levels of government should implement a carefully tailored combination of floodplain management incentives and disincentives initiated in the 1970s to encourage individual responsibility in floodplain use. These include partially subsidized insurance, regulations, disaster assistance conditioned on mitigation measures, flood control measures constructed on a cost-share basis, and selective acquisition. Governments should remedy gaps and deficiencies in existing programs to make them effective and equitable. Floodplain regulations should be simplified, better quantified, and carefully coordinated with other techniques for land and water management. Local governments should upgrade interim regulations. The federal government should support the strengthening of state, local and private roles in floodplain management.

2. Increased specificity is needed in federal, state, and local mapping, standard-setting, and technical assistance to deal with special flood problems such as wave heights, combined erosion and flood hazards, high velocity flows, sheet flows, flash flooding, and long-term fluctuations in ground and surface water levels. Local conditions and the particular needs of rural, urban, and metropolitan areas must also be addressed.

3. All levels of government should put greater emphasis on predisaster planning and postdisaster response for areas threatened by severe flooding. Coastal barrier islands and high velocity beach zones should have special consideration because flood and erosion threats are severe, development pressures are great, and maps are often inadequate. Greater emphasis should also be placed on inland areas subject to flash flooding.

4. Federal agencies (FEMA, SCS, the U.S. Geological Survey, the Corps, and the National Oceanic and Atmospheric Administration) should cooperate with states and localities to selectively upgrade 100-year flood definition criteria for areas with special problems to reflect wave heights, watershed urbanization, sediment (alluvial fans), high velocity flows and special characteristics. Upgraded maps should be at a scale and level of accuracy suitable for land use management.

5. The criteria used by states and localities to evaluate permits should reflect upgraded flood data and be expanded to serve multipurpose resource management goals. Staffs should be expanded and better trained to evaluate how a proposed activity will affect resource values and whether it is consistent with broad community goals. Procedures for determining 100-year flood elevations also need improvement, especially at the local level.

6. Federal, state, and local agencies should integrate floodplain regulations into wetland protection, coastal zone management, shoreland management, public works, and comprehensive land management programs through amendment of policies, plans and regulations. Local agencies should coordinate floodplain management and stormwater management through comprehensive watershed management and combined or closely coordinated ordinances.

7. State legislatures should strengthen floodplain management by adopting or amending statutes, by enlarging staffs and by increasing management budgets. States should work more closely with local programs, particularly in rural areas to provide help in coordination of their programs, permit evaluation, mapping, monitoring, training, and education.

8. FEMA, the Corps, states, and local governments should tighten monitoring and enforcement of regulations. State monitoring with FEMA state assistance funds may be particularly effective.

9. FEMA, the Corps, SCS, states, and localities should stress innovative, multipurpose local floodplain management both before and after flood disasters. Floodplain management should be encouraged as an opportunity to meet multipurpose goals and correct past mistakes through a combination of techniques and approaches.

10. FEMA, states, and localities should conduct major training and education programs for floodplain decision makers such as landowners, engineers, architects, bankers and planners, on the nature and seriousness of floods and on ways to implement flood loss reduction measures such as elevation on fill or open works, floodproofing, flood warning systems, evacuation, relocation, and flood control works.

11. In cooperation with states and localities, NSF, FEMA, NOAA, the Corps, and other federal agencies should conduct research to systematically document flood losses by type, condition and design of structures or uses, the causes of those losses, and the effectiveness of various flood reduction measures; to classify communities by type of flood problem; to further document effective management of special flood situations; and to improve the quality and cost effectiveness of flood studies.

12. OMB, FEMA, and Congress should reevaluate the framework of federal subsidies and incentives to ensure that they support the principle that "those occupying the floodplain should be responsible for the results of their actions." Continued efforts should be made to upgrade flood insurance rates to reflect actual risk. Cost-sharing requirements for state, local and private structural works should be enforced with larger nonfederal shares.

Frequent reference is made in this document to the National Flood Insurance Program (NFIP) and its administering agencies. Usually the Federal Emergency Management Agency (FEMA) is identified as the agency responsible for its administration. Occasionally, reference is made to the Federal Insurance Administration (FIA), which, as a part of the Department of Housing and Urban Development, had responsibility for administering the NFIP from its inception through the formation of FEMA in 1979.

CHAPTER I

THE 1970s: ACCOMPLISHMENTS AND PROBLEMS

A Decade of Continuing Flood Losses

The 1970s were a decade of major floods and more than $25 billion in public and private flood losses in the United States. Almost 80% of the 1970s disaster losses were flood-related.[1] The average annual death toll from flash floods rose to about 200. This was more than double the rate of the 1960s and more than three times the rate of the 1940s.[2] It was also a decade of federal, state, and local cost-conscious efforts to reduce flood damages by guiding future uses away from flood-prone areas or requiring individual flood protection. Efforts were made to reduce flood losses to existing uses through relocation and floodproofing to break the cycle of damage, repair, damage, and further repair for damage-prone uses.

The decade was a period of reduced energy supplies and skyrocketing costs for aggregate, concrete, steel, and labor needed for construction of flood control structures such as dikes, dams and levees.[3] It was a period of broadened environmental awareness and of tightened federal, state, and local budgets. It was a decade of experimentation and testing for various combinations of less expensive nonstructural means for reducing flood damages, with regulations playing a central role.

Major floods were a catalyst for flood loss reduction. The 1960s ended with the most intense hurricane in modern U.S. history—Hurricane Camille, which struck the Mississippi coast August 17-18, 1969, with up to a 24-foot storm surge and 230 mile-per-hour winds. It killed 255 people and left 68 missing. Destruction was widespread in Mississippi, Louisiana, Alabama, Virginia, and West Virginia.

Some major floods in the 1970s were:[4]

July 23-August 5, 1970. Hurricane Celia struck the Texas coast, causing 11 deaths and widespread damage.

June 9, 1972. A cloudburst in the mountains above Rapid City, South Dakota broke an earthen dam. Two hundred thirty-six were killed and 2,000 houses were damaged or destroyed. After the flood, Rapid City acquired much of

its floodplain with $45 million in federal funding. This event focused national attention upon flash flood problems and the vulnerability of dams.

June 14-23, 1972. Tropical Storm Agnes swept the Atlantic seaboard from Florida to New York with torrential rains and winds up to 70 miles per hour, causing 122 deaths and widespread property damage. Inland flooding was particularly severe in Maryland, Pennsylvania, and New Jersey. Over 300,000 structures were destroyed or damaged, with total property damage exceeding $3.5 billion ($5.8 billion in 1979 dollars).

In response to Agnes, Congress adopted the Flood Disaster Protection Act of 1973,[5] which amended the National Flood Insurance Act of 1968. The 1973 act made flood insurance virtually mandatory as a condition for federal investment or disaster relief in the floodplain. New Jersey and Maryland adopted or amended floodplain regulatory statutes to broaden state programs. In addition, many thousands of communities enrolled in the National Flood Insurance Program (NFIP) and adopted regulations meeting minimum NFIP standards.

August 29, 1974. Hurricane Carmen struck the Louisiana coast with 90 mile-per-hour winds, causing damage to sugar cane crops, offshore oil installations, and the shrimping industry.

September 13-24, 1975. Hurricane Eloise hit the Florida and Alabama coasts with 100 mile-per-hour winds that severely damaged crops and structures and caused four deaths. Heavy rains over the Northeast also caused major flooding in eastern states, particularly Pennsylvania and Maryland.

July 31, 1976. Heavy rains at the headwaters of the Big Thompson River in Colorado sent a wall of water, in some instances 15 feet high, surging down the canyon, killing 136 and causing $26 million in damages to public property and $16 million to private property. U.S. Highway 34, which ran the length of the canyon, was essentially destroyed.

Larimer County adopted floodplain regulations for the area after the disaster, beginning with a six-month moratorium on rebuilding. Some of the damage-prone structures have been acquired at a cost of approximately $3 million. This event gave impetus to the Floodplain Management Executive Order (11988) and to federal funding of an acquisition program within FEMA under Section 1362 of the Flood Insurance Act of 1968.[6]

February 6-7, 1978. The most severe winter flood of the decade occurred along the New England coast. A two-day "northeaster," with winds up to 90 miles per hour raised combined tides and storm surge elevations to 14 to 16 feet, and wave elevations up to nine feet. Over 2,000 homes were destroyed with another 9,000 damaged and 29 lives lost in Massachusetts alone.

After the storm, Massachusetts adopted a building code requiring wave protection in coastal construction and reconstruction. The governor issued an executive order tightly controlling further state investment in beach areas.

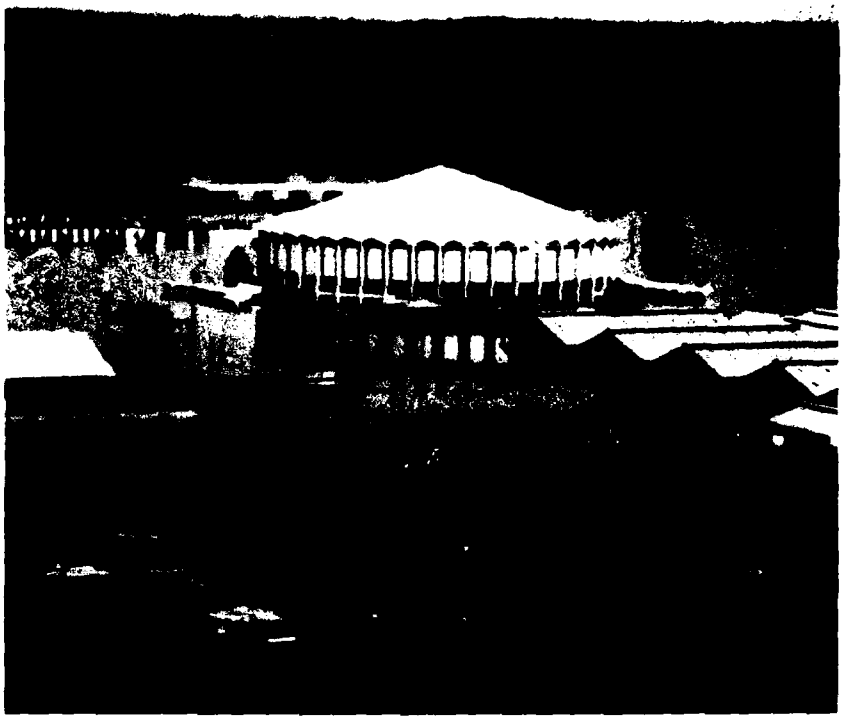
Severe damage in Scituate, Massachusetts, caused by the February 1978 "Northeaster." Photo by Rutherford Platt.

The communities of Scituate and Hull were required to reflect wave heights in their floodplain regulations. Rhode Island also strengthened its coastal floodplain restrictions to require an elevation of six feet above minimum NFIP standards for structures in high hazard areas. To help relocate seriously damaged structures, FEMA provided funds under its Section 1362 floodplain acquisition program.

April 1978. Rains caused water levels to rise along Lake Elsinore, California, severely flooding 600 properties. After this event local, state, and federal agencies developed new procedures for postdisaster planning, with relocation as one component.

December 1978. Severe flooding in central Arizona killed 12 persons and destroyed 700 properties in Allenville, Hollywood, Duncan, and other towns. Arizona responded by adopting a relocation program that used federal and state funds to acquire and relocate an estimated 800 homes in 10 towns. The state also obtained federal funding for acquisition.

April 16, 1979. Heavy rain caused the Pearl River to top levees in Jackson, Mississippi, and severely inundate Jackson and other areas along the river. Over 1,900 residences, 298 businesses, and many public facilities were destroyed and/or damaged in Jackson alone. Total federal expenditures for the disaster were over $375 million.



Flooding behind levees along the Pearl River in Jackson, Mississippi, caused $500 million in damages.
Photo by Rutherford Platt.

FEMA sent teams into the area after the disaster to assess flood hazard mitigation potential. Inadequate federal coordination during the disaster contributed to a July 1980 OMB directive requiring federal agencies to create postdisaster hazard mitigation teams under the leadership of FEMA and to improve postdisaster recovery procedures.[7]

September 12, 1979. Hurricane Frederic struck the Alabama, Mississippi, and Florida coasts with storm tides of 10 to 12 feet and winds approaching 150 miles per hour. Estimated total damages exceeded $2 billion. Over 1,500 structures were damaged or destroyed by flooding in the hardest hit areas, including Gulf Shores, Alabama (500 structures), Dauphin Island, Alabama (200 structures), and Fort Morgan, Alabama and vicinity (500 structures). Many damaged structures had been elevated to the 100-year flood elevation but without consideration of wave heights. Gulf Shores revised its regulations to reflect wave heights.

After this event, FEMA revised recommendations for coastal construction and focused attention on the severe erosion and flood threats to structures in rapidly developing barrier islands.

Severe wave and water damage along the Alabama coast. Hurricane Frederic destroyed structures that had been raised enough to protect them from the 100-year storm surge but not from wave heights.
Photo source: Federal Emergency Management Agency.

May 18, 1980. Mount St. Helens' eruption caused not only widespread destruction from the impact of the eruption and ash fall, but also severe flooding along the debris-clogged Cowlitz and Toutle Rivers. After the event, state and federal authorities shifted attention to broader-based disaster planning and response. Cowlitz County adopted strict regulations for these areas, including plans for relocating some properties.

The 1970s thus ended as they had begun—with a series of catastrophic events.

During the period from July 1, 1973, to June 30, 1979, outlays from the Presidential disaster fund amounted to $1.6 billion.[8] Total mean annual losses approached $4 billion by the end of the decade.[9]

Progress and New Directions

Flood damages and loss of life during the 1970s prompted the piecemeal adoption of many flood loss reduction measures which, by the end of the decade, formed a surprisingly comprehensive and well integrated federal, state, and local floodplain management program for public and private uses in preflood and postflood situations. Nonstructural measures such as regulations, disaster assistance, flood insurance, and flood warning systems were combined with structural measures not only to reduce flood losses but also to promote urban renewal and provide recreation opportunities, preserve wildlife, and meet other goals.

TABLE 1

DWELLINGS DESTROYED AND DAMAGED BY HURRICANES AND FLOODS (1969-1976)

Fiscal Year	Hurricanes	Floods
1969-70		
Destroyed	6,046	77
Damaged	48,734	32,080
1970-71		
Destroyed	1,059	43
Damaged	33,964	5,136
1971-72		
Destroyed	17	4,772
Damaged	24,218	127,802
1972-73		
Destroyed	---	2,181
Damaged	---	69,298
1973-74		
Destroyed	---	1,108
Damaged	---	28,969
1974-75		
Destroyed	14	407
Damaged	1,817	17,834
1975-76		
Destroyed	3,516	913
Damaged	27,497	20,423

Source: Data provided by the Federal Emergency Management Agency.

Congressional and executive initiatives to reduce flood losses through nonstructural measures in the 1970s were largely based upon the recommendations of a 1965 Presidential Task Force on Federal Flood Control Policy which concluded[10] that

> Principles of national economic efficiency require . . . that the benefits of floodplain occupance exceed all associated costs, not merely those borne by the individual or enterprise which so locates. Total associated, or full social, costs include—
>
> Immediate expenses of development,
>
> Damages to be endured by the occupant or the expense of protective measures undertaken to reduce the frequency and extent of flood damage,
>
> Damages forced on others as a result of encroachment, and public costs involved in disaster relief and rehabilitation.
>
> Flood plain occupation in which benefits do not exceed the estimated total costs, or which yields lower returns than other uses such as recreation and wildlife conservation, is undesirable, because it causes an eventual net loss to society.

Any public policy which encourages submarginal development adds to those losses.

The task force further concluded that[11]

> Despite substantial [flood control] efforts, flood losses are mounting and uneconomic uses of the Nation's flood plains are inadvertently encouraged. The country is faced with a continuing sequence of losses, protection, and more losses. While flood protection of existing property should receive public support, supplemental measures should assure that future developments in the flood plains *yield benefits in excess* of their costs to the Nation. This would require a new set of initiatives by established Federal agencies with the aid of State agencies to stimulate and support sound planning at the local government and citizen level.

SPECIFIC PROGRESS IN THE 1970s

Growth of the National Flood Insurance Program (NFIP) conditioned upon land use regulations. In 1970, 3,800 property owners had enrolled in the NFIP. Total policy coverage was $1.5 billion. By January 1, 1980, the NFIP had grown to almost 2 million policies with $100 billion in coverage.

TABLE 2

NATIONAL FLOOD INSURANCE PROGRAM PAID CLAIM DATA BY CALENDAR YEAR

Calendar Year	Policies	Average Insurance Per Policy	Number of Paid Claims	Total Losses	Claim Frequency (Per 100 *Exposure Units*)	Average Paid Claims Cost
1972	105,231	$16,140	2,745	$ 6,510,654	2.6	$2,250
1973	232,677	17,060	15,485	12,694,833	6.7	2,548
1974	342,529	21,950	10,949	23,208,853	3.2	1,936
1975	495,585	25,440	19,982	34,968,535	4.0	3,588
1976	682,386	28,690	12,135	50,114,420	1.8	4,454
1977	996,553	30,100	13,477	74,761,406	1.4	5,678
1978	1,298,383	33,150	28,859	99,456,110	2.2	5,016
1979	1,518,210	37,650	69,175	117,069,208	4.6	6,458

Source: Data provided by the Federal Emergency Management Agency

The program was designed to serve two principal objectives: to provide to state and local government a federally subsidized insurance (up to 90%) for existing floodplain uses as an incentive for them to adopt regulations guiding new development away from the floodplain; and to provide a mechanism whereby floodplain occupants eventually would help pay for flood losses. Although the program was voluntary at its 1968 inception, in 1973[12] it became partially mandatory when Congress adopted the Flood Disaster Protection Act which required that communities enter the program or lose federal disaster assistance and other benefits for activities in the floodplain. From 1974 to 1977, about 13,000 communities joined the program, in part because of these requirements, but more importantly, because communities were becoming aware of the program's benefits. Communities had to state their intent to adopt land use regulations as a condition to entering the program. Despite amendments in 1977[13] which weakened the 1973 act by permitting federally insured banks

to insure conventional loans in communities not participating in the program, few communities chose to withdraw.

Enhanced disaster assistance conditioned on postflood hazard mitigation. Prior to 1970, a variety of disaster assistance grants and loans were available to victims of federally declared disasters. The President was then (as now) authorized to declare disasters at the request of a state governor if the necessary assistance exceeded the resources of the state or local government. The Disaster Relief Act of 1970[14] (adopted in response to the San Fernando earthquake) made five new types of disaster assistance available to private individuals, states, and local governments: free temporary housing for one year, disaster unemployment insurance, food stamps, grants to local governments with major loss of tax revenue, and forgiveness of up to $2,500 in Small Business Administration (SBA) loans.

The Flood Disaster Protection Act of 1973,[15] adopted after Tropical Storm Agnes, broadened assistance to forgive federal loans up to the first $5,000 and lowered interest rates on additional balances to 1%. This money is available after a Presidentially declared disaster or after SBA and the Federal Housing Administration make their own disaster declarations in smaller disasters. Under the 1973 law, the federal government assumed costs previously assumed by the Red Cross for goods and services such as bulk cleaning supplies, temporary housing, and household accessories. It also introduced provisions for withholding federal benefits from flood-prone communities that chose not to participate in the NFIP.

The Disaster Relief Act of 1974[16] (Section 406) made available disaster loans and grants to states and local governments on condition that recipients evaluate and mitigate hazards. FEMA adopted hazard mitigation regulations to implement this act in 1979.[17]

Increased local regulation of flood hazard areas. Encouraged by the National Flood Insurance Program, strengthened state regulatory programs and environmental concerns, most communities with flood problems adopted at least preliminary regulations. In 1970, only about 300 to 400 communities had adopted floodplain regulations. By May 1981, over 17,000 had adopted or indicated an intent to adopt regulations in order to qualify for the NFIP.

Strengthened state floodplain management programs. In 1970, 24 states had adopted either direct state floodplain regulations or state standards for local regulations. By 1980, 31 states had adopted programs. Many states significantly strengthened and expanded existing programs during this period.

Accelerated floodplain mapping. In 1970, only a small portion of the nation had flood hazard maps. During the 1970s, the U.S. Geological Survey prepared "approximate" floodplain maps for 20,000 flood-prone communities. FEMA and its study contractors prepared more detailed maps for 3,500 communities. New FEMA maps for 6,500 communities are in various stages of completion. Maps for some areas were also prepared by the SCS, the Corps, and the Tennessee Valley Authority (TVA). California, Iowa, Maryland, Nebraska, New

Jersey, and Wisconsin have prepared maps for some areas and many local communities prepared their own larger-scale maps to facilitate regulation.

Hazard mitigation requirements for public uses. In 1970, public uses were rarely protected from flooding, despite the 1966 Executive Order 11296, Evaluation of Flood Hazards. This order directed federal agencies to encourage "a broad and unified effort to prevent uneconomic use and development of the Nation's floodplains." In 1977, President Carter issued Executive Order 11988, Floodplain Management, which strengthened and superseded E.O. 11296 by requiring federal agencies to avoid public investment in the floodplain, including grants in aid to local governments, if alternatives exist. The Coastal Barrier Resources Act of 1982 also prohibits federal expenditures or assistance on certain undeveloped barrier islands. In the 1970s, many states amended state regulations or issued executive orders to control public uses of the floodplain.

Emphasis on nonstructural approaches. In the 1970s, all levels of government shifted attention to nonstructural measures to reduce flood losses, although some dikes, dams, levees and channelization projects continued to be built. Congress emphasized nonstructural approaches in the National Flood Insurance Act of 1968[18] and its subsequent amendments as well as in the disaster assistance acts cited above. Congress enacted Section 73(a)[19] of the Water Resources Development Act of 1974, which required agencies to consider nonstructural alternatives, including floodplain regulation, acquisition, and relocation, "with a view of formulating the most economically, socially, and environmentally acceptable means of reducing or preventing flood damages." Executive Order 11988,cited above, emphasized nonstructural measures as did the President's Water Policy Message of June 6, 1978, and Executive Order 12113, Independent Water Project Review. The latter directive required that whenever water resources projects or programs are considered, a nonstructural plan must be evaluated as one alternative.

Concern with dam safety. A number of dam failures with catastrophic losses of life increased national and state concern about dam safety during the 1970s.[20] When a dam formed from coal mine waste gave way in Buffalo Creek, West Virginia, in 1972, 118 people were killed. Two hundred thirty-six died in Rapid City, South Dakota, when an earthen dam burst after a severe rainfall. In reaction to these failures, Congress adopted the 1972 National Dam Inspection Act,[21] which authorized the Corps of Engineers to inspect dams. Other dam failures added impetus to the national dam inspection program. These included the spectacular rupture of the Teton Dam on June 9, 1978, which killed 11, left 25,000 homeless, and totally or partially inundated a 300 square-mile area. Thirty-eight died in Taccoa, Georgia, in November 1977 when heavy rains ruptured an earthen dam. In addition to the federal dam inspection program, which now covers 9,000 large dams, 44 states require state permits for dams.

Community and state innovation. In the 1950s and 1960s, state and local authorities often applied regulations alone to accomplish floodplain manage-

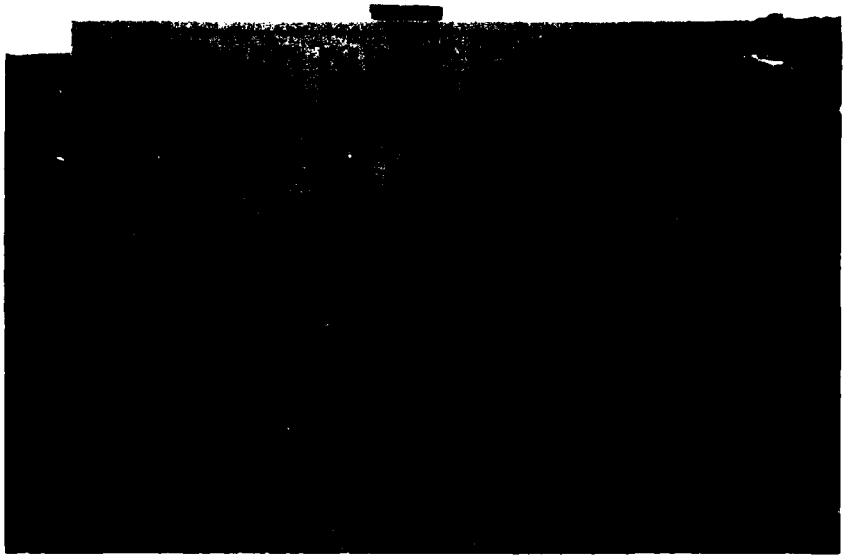
ment goals. During the 1970s, many states and hundreds of local communities adopted innovative combinations of different types of regulations and in some instances combinations of regulations and nonregulatory measures such as acquisition and flood warning systems. These innovative programs have tested new approaches and now serve as models. Descriptions of some of these programs appear in Appendices I and III.

Heavy rains caused the rupture of an earthen dam at Buffalo Creek, West Virginia, in September 1972. One hundred twenty-six people were killed in the disaster.
Photo source: Federal Emergency Management Agency.

Growing expertise. During the 1950s and 1960s, few local governments, regional planning agencies, or private contractors had expertise in floodplain management. Many groups lacked expertise in mapping, map interpretation, drafting and administering regulations, backwater computations, acquisition, environmental impact analysis, wetland analysis, and other related topics. In the 1970s, expertise at all levels of government and in the private sector increased, although lack of expertise is still a common problem. City councils, architects, engineers, insurance agents, bankers and others sought information on flood hazards, floodproofing, and similar subjects in order to adopt wise regulations, design low risk structures, and reduce hazards to existing uses. States, federal agencies, regional planning agencies, and universities provided training through workshops, technical assistance, guidebooks, and consultations.

Growing public awareness. Public awareness of flood problems grew during the 1970s due in part to widespread press coverage of flood disasters; floodplain mapping by FEMA, other agencies, and states; flood insurance re-

quirements; public notice and hearings accompanying the adoption of regulations; and public education programs at all levels of government. Despite a growing general level of awareness, many floodplain occupants underestimated floods which did occur such as those from Hurricane Frederic.



The East Hampton chapter of the Nature Conservancy purchased over 600 acres of coastal wetlands, dunes, and floodplains in East Hampton, New York.
Photo by Jon Kusler.

Enhanced role for the private sector. Before 1970 the private sector played a limited role in hazard mitigation. The federal government, states, or localities were expected to remedy flood problems or provide disaster assistance. During the 1970s, industries and private homeowners floodproofed existing structures in some areas and helped establish flood warning systems.[22] Local conservation organizations promoted floodplain acquisition and regulation. National organizations such as the Nature Conservancy and the Audubon Society educated the public and acquired wetlands, floodplains, and barrier islands. Banks also indirectly enforced floodplain regulations by notifying potential mortgagees of regulations and by refusing mortgages for flood hazard areas unless flood insurance was purchased and minimum local and state standards were met.[23]

Recognition that flood hazard reduction must be a cooperative effort. In the 1950s, flood problems were addressed primarily by the federal government through flood control works. In the 1960s, at least 24 states adopted regulations or standards for local regulations. Although local programs grew in the 1970s, the decade also confirmed that the partnership of all three levels of government is needed to effectively reduce flood losses. This partnership is

the basis for **A Unified National Program for Flood Plain Management**[24] adopted by the U.S. Water Resources Council and member agencies in 1976, revised and sent by President Carter to Congress in 1979. This partnership is reflected in the cooperative work of FEMA, the WRC and the Coastal Zone Management Program to strengthen state and local programs, and in requirements of OMB and Congress that states and local governments cost share in floodplain management.

Growing awareness of floodplains as natural resources. In the 1950s and early 1960s, concern about the value of floodplain land for recreation, farming, forestry, wildlife, and pollution control was limited. During the 1970s, widespread recognition of these resource values[25] led to: (1) the adoption of Executive Order 11990, Wetland Protection, Executive Order 11988, Floodplain Management; and the Coastal Barrier Resources Act; (2) the Federal 404 permit program providing protection for navigable waters and wetlands;[26] (3) state wetland statutes in most coastal and some inland states; (4) state shoreland zoning programs in seven states; and (5) thousands of local resource protection programs, including shoreland zoning, wetland regulation, agricultural land zoning, and mineral resource zoning. Coastal states became concerned about barrier island and beach protection and comprehensive coastal zone management. Where complete protection of resource values was not feasible, floodplain and resource protection regulations often required measures to reduce environmental impact as a condition of development permits.

Combining regulatory and nonregulatory measures. Prior to 1970, only a small number of communities had combined regulations with nonregulatory measures. Now perhaps 30% of flood-prone communities have combined regulations with acquisition, flood warning systems, evacuation plans, marking flood hazard areas, or flood control works.[27]

Coordinated floodplain management. Until 1970, federal, state, and local flood control, floodplain regulation, disaster assistance, and open space programs were poorly coordinated and often contradictory. Real progress in coordination was made in the 1970s in large measure as a result of executive decisions such as issuance of the Floodplain Management and Wetland Protection Executive Orders, the creation of the Federal Emergency Management Agency, and adoption of a **Unified National Program for Flood Plain Management**. Congressional cross-referencing of disaster assistance,[28] flood insurance, and regulations also helped. Coordination at state and local levels was strengthened through state executive orders, improved state floodplain management programs, and more aggressive local programs.

Revisions in cost sharing. In the 1960s and early 1970s, the federal government subsidized federal flood control works and some types of disaster assistance at near-100% levels. Flood insurance received an overall 70% to 90% subsidy. During the 1970s, OMB, WRC, and Congress worked to develop consistent cost-sharing policies for flood control, disaster assistance, and other hazard reduction measures.[29] State and local cost-sharing increased from zero to 20%.

ructural projects. During the 1960s, WRC and its oped federal criteria ("principles and standards") to the economic costs and benefits of water resources 1970s, these criteria were refined and revised[31] and Ex- proposed an independent executive project review func- ources projects. Federal environmental impact review pro- ects were strengthened, and many states and localities adopted their vironmental impact review procedures.

Research. During the 1950s and 1960s, floodplain research focused on general policy issues; during the 1970s, it shifted to implementation. Many reports, manuals, and other materials addressed the flood insurance program, disaster preparedness, postdisaster response, floodplain regulations, flood warning systems, and floodplain acquisition.[32] The effectiveness of state and local floodplain regulations was examined by several major studies.[33] More than a dozen manuals and reports dealt with floodproofing techniques.[34]

Improved education and technical assistance efforts. Before 1970, federal agencies and states did little to educate elected officials, planners, architects, lawyers, and others in the specifics of floodplain management. During the 1970s, federal and state agencies distributed manuals, ordinances, and other materials and conducted hundreds of workshops with local governments. A variety of floodplain management films and slideshows were developed and more technical assistance was provided to local governments in map interpretation and case-by-case evaluation of floodplain permits. The Corps, NOAA, SCS, TVA, and USGS strengthened their assistance programs.

Emphasis on improved disaster preparedness and postdisaster hazard mitigation. Until 1970, the goal of most federal, state, and local disaster response efforts was rapid " return to normalcy," which usually meant reestablishment of the *status quo*. In the 1970s, federal agencies improved their disaster preparedness and postdisaster hazard mitigation to reduce flood damage potential after flood losses and to break the cycle of repeated flood losses. The Disaster Assistance Acts of 1973 and 1974, which made mitigation a condition of disaster assistance, were important first steps. Additional measures[35] included federal funding for state and local disaster preparedness and evacuation plans; postflood assessment (*e.g.*, Scituate, Massachusetts; Jackson, Mississippi); evaluation of postdisaster responses and recommendations for improved response; and the OMB directive requiring the formation of postdisaster teams under the leadership of FEMA to assess mitigation potential.[36]

Improved stormwater management. Before 1970, community stormwater management programs emphasized design of underground systems to convey five-year to ten-year flows from subdivisions to downstream areas as quickly as possible. In the 1970s, many metropolitan areas and some smaller cities and counties adopted not only subdivision regulations but grading, fill, and drainage ordinances that also applied to broader watershed uses.[37] These ordinances were designed to maintain natural flood levels by restricting im-

permeable surfaces, regulating vegetation removal and requiring detention ponds and compensatory storage. Regulations also included above-ground drainage systems capable of conveying 50- to 100-year floods. Large-scale mapping and hydrologic investigations that include future watershed conditions and flood storage formed the technical basis for these measures.

Principal Federal, State, and Local Roles

Progress in floodplain management in the 1970s was due to joint federal, state, and local efforts which are discussed in greater detail in the following chapters. The federal role in nonstructural floodplain management was to provide incentives and guidance, including subsidized flood insurance; standard-setting for state and local activities as a condition to flood insurance; disaster assistance; grants in aid for acquisition; mapping; technical assistance; public education; and research. The federal government also constructed flood control works and flood warning systems and selectively acquired floodplain areas and floodproofed structures. These activities formed an increasingly comprehensive program during the decade, even though they were often perceived as piecemeal or special problem responses.

The state role was also to set standards, map, provide technical assistance, and educate the public. Thirty-one states regulated or established standards for local floodplain regulations. However, most of the actual implementation was done by local units of government (cities, villages, towns, and counties).

Regional planning agencies were not generally authorized to adopt floodplain regulations or acquire floodplains. However, many agencies, such as the Southeastern Wisconsin Regional Planning Commission, assisted local governments to draft and administer ordinances, gather data, and plan for matters of regional concern.

Local special government divisions such as sewage and flood control districts played important floodplain management roles in some areas. Their roles will probably become more important, particularly for metropolitan areas where stormwater management is being integrated with floodplain management within each watershed.

Problems with Implementation

Despite progress in the 1970s in developing comprehensive federal, state, and local floodplain management, gaps remain and implementation is incomplete. In the following sections, problems with implementation will be described first by geographic location and then by type of program.

COASTAL AREAS

Floodplain management in the 1970s has been least effective along the coasts, which have the most severe hazards and the greatest development pressures.[38] Perhaps 70% of the damage-prone structures in the nation lie in coastal areas. Many are located below the 100-year flood elevation. Coastal hazard areas are of two types: (1) wave or "velocity" zones,[39] often extending 200 to 2,000 feet inland, which are subject to storm waves, inundation and sometimes erosion; and (2) backlying areas, extending 2,000 feet to several miles inland, which are primarily affected by inundation.

Development in high velocity wave areas has been the major problem where the coastline is flat and waves may travel far inland. Beach front and barrier island areas with storm surge and wave elevations of 14 to 20 feet are found along much of the mid-Atlantic, Florida, and Gulf coasts. Velocity zones are less a problem along bluff shorelines of the West and upper New England, but erosion there is a significant threat.

Barrier island development is a special problem because of the combination of storm surge, waves, erosion and the inadequacy of evacuation routes to the mainland during hurricanes.[40] From the coast of Maine to Texas, there are 288 elongated, narrow "barrier" islands made up of unconsolidated and shifting sand.

Typical beach, dune system, backlying salt marsh, and bay can be seen in this aerial view of a barrier island (Sappello Island, Georgia).
Photo source: Georgia Department of Natural Resources.

Most of these islands are moving landward at rates of three or more feet each year.[41] Winds, tides, waves, currents, and rising sea levels of six to 15 inches per century cause this movement. Barrier islands are the first landforms affected by hurricanes and northeasters striking the Atlantic and Gulf coasts. With average elevations of less than six feet, the waves and storm surges deeply inundate the islands and cause major erosion.

During a hurricane, public safety is threatened due to limited access to and from barrier islands such as Sanibel Island, above.
Photo source: John Clark.

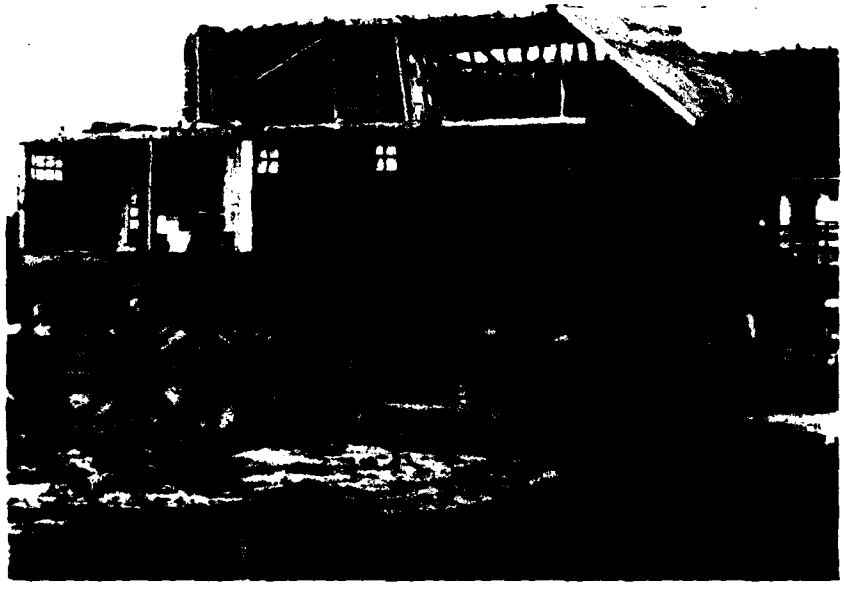
Until the twentieth century, development on barrier islands was largely confined to fishing shacks and seasonal structures in bayside areas. In the 1960s and 1970s, the demand for second homes led to massive construction of houses and condominiums. A Department of Interior report estimated that island urbanization proceeded at twice the mainland rate during the 1970s and that 14% of the barrier island area had been developed at urban densities,[42] compared to 3% of the rest of the nation's land. Federal investment in roads, sewers, water supply systems, and flood insurance has encouraged and helped finance this growth.[43] Such federal expenditures were prohibited for undeveloped barrier islands by the Coastal Barrier Resources Act of 1982, a measure that should help limit future losses.

Despite the severity of flood hazards in wave action areas, floodplain regulations have been only partly effective. FEMA flood maps did not reflect wave elevations and erosion. State regulations for such areas were virtually nonexistent until the mid-1970s, even though state regulation of inland flood hazard areas was widespread. Most of the 188 local governments with jurisdiction over barrier islands adopted minimum NFIP regulations, but the regulations

did not cover wave heights or erosion. State programs lacking technical assistance capability limited the effectiveness of local programs. Flood insurance subsidies were also high in wave zones, which may have encouraged private development.

FEMA is now developing new maps and individual ratings for structures in velocity areas. However, it will be at least several years before revised maps are available for most of the coast.

Hurricane Frederic pointed up the seriousness of flood problems for coastal velocity zones and the inadequacy of existing maps and standards.[44] A modest-sized storm, Frederic seriously affected about 50 sparsely populated miles of the nation's 58,200 miles of coastline. A combination of storm surge, waves, wind, and erosion damaged or destroyed approximately 1,500 structures, with losses exceeding $2 billion. Wind and waves destroyed 80% of the 500 structures in the first tier along a 20-mile barrier spit from Fort Morgan to Gulf Shores, Alabama. Many had been elevated to the 100-year flood protection level, but that elevation did not account for wave heights on top of the standing water. Consequently, many houses were swept off their pilings. Much of the dune system was also destroyed. Shoreline erosion averaged 45 feet inland along the Gulf side of the western two-thirds of Dauphin Island and 76 feet along the Mississippi sound side.[45] Erosion was particularly severe where driveways, drainage channels, boat channels, and marina entrances acted as conduits for flood water. House supports (even where houses were built on pilings) increased turbulence and accelerated erosion.



Hurricane wind and flood damage along the Alabama coast.
Photo source: Federal Emergency Management Agency.

Flood and erosion-damaged road, St. Augustine, Florida.
Photo by Jon Kusler.

Hurricanes of this sort are not freak events. On the average, two hurricanes strike the mainland United States each year, with the likelihood of one hitting Florida every 1.5 years.[46] One hundred twenty-nine hurricanes have struck the Atlantic and Gulf coasts since 1900. Fifty-three had winds of at least 110 miles per hour. The two deadliest killed 6,000 in Galveston in 1900 and 1,500 at Lake Okeechobee, Florida, in 1928. The fact that a major hurricane has not struck the Florida or Atlantic coast in the last 20 years has led to unwarranted optimism.

Although velocity zone damages are often the most serious, problems with coastal development are not confined to this zone. Backlying lands one-half to several miles inland along the mid- and south-Atlantic and Gulf coasts are often flooded three to eight feet by a 100-year storm. These areas are also subject to much greater wind velocities (75 to 150 miles per hour) and combined wind and water damage than are comparable riverine properties for a similar 100-year flood. Winds and the rapid rise and fall of hurricane-driven flood waters increase wave heights and water velocities, although backlying areas do not technically qualify as wave velocity zones. Regulations have been adopted for most coastal areas, but most do not protect against high velocity winds or waves.

INLAND AREAS

Floodplain management in the 1970s was more successful in inland areas where the combined threat of wind, water and erosion was less serious. Development could be shifted to upland sites in many instances; the demand for waterfront sites was not as strong. Relatively permanent adjustments such as elevation on fill were more successful than in coastal areas that are eroded by high velocity water. Many states adopted strong floodplain regulations. Moreover, many communities have adopted their own aggressive and innovative floodplain management programs. The concept of a "floodway" linked to the prevention of damage to upstream and downstream landowners had broad-based political and legal acceptability. Structural solutions and relocation also proved practical in many situations.

Despite the greater success of inland floodplain management efforts, problems with implementation also arose in some areas. Approximate flood maps that failed to provide the 100-year flood elevation and floodway boundaries were the only maps available for most rural and urbanizing areas where much of the new development occurred. Some local governments lacked sufficient expertise to administer regulations, particularly in rural areas. Only a portion of the country had state floodplain programs with strong technical assistance capability. Development in upstream areas often substantially increased flood heights in downstream areas, particularly in urbanizing watersheds.[47] The possibility of federally funded flood control measures discouraged communities from adopting stringent floodplain regulations.

Lack of specificity in measures for inland flooding was also a problem. NFIP standards and those of most states have been quite successful for low-velocity and moderate-duration flood areas located along major rivers and streams. The single-district and two-district ordinances developed for Volumes 1 and 2 of **Regulation of Flood Hazard Areas**, were designed for these areas. However, for inland areas with unique flood characteristics application of these standards and models has caused problems.

Flash flooding and high velocity flows. High gradient streams with rapid flood flows and, in some instances, flash flood characteristics are found in all areas of the nation, but they are concentrated in the mountain states. The National Weather Service (NWS) has identified at least 2,500 communities with flash flood problems.[48] Particularly serious flash floods occurred in Rapid City in 1972 and Big Thompson Canyon in 1978. The two floods killed 372.

The regulations established by the NFIP and those proposed in Volumes 1 and 2 were partially unsatisfactory for such areas. Floodway modeling that assumes subcritical flows was not satisfactory for high velocity or supercritical flows. These areas needed much stricter regulations to deal with high velocities and flash flood conditions. Unfortunately, no manuals or ordinances have been developed for high velocity or flash flood conditions.

Long duration flooding along lakes and ponds. Long duration flooding occurs along major lakes with fluctuating water levels such as the Great Lakes and

also around thousands of smaller lakes and ponds fed by groundwater. Regulations developed for riverine areas that permit elevated development in areas subject to short duration flooding have proved inadequate for these areas, since most structures on pilings will be damaged or rendered useless if surrounded by water for months or years. For example, once flood insurance became available, Lake Elsinore, a community along Lake Elsinore in California, amended its floodplain regulations to permit buildings elevated on pilings to the 100-year flood protection elevation, as permitted by the NFIP. Previously it had prohibited development on ground below the elevation of fluctuating lake levels. After basinwide rainfall caused long-duration flooding in 1979, elevated structures were isolated and rendered unusable. In many instances, the water and waves gradually destroyed them. Because of this problem, the community again tightened its regulations and prohibited development except where the land surrounding the structures was above the 100-year flood elevation.

Flooding behind dikes and levees. Regulations have been difficult to enforce in areas that have levees and dams to protect from a 100-year flood. Landowners often believe they are protected, so they oppose regulation, unaware that inadequate drainage causes flood problems in such areas. When a flood exceeds design capacity, damage to backlying areas can be catastrophic. For example, $500 million in damages occurred along the Pearl River in Jackson, Mississippi, when flooding overtopped levees, inundating backlying areas to the full heights of the flood.

Flooding along small streams and drainageways. Floodplain mapping and regulations in the 1970s focused on the floodplains of larger rivers and streams. However, substantial urban and metropolitan flood damages were caused by flooding along smaller creeks and streams. Urbanization also increases peak flows. Adequate watershed mapping and programs that combine floodplain regulation and stormwater management are rare.

Alluvial fans and mud flows. Flood mapping and regulation for riverine areas have been only partially applicable to areas built on alluvial fans or those subject to mud flows. In these regions, a traditional floodway concept does not apply and elevation requirements make little sense if the force of the flow will destroy pilings or the lower floors of structures. Alluvial fan flood problems occur in the canyon areas of the West and Southwest. Rather than following a well-defined course, flood waters exit the canyons through many small, rapidly shifting channels. Flash flooding is common, and flood damages are often compounded by severe erosion.

Mud flows are caused by unstable, supersaturated soils. The great force of the moving mass makes mud flows particularly damaging. The cost of cleanup is very high since mud must be mechanically removed.

FEMA and the Corps are trying to address alluvial fan and mud flow problems more specifically, but maps and regulatory standards tailored to these special needs are still needed.

PROGRAM PROBLEMS

Although problems with implementing state and local floodplain management in the 1970s have varied, most programs have the following difficulties.

Federal efforts focus on urban areas. Most NFIP floodplain mapping and technical assistance has focused on urban areas that have the most existing flood-prone uses and the greatest potential for flood insurance. The NFIP has paid much less attention to rural and urbanizing areas where the opportunity for guiding future uses is greatest.

Existing uses. The 1970s demonstrated that floodplain regulations are least effective in reducing losses to existing uses, unless the uses are destroyed or very seriously damaged by floods.[49] For developed areas, even after a severe flood, pressures for rebuilding are often so great that communities permit redevelopment without flood protection measures. Regulations have not effectively controlled repair of damaged buildings.

Untested floodproofing measures. The long-term adequacy of many structural floodproofing measures for commercial, industrial, and residential buildings is questionable.[50] Preliminary surveys after actual flooding show that total waterproofing from even low levels of inundation (2 to 3 feet) is difficult. Structural floodproofing is particularly vulnerable to large floods, waves, and high-velocity flows: few structures can withstand the force of a three-foot breaking wave. In addition, temporary floodproofing measures such as emergency doors are likely to be placed incorrectly or become inoperative. Long-term losses are also likely when flood adjustments are used such as elevation on wooden pilings which may deteriorate over time.

Flood maps underestimate hazards. Flood maps often underestimate the elevation and severity of actual hazards.[51] This problem is particularly serious in coastal areas where wave heights and combined erosion and flood hazards are not considered. At some points along the coast with steep offshore water depths and high waves, the 100-year elevation shown on FEMA maps may be reached annually or with a 5- to 10-year recurrence interval. Flood velocities, erosion, and duration of flooding are also inadequately considered in some inland areas. Because urbanization of watersheds greatly increases flood flows, flood maps quickly become obsolete.

Activities with severe flood damage potential are unregulated. Regulations that require elevated or floodproofed structures often do not apply to public works such as bridges, roads, sewer systems, and water supply systems that must be constructed to serve these areas. Increased and repetitive flood losses to these works result. Location of hospitals and low income housing in hazard areas threatens public safety.

Placement of hazardous items such as gasoline and propane tanks is also often inadequately regulated. These may cause fire and pollution during floods and injury to rescue workers. If inadequately anchored, they may also break free and lodge in bridge openings, obstructing the flow of flood water.

Empty gas storage tanks, Austin, Minnesota. During floods, gasoline and propane tanks may float free, causing fire and pollution problems as well as increased flood damages.
Photo source: Patricia Bloomgren.

Mobile homes and mobile home parks are common in the floodplain and are subject to severe flood damages. Mobile homes often break free from their foundations and lodge in bridge openings or crash into other structures. Many of the flood-related deaths at Rapid City, Buffalo Creek, and during Hurricane Agnes were due to occupancy of mobile homes in the floodplain. Inadequate regulation is common.

Legal and administrative inadequacy of emergency regulations. Regulations adopted by many of the smaller towns and rural communities that remain in the emergency program of the NFIP are often inadequate both in substance and administration. Many communities have adopted only a "resolution" stating their intent to adopt detailed regulations when base flood information becomes available. Such resolutions require only that permits be secured for construction the the floodplain. In some jurisdictions the resolution has limited enforceability. Equally serious, administration of emergency program provisions is limited by lack of maps or case-by-case project evaluation procedures to identify 100-year flood elevations, floodways, and coastal velocity zones. The completion of an additional 4,000 floodplain studies in 1981-1982 and the conversion of these communities into the regular program will help to solve this problem. The NFIP's efforts to convert the remaining 6,000 communities into the regular program through "emergency conversion" procedures should also help, but only if the communities are required to adopt and monitor more effective regulations as a condition to the conversion. For example, the NFIP could require communities to make a case-by-case evaluation of flood hazard for new structures.

Mobile home destroyed by flooding at Buffalo Creek, West Virginia.
Photo source: The Federal Emergency Management Agency.

Inadequate expertise in program development and administration. Inadequate expertise in floodproofing techniques, map interpretation, flood warning systems and acquisition procedures continues to be a problem, despite gains in the 1970s. It is particularly serious in rural areas.

Floodplain maps not designed to meet land use management needs. FEMA mapping is more responsive to insurance needs than to land use management. Consequently, scales are often too small for management purposes, topographic information is lacking, and existing development and other useful information is omitted. Maps are rarely detailed or accurate enough to provide the basis for sophisticated floodplain management before and after disasters, although they have been relatively satisfactory for floodplains under light development pressures. More detailed flood studies and maps on a topographic or orthophoto base are needed.

Inadequate map data storage and dissemination. From a management perspective, raw map data and other data in flood insurance studies are often equally or more important than the map itself. Storage of raw data has been and continues to be unsatisfactory. FEMA study contractors (usually private engineering firms) are required to maintain the data for five years from contract completion. After this period, the data may be discarded. The unavailability of such data may seriously undermine the legal acceptability of regulations. In addition, updating will be very difficult, if not impossible. More satisfactory methods must be found to retrieve and store data for future use. The distribution and interpretation of maps has also been spotty and unsatisfactory in some instances.

Inconsistent administration of floodplain regulations. When development is proposed, many communities issue variances or amend regulations without compliance with minimum regulatory standards.[52] Structures and fill may be

permitted in floodways. First floors may be permitted at elevations far below the 100-year flood elevation. Sometimes failure to comply with standards is due to lack of flood data or expertise in evaluating permits. In other instances, federal, state, and local standards are ignored.

Inadequate coordination. Despite the executive orders and other measures of the 1970s, coordination is often poor for floodplain regulation, flood control, disaster assistance, flood insurance, park planning, capital improvement planning (roads, sewers), and other land and water management activities. Floodway delineation and watershed management policies of one community are often not coordinated with activities of upstream, downstream, or adjacent communities.[53] Floodplain regulations often fail to take into account resource protection and broader community land use planning activities.

Lack of specificity. In the 1970s, federal and state authorities applied relatively uniform standards for floodplain mapping, regulations, and technical assistance. These uniform, generalized approached were necessary in light of available program budgets and to avoid charges of favoritism. Although this policy provided valuable minimum standards, the need to tailor program standards became apparent, especially for areas subject to waves, high velocity flows, flash floods, combined flooding and erosion, long-term fluctuations in water levels, or mud flows. Lack of specificity in program standards has also hindered attempts to deal with rural, urban, and metropolitan areas where density, existing uses, land use planning goals and levels of expertise differ.

Federal program bias for flood control works. Criteria for cost/benefit ratios of federal water resources projects permitted agencies to claim benefits for dams and other flood control measures to enhance undeveloped floodplain lands for structural uses, even though unflooded sites were available in the communities.[54] Nonstructural alternatives for maintaining an open floodplain are assigned minimal benefits in these calculations. This bias toward flood control is also reflected in large federal subsidies for flood control projects but minimal funding for floodplain acquisition, regulations, and flood warning systems.

Flood losses encouraged by subsidized insurance. The NFIP has provided the major incentive for state and local adoption of regulations and has been a positive influence in most situations. However, heavily subsidized insurance (70% to 90%) has also apparently encouraged some unwise floodplain and wetland development, particularly in coastal areas and on barrier islands.[55] This high subsidy lowers the risks to banks of making mortgage money available, and reduces the burden of losses for property owners. Subsidized insurance also acts as a disincentive to private floodproofing or relocation of existing structures. Low, subsidized flood insurance rates can be perceived by the public to imply a small chance of damage from floods.

FEMA is now addressing these problems by including wave elevations in coastal flood maps and accelerating the conversion of emergency program communities into the regular program. Flood insurance rates are being revised to reflect risk more accurately.

Inadequate monitoring of floodplain uses. Floodplain development has not been carefully monitored at federal and state levels. Each year FEMA carries out about 200 community field monitoring studies (Community Assistance and Program Evaluation Reports or CAPEs) to determine whether communities have adopted and are properly administering regulations.[56] These studies typically involve a site visit to a community, discussions with local government officials, and a tour of the floodplain. The visits do provide some measure of monitoring and deter blatant violations by other communities. However, FEMA has done little to monitor damages to individual structures after flooding and has completed only about 600 CAPEs for the 17,000 communities in the NFIP. CAPEs are not being carried out in all 10 FEMA regions. Rarely has FEMA suspended a noncompliant community from the flood insurance program. FEMA lacks a staff of sufficient size to perform detailed follow-up on violations. Because of inadequate staff size and funds, state floodplain monitoring has also been generally unsatisfactory. In fiscal year 1981, state monitoring has been strengthened through the use of FEMA State Assistance funds.[57]

Most monitoring of development is at the local level. Communities do not typically have formal monitoring systems to assess floodplain development on a regular basis, so they depend instead on complaints from citizens or random building inspections.

Addressing Problems

The remaining chapters of this report address these and other problems in greater depth including work done in the 1970s to address them. Possible strategies are suggested for the 1980s to: reduce losses to future uses (Chapter II); reduce losses to existing uses (Chapter III); combine hazard mitigation and resource protection (Chapter IV); regulate uses at the state level (Chapter V); and regulate uses at the local level (Chapter VI). Judicial reaction to regulations is outlined in Chapter VII. Chapter VIII concludes the report with a discussion of floodplain management strategies to reduce flood losses in the 1980s.

Footnotes

1. Statistics provided by the Federal Disaster Assistance Administration.
2. See National Oceanic and Atmospheric Administration (1978).
3. For example, the consumer price index lists the cost of cement at $17.69 per short ton in 1970 and $46.24 in 1979.
4. This information was derived in part from National Oceanic and Atmospheric Administration (1977).
5. Flood Disaster Protection Act of 1973, P.L. 93-234 (codified at 42 U.S.C.A. §§4001-4128 (West 1977)).
6. Section 1362, National Flood Insurance Act of 1968, P.L. 90-448 (codified at 42 U.S.C.A. §§4001-4128 (West 1977)).
7. Memorandum, Office of Management and Budget, July 10, 1980.

8. See Platt (1979).
9. *Id.*
10. Task Force on Federal Flood Control Policy (1966).
11. *Id.*
12. Flood Disaster Protection Act of 1973, P.L. 93-234 (codified at 42 U.S.C.A. §§4001-4128 (West 1977)).
13. Housing and Community Development Act of 1977 (P.L. 95-128).
14. Disaster Relief Act of 1970, 15 U.S.C.A. §636 (West 1976).
15. Flood Disaster Protection Act of 1973, P.L. 92-234 (codified at 42 U.S.C.A. §§4001-4128 (West 1977)).
16. Flood Disaster Relief Act of 1974, P.L. 93-288, Section 406 (codified at 42 U.S.C.A. §5131(c)(d) (West 1977)).
17. These regulations became effective on December 10, 1979, more than five years after the act was signed. 44 C.F.R. §205.400-205.411 (1981). 44 C.F.R. §9 (1981).
18. National Flood Insurance Act of 1968, P.L. 90-448 (codified at 42 U.S.C.A. §§4001-4128 (West 1977)).
19. Water Resources Development Act of 1974, P.L. 93-251 (codified at 33 U.S.C.A. §701b-11, 701c (West Supp. 1981)). According to §701c, cost-sharing provisions for nonstructural alternatives should be comparable to cost-sharing for structural alternatives with a maximum local share of 20%.
20. See Binder (1979).
21. Federal Dam Inspection and Safety Act of 1972, P.L. 92-367 (1972).
22. See discussion in Chapter III and Bresenhan (ed.) (1979).
23. 42 U.S.C.A. §4012 (West 1977) requires, in effect, that lending institutions regulated by the federal government not make real estate loans unless flood insurance (if available) is purchased. The statute also directs agencies regulating banks, savings and loan associations and similar institutions to adopt regulations requiring institutions to notify a purchaser of property of special flood hazards or to obtain assurances that the seller or lessor has notified the purchaser.
24. U.S. Water Resources Council (1976). An updated version was sent to Congress in January, 1980.
25. See Chapter IV.
26. 33 U.S.C.A. §§401-466, 1251-1376 (West 1970).
27. See Chapters II and III.
28. See, for example, the Flood Disaster Protection Act of 1974, footnote 29, which requires flood insurance as a condition to disaster assistance.
29. Flood Disaster Protection of 1974, P.L. 93-251 (codified at 33 U.S.C.A. §701b-11 (West Supp. 1982).
30. The President's Water Resources Council, **Procedures for Evaluation of National Economic Development Benefits and Costs in Water Resources Planning**. 18 C.F.R. §713 (1981).
31. 18 C.F.R. §711 (1981) (Principles and Standards for Water and Related Land Resources Planning).
32. See publications listed in the bibliography.
33. *Id.*
34. See the bibliography for a partial listing.
35. See footnote 8. See also Abeles, Schwartz, Haeckle & Silverblatt, Inc. and Ralph M. Field Associates, Inc. (1981).
36. Office of Management and Budget Memorandum, July 10, 1980.
37. See Chapter II for discussion of Baltimore County, Maryland; Alexandria, Virginia; Howard County, Maryland, and several other programs.
38. For studies concerning floodplain management in coastal areas see White *et al.* (1976) and National Oceanic and Atmospheric Administration (1980).
39. Velocity zones or coastal high hazard areas are defined by regulations (24 C.F.R. §1909.1 (1981)) to include:

> the area subject to high velocity waters, including but not limited to hurricane wash or tsunamis. The area is designated on a FIRM as Zone VI-30.

40. See references on barrier islands in the bibliography.
41. See Kaufman and Pilkey (1979), Leatherman (1979), and Leatherman (1981).
42. U.S. Department of the Interior (1979).

43. *Id.* See also Sheaffer and Roland, Inc. (1981). This report concluded that (using an average purchase price of $5,000 per acre) recent estimates indicate that acquisition costs could be one-fifth or less of the costs to the federal government of continuing its current development program on the undeveloped barrier islands. See also footnote 55.
44. An analysis of damages caused by Hurricane Frederic by Sheaffer and Roland, Inc. (1980) revealed that 322 houses out of a total of 442 in the first tier along 22 miles of coast from Fort Morgan through Gulf Shores, Alabama, were destroyed. One hundred seventeen out of 130 were destroyed in a 16-mile portion of the 22 miles. Of the 1,059 structures in the first three tiers along the 22 miles, 534 were destroyed—over 50%. First tier houses were generally 200-300 feet from the shoreline; second or third tier setbacks were generally 800-1,000 feet from the shoreline. Wave elevations at the shorefront were approximately 18 feet while the still water storm surge elevation was 11 feet.
45. See Penland *et al.* (1980).
46. See National Oceanic and Atmospheric Administration (1977).
47. See National Science Foundation (1980), which concluded that, "[u]rbanization increases peak flow rates from two to six times for the more frequent floods on small streams with less relative effects on larger events and larger streams." It recommended that "[p]lanning for urban storm run-off involving prediction of future probabilities of flooding should include consideration of future changes in land use." (p. 213)
48. See National Oceanic and Atmospheric Administration (1978). This total may (it is not clear from the report) include coastal communities.
49. See Chapter II.
50. *Id.*
51. See discussion accompanying footnote 5 in Chapter VIII.
52. This conclusion is based upon discussions with state floodplain management personnel (See Appendix I), FEMA staff, and examination of approximately 600 FEMA field reports (CAPEs) evaluating individual local programs. Although variances are routinely granted in some communities, many other communities are apparently "holding the line" in administration of regulations.
53. See Platt *et al.* (1980).
54. See Sheaffer and Roland, Inc. (1981). In analyzing criteria or federal water projects this report concluded that,

> With regard to existing development, the economic evaluation of nonstructural measures such as flood proofing, rehabilitation, and evacuation can compete with structural measures on a reasonably equal footing. For new development, however, the deck is stacked in favor of structural measures. Unless the policies and evaluation procedures are changed to provide the proper consideration of alternative locations for new development, there is not much hope for greater success in the implementation of nonstructural measures. . . .
>
> There are always practicable alternative locations for new development, but potential for elimination of flood risks on the floodplain often causes floodplain owners to expect large economic gains through use of their lands for high-intensity development. Thus organized, they present a powerful economic and political force, usually successful, in opposition to any significant nonstructural uses of the floodplain (p. 8).

55. Whether federally subsidized flood insurance has encouraged floodplain development has been widely disputed. There has been little field study concerning development in insured and uninsured areas. In addition, it is difficult to separate the importance of insurance, regulation, recession, and other factors in encouraging or discouraging development in a particular circumstance. Nevertheless, most state and local officials interviewed by the author were of the belief that the insurance had encouraged some development although how much was unclear. Researchers who had addressed the topic generally showed this belief. Miller (1977) concluded after conducting a field survey of 15 communities, that once flood insurance became available, lending institutions in Westerly, Charlestown and South Kingston, Rhode Island and Galveston, Texas (⅓ of the communities studied) reversed earlier restrictions on mortgages in coastal high hazard areas.

    Burby and French (1981) concluded, based upon a survey of 1,203 local jurisdictions (see description of this survey in Chapter V) that:

> It often appears that the NFIP induces increased floodplain development because the same factors which lead communities to participate in the NFIP are also associated with continuing floodplain invasion. These factors include past invasion of the floodplain and a need for insurance and the potential for new construction in the hazard area because of its attractiveness for development. (p. 294)

State and local officials interviewed by the author suggested a stronger correlation. They argued that bank financing would not have been available for much of the new development without flood insurance. During the last five years, interest rates have been high, money has been scarce in most areas, and banks have carefully screened mortgagees. Due to the widespread availability of flood maps, bankers have been well aware of hazards (unlike the 1950s and 1960s). Would banks have provided mortgages with knowledge of such hazards, a tight money situation, and lack of meaningful private flood insurance? Probably not. Of course, other factors may also have contributed to floodplain development ranging from income tax write-offs for interest, favoring purchase of second homes in barrier islands and other high amenity areas by high income city-dwellers to federal subsidies for roads, water supply systems and the like.

The Coastal Barrier Resources Act of 1982 has banned federal flood insurance for properties on barrier islands.

The General Accounting Office is presently studying the effect of the National Flood Insurance Program on coastal development.

56. Regional Offices of the Federal Emergency Management Agency have prepared an estimated 600 Community Assistance Program Evaluation reports (CAPEs) to serve two principal and often complementary purposes: (1) monitor enforcement, and (2) provide technical assistance to communities. These reports include a field visit to the community, discussion with community officials (and in some instances banks and insurance agents), examination of files and field inspection of the floodplain. Monitoring efforts have been focused on areas where there have been complaints of noncompliance with federal regulations or severe flood problems and continued developed (*e.g.*, Monroe County, Florida—the Florida Key; Ocean City, Maryland). Technical assistance efforts have focused on past disaster communities, (*e.g.*, Scituate, Massachusetts) and communities requesting or needing assistance. Regionally, CAPE preparation has been uneven with most CAPE preparation in the mid-Atlantic states and Midwest. Only a small number of CAPEs have been prepared for New England, the West and the South.
57. In 1981 and 1982 a number of states conducted systematic community monitoring efforts with help from FEMA state assistance funds. These include efforts by New Jersey to conduct CAPEs for all 270 New Jersey municipalities in the National Flood Insurance Program and efforts by California to monitor all regular program communities.

CHAPTER II

ADJUSTING FUTURE USES

Overview

Floodplain regulatory programs in the 1970s were designed primarily to guide the future use of undeveloped floodplains in order to reduce flood losses. Other goals included protection of natural resources, protection of the tax base, and implementation of federal, state, and local comprehensive land and water management plans. The overall objective was "wise" or socially beneficial use of floodplains in light of their values and special hazards.[1]

Regulations in the 1970s were most effective in establishing minimum flood protection elevations and guiding development away from rural floodplains where land values were low and where alternative building sites were available. In urban and urbanizing areas, they also effectively protected floodways, dunes, wetlands, and other critical areas. They guided "infilling" of partially developed areas and redevelopment. By guiding future development, regulations reduced future flood losses.[2]

Regulations to guide future uses differed from state to state and community to community. Nevertheless, they were remarkably similar in one respect—almost all required protection of new structures to the 100-year flood elevation where flood studies or maps that included this elevation were available. All state floodplain regulatory programs adopted the 100-year standard for mapping and regulation during the 1970s. The National Flood Insurance Program and the Floodplain Management Executive Order adopted the 100-year standard. Most federal maps applied the standard.

Two approaches were applied at state and local levels to require protection of structures to the 100-year flood elevation. The most common required elevation of residential structures on fill, pilings, or other open works and (alternatively) elevation or floodproofing of commercial and industrial buildings. The second prohibited new structures or reconstruction in the 100-year floodplain.

The first approach, taken by the NFIP and most state and local programs, allowed for a balance of flood loss reduction and development needs in areas with broad floodplains. It was most widely applied in Atlantic and Gulf coastal areas and along major rivers and streams. Regulatory standards prohibited fill

TABLE 3

TECHNIQUES TO REDUCE LOSSES TO FUTURE DEVELOPMENT

Adoption of floodplain regulations to guide new development away from floodplains or floodways or require elevation or floodproofing of structures

- Zoning
- Subdivision controls
- Building codes
- Special codes

Planning of public facilities, roads, sewers, and water supply systems to avoid floodplains, to provide for elevation of facilities, etc.

Floodproofing of new structures

- Elevation on fill or open works
- Temporary or permanent waterproofing
- Wet floodproofing
- Structural design elements
- Water resistant materials

Emergency evacuation

- Flood forecasting
- Flood warning
- Evacuation procedures

Acquisition of undeveloped hazard areas

- Fee (purchase, donation, exchange)
- Easements
- Transfer of development rights

Education

- Floodplain mapping
- Flood warning signs
- Workshops
- Distribution of pamphlets, newspaper articles, etc.

Preventing increases in stormwater runoff

- On-site storage requirements
- Regulations protecting flood storage areas

Resource protection and management regulations with hazard mitigation standards

- Wetland
- Dune
- Coastal setbacks
- Agricultural and forestry zoning
- Performance zoning

Tax incentives

- Preferential assessment of real estate in hazard areas pursuant to open space tax statutes
- Income tax incentives for bargain sales, donation of lands to public agencies, non-profit corporations
- Estate and gift tax incentives for donation of lands to public agencies, non-profit corporations

Flood control measures

- Dams
- Dikes, levees, seawalls
- Channel modifications

and structures in floodway, wave velocity, and dune and mangrove areas where these activities would increase the 100-year flood elevation or flood velocities on other lands. Storm drainage measures were also commonly required.

Despite its advantages, this approach rarely led to substantial reduction of floodplain development.[3] Problems, which are discussed below, also arose in defining 100-year flood elevations and in requiring adequate floodproofing of buildings. Moreover, the roads, sewers, and water supply systems that had to be extended to serve new flood fringe development increased total public flood losses. To be effective, implementation of this approach required detailed flood maps and technical expertise to evaluate floodproofing measures, flood heights, velocities, and other matters.

Hundreds of communities applied the second approach—one that prohibited all new development in the floodplain. This was most commonly used in areas with steep topography and narrow floodplains and in rural areas with low land values. The purpose was to prevent gradual increases in flood heights and velocities caused by the elimination of flood storage and encroachment in floodway areas and to reduce flood losses to costly public works such as roads, sewers, and water supply systems. It provides a measure of safety against uncertainties about the long-term effectiveness of floodproofing measures. It protects resources and supports broader community land management objectives. Moreover, it can be applied with relatively imprecise flood data and low levels of expertise. However, it more often encountered political problems.

A combination of the two approaches was applied by thousands of local governments and many states. They prohibited all fill and structures in floodways and coastal areas, but permitted some fill and structures protected to the 100-year flood elevation in fringe areas. The restrictiveness of this approach depended on the definition of floodway, as discussed below.

Although the 100-year flood protection elevation requirement was used by much of the nation, the specifics of community regulations differed based upon community preferences, state standards and available flood data. NFIP requirements for state and local regulations varied according to the type and amount of information provided in its flood maps. Communities were required to

upgrade regulations within six months of receiving upgraded flood data from the NFIP.

Problems in Implementation

Regulations were least effective in the 10,800 communities (as of January 1981) in the emergency program of the National Flood Insurance Program. Many of these communities have adopted only a resolution indicating their intent to adopt more detailed regulations in the future or a preliminary ordinance requiring building permits and general subdivision review. The legal sufficiency of the resolutions to control new development is questionable in some jurisdictions.[4] In addition, most emergency program communities enrolled in the regular program of the NFIP. Three to four thousand more are expected to enter the regular program in 1981-1983. A community must enter the regular program within six months after FEMA completes a flood insurance study, which includes a map showing 100-year flood elevations, or the community's participation in the program will be suspended. A community qualifies for additional flood insurance upon entry into the regular program. It also must upgrade its regulations.

States and communities in both phases of the program encountered the following problems in reducing flood losses to future uses:

- NFIP and community criteria for defining the 100-year flood protection elevation sometimes underestimated hazards by failing to recognize wave and erosion hazards, changing watershed conditions, and other related factors.
- Flood maps defining 100-year floodplain boundaries and the 100-year flood elevation were available for only a portion of the nation.
- NFIP criteria for defining floodways (*i.e.*, one foot of backwater effect) increased flood damages.
- NFIP criteria for defining coastal high hazard areas were inadequate in some instances. Few coastal high hazard zones have been mapped.
- Regulations failed to provide adequate protection for dunes and wetlands.
- Few floodplain mapping and regulatory standards were adequate to meet the combined needs of flooding and stormwater management in urbanizing areas.
- Methods for protecting structures to the 100-year elevation were subject to limitations.
- Federal subsidies for some flood control works and flood insurance undermined nonstructural floodplain management.

These problems and ways states and communities addressed them are discussed more fully below.

INADEQUACIES OF THE 100-YEAR FLOOD PROTECTION ELEVATION

Most states and communities adopted the minimum NFIP standards for protection of structures in flood fringe areas. The NFIP requires that new structures in coastal and inland fringe areas either be elevated on pilings or fill or be floodproofed to the 100-year flood protection elevation. Residential uses are to be elevated on pilings or fill.[5] Commercial and industrial uses can be either elevated or floodproofed.

During the late 1960s, the NFIP selected the 100-year flood as the basis for regulation because it was considered a "middle-of-the-road" approach to balance potential damage against the costs of protection. NFIP studies during the 1970s showed that elevation to the 100-year flood level was, in general, cost-effective for landowners.[6] Despite some controversy, states and localities also accepted the 100-year elevation as a general standard, but permitted some structures such as those for agricultural storage at lower elevations and required higher elevations for particularly sensitive or dangerous "critical uses" such as hospitals or nuclear power facilities.

Two problems were encountered in applying the 100-year standard: lack of agreement on criteria for establishing the 100-year elevation and lack of agreement on the most appropriate flood protection measures based upon this standard.

The first problem concerned assumptions in calculating the 100-year elevation. The NFIP decided to use existing watershed conditions to calculate the 100-year elevation because future watershed conditions are difficult to predict and FEMA had concluded that flood insurance rates must be calculated according to existing, not future hazards. One hundred-year surge elevations were calculated for coastal areas without consideration of wave heights because at first the method of determining wave heights was technically questionable and because strong political pressures opposed using such heights since they may add 50% or more to the 100-year flood elevation. These criteria and guidelines were challenged by some states and localities.

Basing flood protection measures on particular 100-year flood elevation criteria was also challenged. One study pointed out that perhaps 60% of the flood damages in the 1970s resulted from floods exceeding 100-year levels as defined by NFIP criteria.[7] If the capacity of a levee designed to the 100-year criteria is exceeded, backlying structures are flooded to the full height of the 100-year flood.[8]

After severe floods in the 1970s demonstrated these deficiencies in applying a 100-year flood elevation criteria, some states and communities adopted more stringent protection elevations.

Regulations for urbanizing watersheds. Because FEMA flood maps assume existing watershed conditions in calculating flood flows in urbanizing watersheds, they can quickly become outdated. Urbanization may increase peak flow two to six times.[9] To avoid this problem, a number of urban and metropolitan

communities prepared their own maps based on assumptions of future urbanized watershed conditions.

- Arvada, Colorado, and other communities in the Denver area adopted floodplain regulations for the 100-year floodplain as defined through studies of the Denver Urban Drainage and Flood Control District that accounted for projected watershed development.
- Dallas, Texas, calculated runoff according to projected land use in the watershed.
- Tulsa, Oklahoma, has assumed future watershed conditions in its mapping and regulations since 1975.
- Racine County and other counties in the Southeastern Wisconsin Regional Planning Commission adopted regulations based on Commission studies that assumed future watershed conditions.

Regulations for broader inland floodplain areas. Most state regulatory programs and several thousand local programs have added "freeboard" (additional elevation) requirements to the NFIP 100-year flood elevation or have regulated based on the height of floods larger than the 100-year flood. This has been done in order to deal with increasing flood levels from urbanizing watersheds, special problems such as ice jams, or destruction of flood storage areas. For example, Wisconsin requires two feet of freeboard in all of its communities. Highland Park, Illinois, requires two and one-half feet of freeboard, while Sioux Falls, South Dakota, and Howard County, Maryland, require two feet.

Regulations for coastal velocity zones and erosion areas. Some communities and states have gone beyond NFIP standards to reflect more accurately coastal wave and erosion problems.

- Massachusetts took into account wave heights when the state amended its building code regulations after the severe winter storm of 1979.
- Following the devastating hurricane in 1954, the governor of Rhode Island appointed a hurricane damage reduction task force, which formulated recommendations for two-zone regulations of coastal hazard areas. These were implemented by East Providence, Rhode Island, which prohibited structures in a high hazard zone severely damaged by the 1954 hurricane and required that structures in backlying low hazard zones be protected to a height of 15 feet, in contrast to a 100-year storm surge elevation of about 10 feet. South Kingston, Rhode Island, adopted a similar ordinance in 1975.
- Southampton, New York, requires a minimum elevation of 15 feet for new structures. The 100-year storm surge elevation is 10 to 12 feet.

Other communities with regulations reflecting anticipated wave heights and/or erosion hazards are Gulf Shores, Alabama, with a protection elevation of 15 feet; Santa Rosa Island, Florida, with a protection elevation of 13 feet; and a portion Virginia Beach, Virginia, with protection elevations of 18.5 feet.

In remapping coastal areas, the NFIP now includes wave heights, but it will be several years before the maps are completed. FEMA is also considering individual insurance rating of structures in velocity zones to take into account wave heights.

LACK OF 100-YEAR FLOOD BOUNDARY MAPS

As discussed in Chapter I, the USGS prepared "approximate" flood maps for 20,000 communities in the early 1970s. These maps were based on historical flood maps, records of flooding, and other sources of information. They varied greatly in accuracy, depending on available information. These approximate maps have been of some value for regulatory purposes, but their use has been limited because they lack floodway and coastal high hazard area boundaries and 100-year flood elevations. FEMA did not require communities with approximate maps (about 11,000 of 17,000 in the NFIP) to undertake more detailed flood analyses to determine how proposed development would affect flood heights and velocities. Consequently, some development occurred in the 1970s (and is now occurring) in floodway and wave velocity areas and at elevations below that of the 100-year flood. Some of this development was encouraged by subsidized flood insurance, which is still available for new development.[10]

Some states and communities have taken steps to regulate new uses more effectively where only approximate flood maps are available.

- Some communities have prohibited development on an interim or long-term basis until detailed data becomes available for the entire approximate floodplain to avoid possible encroachments into high hazard areas and construction at inadequate elevations.
- Minnesota, Wisconsin, Maryland and other states have required permit review at the state level for development in approximate flood hazard areas in order to calculate 100-year flood elevations on a case-by-case basis and to study how the proposed development will affect flood flows. The states provide the results of this review to local governments and landowners.
- Maryland and Michigan require developers to undertake detailed flood studies consistent with state criteria to calculate 100-year flood elevations and whether new development will affect flood flows.
- California, New Jersey, Wisconsin, Arizona, several other states and many local governments undertook independent mapping with the help of consultants, regional planning agencies, or special districts. Some local governments produced flood maps exceeding minimum NFIP standards in accuracy and scale. FEMA later remapped these areas without use of the locally produced maps.

PROBLEMS WITH THE REGULATORY FLOODWAY AND THE LACK OF FLOODWAY MAPS

During the 1970s, many regulations applied the concept of the hydraulic conveyance regulatory floodway (*i.e.*, the stream channel and a portion of the adjacent floodplain needed to convey flood flows form upstream to downstream points without increasing flood heights more than a predetermined amount). FEMA regulations require that riverine communities with a flood insurance rate map but without a floodway map prevent new construction, substantial improvements, or other development in the 100-year floodplain "unless it is demonstrated that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community."[11] Where floodway maps are available, communities must "adopt a regulatory floodway based on the principle that the area chosen for the regulatory floodway must be designed to carry the water surface elevation of that flood with no more than a one foot rise in surface water elevation at any point."[12] The community must also prohibit encroachments and construction within the regulatory floodway "that would result in any further increase in flood levels within the community during the occurrence of the base flood discharge."[13] Similar standards have been adopted by many communities and states.

Problems have arisen in understanding and accepting these standards. The standards assume that some continued floodplain development will be permitted even if increased flood heights and velocities and increased flood damages result. The NFIP floodway based on one foot of allowable increase in flood heights also widens the floodplain. The increase of one foot in surface water elevation and resulting increase in water velocity may make the difference between flooding that can be controlled through emergency levees and flooding that cannot. The feasibility of floodproofing structures is also affected because floodproofing higher than two feet for residences or three feet for commercial buildings is usually impractical due to water pressure on the floors and walls.

Because of these problems, at least a dozen states and many communities have adopted a more restrictive floodway standard. Water surface elevations may be raised no more than one-half foot (depending on the state and community). The "no-rise" floodway, which prohibits all future development which would increase flood heights measurably, is becoming more common. For example, Dallas, Texas and Rockville, Maryland, have adopted "no-rise" floodway regulations which apply to the entire 100-year floodplain. More restrictive approaches like these have been endorsed by the National Science Foundation.[14]

The FEMA floodway concept is difficult to apply in mountainous areas where steep topography and stream gradients cause high velocity flows throughout the floodplain. Water several inches deep can cause severe damage when it flows at five or more feet per second. Mathematical models for computing

floodways are difficult or impossible to apply in high velocity flow areas. Consequently, some communities prohibit development throughout the entire high velocity floodplain rather than attempt to define a specific floodway.

Floodway mapping has been costly and time consuming. Maps are available for only 3,500 of the 20,000 communities with flood problems. Without such a data base, the flood conveyance function of floodways has little protection except in states or communities that prohibit all development in the floodplain or provide case-by-case analyses of the potential effects of development on conveyance or individually determine floodway boundaries.

Some communities use other means to define floodways if NFIP floodway maps are not available. Brown County, Wisconsin; Prince George's County, Maryland; and Lewisburg Borough, Pennsylvania, have defined the floodway to be the 50-year floodplain. Other communities have established stream setback lines of 50 to 200 feet. Still others have applied an approximate "no-rise" or "natural" floodway concept which assumes no permissible increase in flood heights and can often be mapped more easily than a one-foot NFIP floodway.

With a traditional floodway permitting a one-foot rise, each floodplain must be hydrologically modeled to determine how much area is needed to convey specific flows with a one-foot rise. Detailed topographic information, flood flows, and estimates of existing development are needed to compute the one-foot rise. In contrast, mapping of a no-rise floodway is less complicated since it assumes that most of the floodplain is needed to convey flood flows. Thus, only outlying areas (*e.g.*, tributary valleys) are omitted from floodway boundaries. Relatively accurate estimates of a no-rise floodway based on topography can often be made without detailed modeling.

PROBLEMS WITH DEFINITION CRITERIA AND MAPS FOR COASTAL HIGH HAZARD AREAS

Most states and coastal communities have adopted NFIP standards that require elevation to the 100-year base flood elevation for coastal areas, if data on the elevation is available. Communities in the regular phase of the NFIP and with identified coastal high hazard (velocity wave) areas must ensure that construction is "located landward of the reach of the mean high tide."[15] However, under NFIP standards, structures may be built in wave velocity zones and erosion areas if protection is provided to the 100-year flood elevation and a registered architect or professional engineer certifies that the structure is "securely anchored to adequately anchored pilings or columns in order to withstand velocity waters and hurricane wave wash."[16] Structures may be elevated by construction on pilings, columns, or piers.

Special restrictions for coastal high hazard areas have been only partially implemented because many NFIP maps do not designate velocity zones. Moreover, as discussed earlier, wave heights have not been considered in establishing mapped 100-year base flood elevations. Water-related erosion,

which poses a more serious threat than flooding near bluffs and on some beaches, is also omitted from maps and the NFIP's regulatory standards.

Because of these deficiencies, some states have adopted standards that exceed the NFIP's for protection of development in coastal high hazard areas. For example, in 1970, Florida adopted interim legislation requiring that construction begun after July 27, 1970, be at least 50 feet inland from the mean high water mark to protect structures from erosion and waves. This statute was amended in 1971 to provide a variable "engineered" setback line for high energy beaches.[17] The Hawaii legislature adopted a beach setback line in 1968.[18] Rhode Island prohibits development on most dunes, beaches, and wetlands under a variety of laws.[19] Regulations cover erosion areas and require a minimum structural elevation of six feet above the base flood elevation. Since 1978, Delaware has required protection against waves for development in beach zones. Many of these states have complained that less restrictive NFIP standards undercut their programs.

A variety of more restrictive local programs were also adopted.

- San Diego and Santa Barbara, California require sufficient setbacks from eroding bluffs to provide protection for the expected life of the structure. Where erosion rates are three feet per year, for example, a 300-foot setback is required for a structure expected to last 100 years. Regulations are usually part of more comprehensive coastal zone management provisions required by the *California Coastal Zone Acts of 1972 and 1975.*

- Washington communities require erosion setbacks as part of the state's Shoreland Zoning Act of 1971, which applies to all coastal beaches and floodplains.[20] All communities are required to prepare "master programs" consistent with standards of the Department of Environmental Regulation. The Department prepared a detailed atlas of coastal areas showing 100-year flood elevations, erosion areas, and wave hazard areas to assist communities in their planning and regulation.

- Some Florida jurisdictions such as Sarasota County adopted coastal setback lines for distances of 25 to 150 feet from the high water mark to protect against erosion and wave action. Community setback lines usually coincide with setbacks defined by the state.

- At least 10 Michigan communities along Lake Michigan adopted erosion setback lines consistent with standards of the Michigan Department of Natural Resources. The 1971 Shoreline Act[21] authorized the Department to define high risk erosion areas, flood areas, and "environmental" areas. The Department conducted a detailed inventory of erosion areas based on air photo sequences dating from 1938 to the present. Field inspections were also used to define a setback line reflecting a 30-year erosion recession rate. After definition, the state required that state or local construction permits be granted only for areas behind the setback line.

INADEQUATE PROTECTION FOR DUNES AND WETLANDS

The NFIP requires that coastal communities with defined coastal high hazard areas adopt regulations prohibiting "man made alteration of sand dunes and mangrove stands . . . which would increase potential flood damage."[22] Protection is required because FEMA recognizes that dunes and mangrove stands reduce wave heights and water-related erosion. However, the NFIP does not provide for the mapping of dunes and mangroves and has not effectively monitored the adoption of regulations for their protection. Consequently, the extent and results of adoption are uncertain.

Several states and many localities have adopted dune protection measures meeting or exceeding NFIP standards. Maine prohibits alteration of dunes under a coastal wetland act.[23] Rhode Island and North Carolina regulate dune alteration under coastal zone management acts.[24] Georgia and North Carolina have adopted dune protection legislation. Florida has adopted the setback line discussed above. Many communities in these and other states regulate or prohibit alteration of either primary or both primary and secondary dune systems.

- Wrightsville Beach, North Carolina, has setback lines and dune protection ordinances.
- Rhode Island coastal communities such as South Kingston, Warwick, and Westerly have dune protection regulations.
- Beach Haven, Avalon, and many other New Jersey communities adopted beach setback and dune protection regulations following the severe winter storm of March 1962, which destroyed much of the primary dune system along the coast. Beach setbacks have generally been combined with dune restoration and protection, such as planting grasses.

INADEQUACIES IN COMBINED FLOOD HAZARD AND STORMWATER MANAGEMENT

Prior to 1970, floodplain regulations in urban areas were rarely adopted for small streams and watercourses. Future urbanization was not considered in calculating flood flows. Subdivision regulations usually required that subdividers install drainage systems sufficient to accommodate the discharge of the 5- to 15-year storm, but not larger events.

In the 1970s, many urban and metropolitan areas adopted floodplain regulations for small rivers and creeks based on flood studies that included projected urbanization of watershed areas. These floodplain regulations and stormwater management ordinances usually require developers to install stormwater management measures maintaining peak runoff levels or increasing runoff by no more than a specified amount. Above-ground drainage systems for the 100-year flood as well as below-ground storm sewers for small floods (*e.g.*, 5- to 10-year storms) are required. Onsite detention areas or "compensatory storage" are also usually required. Some ordinances permit developers to con-

tribute to a general drainage fund rather than require a drainage system and detention areas. The community uses this fund to construct and maintain common drainage systems and detention areas. The funds may also be used for stream channelization projects, levees, and other flood control measures.

Some communities or developers have also carried out detailed mapping and hydrologic studies on a watershed basis for drainageways and small streams not included in the NFIP flood studies. Map scales range from 1″=500′ to 1″=200′ with 1′ to 4′ contour intervals. "Urbanized" watershed conditions are assumed in flow calculations. If floodways are not mapped, setbacks of 50 to 200 feet from small streams and drainageways are sometimes required.

The community or developer typically computes stormwater runoff prior to subdivision approval. Some communities have prepared computer models to help evaluate impact. Examples of effective stormwater management are:

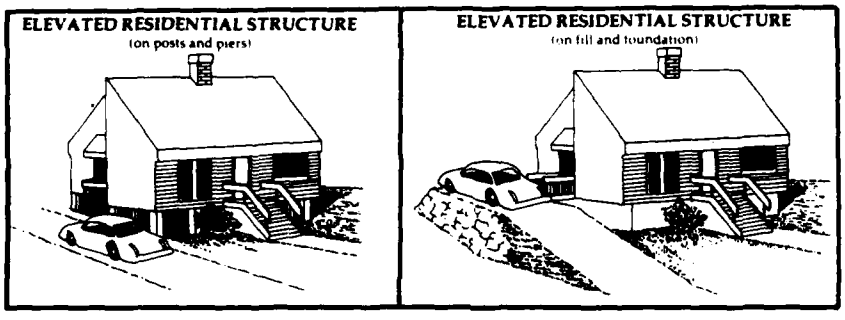
- Baltimore County adopted both floodplain and stormwater management regulations requiring onsite detention. Some of the funds for flood-related drainage repairs were combined to create a $27 million floodplain acquisition program.
- Alexandria, Virginia, adopted sophisticated stormwater management regulations for Four-Mile Run. A computer model prepared by the Corps of Engineers calculates the effect of proposed development on storm runoff.
- Montgomery County, Maryland, adopted a stormwater management ordinance that requires onsite detention to prevent runoff from exceeding the quantity expected from a 10-year storm. Rockville, Maryland, also requires that stormwater held in onsite detention be released at no greater than a 2-year rate of flow.
- King County, Washington, has studied and is adopting a stormwater management program that requires a utility fee (based on quantity of discharge) for discharges into the county drainage system. Arvada, Colorado, also adopted a drainage fee ordinance. In addition, developers must provide compensatory storage and must deed 6% of the land to the city. Santa Barbara County, California, adopted a similar "benefit assessment" ordinance.
- Howard County, Maryland, requires detailed flood studies if a subdivision is partially within a floodplain or if the watershed drainage covers more than 50 acres. The county also adopted a phased-growth management policy to prevent overburdening of streams and comprehensive subdivision design standards to encourage clustered development and preserve as much open space in the floodplain as possible.
- Lake County, Illinois, adopted a natural resources protection plan prohibiting all floodplain development. In addition, runoff from other watershed areas must not be increased above certain "performance" levels. Maximum limits are placed on the real extent of impervious surfaces and

development densities. Many towns in Bucks County, Pennsylvania, have adopted similar performance controls.

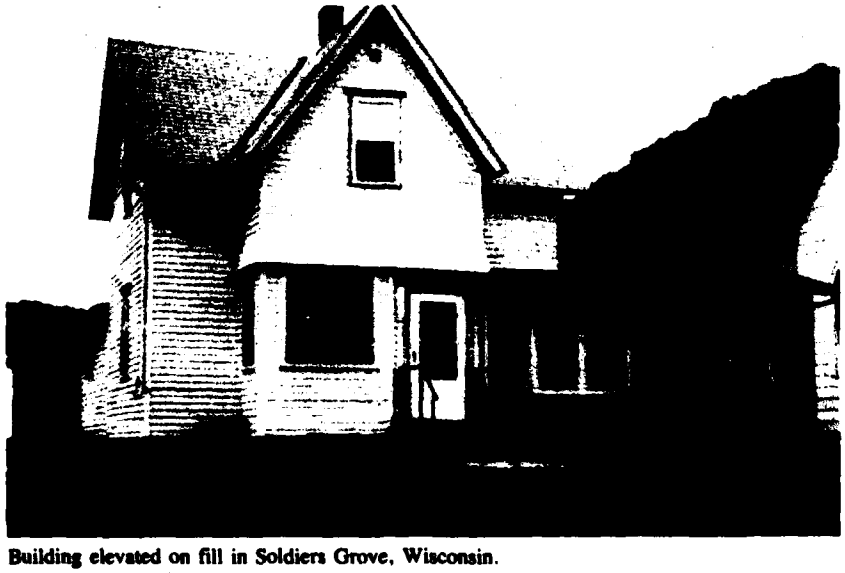
Comprehensive stormwater management has encountered problems. Some onsite detention has increased rather than decreased flood peaks where natural flood peaks occur slowly. Debris and sediment have clogged underground detention areas. Runoff techniques that did not include flood storage were difficult to integrate into traditional floodway/flood fringe regulations.

LIMITATIONS OF FLOOD PROTECTION MEASURES

Implementation of floodplain regulations was hindered in the 1970s by uncertainties about the long-term effectiveness of elevating structures on pilings in wave velocity zones and floodproofing industrial and commercial buildings.



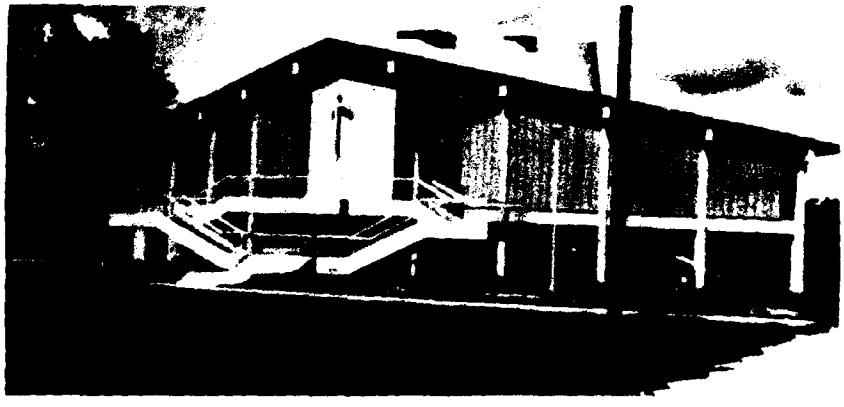
ELEVATED STRUCTURES
Source: Missouri Department of Public Safety, Disaster Planning and Operations Office.



Building elevated on fill in Soldiers Grove, Wisconsin.
Photo by Jon Kusler.

Elevation on fill. State and local governments favored elevation on fill for inland areas in 1970 when Volumes 1 and 2 of **Regulation of Flood Hazard Areas** were written. Even though it is not favored by FEMA because it eliminates flood storage, many states and localities continue to prefer this approach for inland areas. Elevation on fill up to a few feet is relatively inexpensive and permanent. In addition, it has a built-in safety factor: if the base flood elevation is exceeded, often only minor flooding occurs in a structure elevated on fill, causing limited damage. By contrast, a floodproofed structure will be flooded to the full flood height or it may collapse if the base flood elevation is exceeded.

Despite its advantages in low velocity inland areas, fill destroys wetlands and flood storage capacity. It is subject to erosion in high velocity flow areas and it creates a mounded effect, which, even with skillful landscaping, may be aesthetically unattractive, especially if existing structures were built at substantially lower elevations.



Building elevated on pilings in a coastal area.
Photo source: Federal Emergency Management Agency.

Elevation on pilings and other open works. The NFIP, state, and local programs prefer elevation on wooden, concrete, or steel pilings or other "open works" such as walls, columns, or piers in most coastal and inland floodway areas. Elevated structures offer less resistance to waves and flood flows. Pilings and other open works are not as easily eroded as fill. Open works have negligible effects on conveyance and flood storage, and are less disruptive of wetlands.

However, open works are also subject to limitations. In coastal areas, the elevated structure and its supports must be designed to withstand not only the stress of waves and swiftly flowing water (often not considered), but also hurricane winds of 70 to 200 miles per hour. Inadequately braced structures may tilt and fall. Buildings may also be blown or swept off the open works if not adequately secured by bolts or tie-downs. Pilings without deep footings in wave and high velocity flow areas may be undermined by erosion. Wood pilings may also rot or be weakened by termites. Structures elevated on open works

become inaccessible during flooding, complicating the evacuation of occupants and rendering the structure unusable.

As discussed in Chapter I, Hurricane Frederic dramatically revealed problems with elevation on inadequately designed pilings. Winds and waves almost totally destroyed the first tier of structures along 36 miles of beach, 70% in the second tier, and 50% in the third tier. Most structures had been elevated on pilings, ostensibly to the 100-year flood elevation, but without consideration of waves or erosion.

Floodproofing. Design standards for floodproofing advanced during the 1970s, although the effectiveness of these designs during actual flood conditions is still questionable. The NFIP and most state and local regulations permit the construction of commercial and industrial but not residential buildings below the base flood elevation, if adequately floodproofed.

Prior to 1970, floodproofing was not widely applied because engineers and architects were not familiar with floodproofing techniques and little had been done to develop specific design standards. In 1970-1971, the Corps of Engineers published a document entitled **Floodproofing Regulations**,[25] which established the first detailed floodproofing guidelines. FEMA and others subsequently developed numerous floodproofing handbooks.[26]

Most floodproofing during the 1970s was "dry floodproofing." This type of floodproofing is designed to keep the flood waters out of the structures. To prevent inundation, floors and walls were reinforced and sealed. Basements

This building combines five dry floodproofing techniques: reinforced concrete walls, an emergency flood door to prevent water entry, bricked-in window openings, elevated utility lines (near top of photo), and ladder for access through the roof.
Photo source: U.S. Army Corps of Engineers, St. Paul District.

were prohibited unless they also were reinforced and sealed; and doors, windows, and other openings were reinforced and fitted with emergency closures.

Despite widespread use of dry floodproofing, there has been little field documentation of its effectiveness. Preliminary evidence suggests that because of water pressure, it is impractical to dry floodproof most structures higher than 2 or 3 feet. Waterproofing has also proved difficult because of small leaks along doors and in foundations. These may be serious when flooding is of long duration. Sump pumps may be used to remove residual seepage, but this requires continuous use of electrical power which is often only provided on an emergency basis during floods and thus is undependable. The long-term effectiveness of dry floodproofing that requires temporary closures is also questionable without continuous monitoring, training, and practical exercises in their use. Temporary closures must be kept at hand.

To a less extent "wet floodproofing" was also used during the 1970s.[27] This method intentionally allows floodwaters to enter basements or first floors or uses fresh water to flood those areas to counteract floodwater pressure and prevent the intrusion of sediment-laden floodwaters. Wet floodproofing is designed mainly to protect the structural integrity of a building by permitting damage to electrical systems, building contents and interior walls. Measures must be taken to permit rapid removal or floodproofing of machinery, materials, and other damageable contents. Although conceptually sound, flooding a building to equalize interior and exterior pressures requires careful application and continuous monitoring of the rate at which internal and external flooding takes place in order to prevent structural damage. In addition, if water free of sediment and other pollutants is to be used for intentional flooding, a continuous source of fresh water must be available.

FEDERAL SUBSIDIES THAT UNDERMINE FLOODPLAIN REGULATIONS

Federally subsidized flood insurance and the standards of the NFIP have encouraged state and local adoption of floodplain regulations, but may also have encouraged floodplain development.[28] Federal funding of flood control works with an 80% to 100% federal subsidy also encourages development and discourages nonstructural flood loss reduction techniques which shift loss-bearing to the floodplain occupant. Development is also supported by federal principles and standards for flood control measures which permit the Corps and other agencies to include the highest intensity future floodplain uses as economically feasible elements in the cost/benefit analyses. At the same time, limited or no benefits can be claimed for open space use or maintenance of natural resources. Many of the aggressive floodplain management programs that incorporated regulations and other elements were developed by communities during the 1970s only after federal agencies rejected structural solutions due to problems with soils, topography, or unfavorable cost/benefit ratios.[29]

Regulations Combined with Other Techniques

Many communities and some states combined regulations with other management techniques to reduce future flood losses, provide areas for public use, and accomplish broader floodplain management and land use objectives.

ACQUISITION

An estimated several thousand communities acquired a portion of their floodplains for park, parkway, wildlife, conservation, agricultural, or other environmental or social uses.[30] Acquisition complements regulations by providing total protection for critical environmental areas such as habitat for threatened and endangered species. It also makes the land available to the public for hiking, picnicking, or other recreational purposes.

Acquisition is more permanent than regulations—once completed it is not so subject to the whim of local legislative bodies. However, it is costly if the purchase is made in fee. Typical floodplain acquisition costs in rural areas range from $300 to $1,000 an acre. Urban costs often range from $1,000 upward, depending on a wide range of variables.

Localities have acquired the most land and have held it in fee. However, some communities such as Glastonbury, Connecticut, and East Hampton, New York, have acquired easements to reduce costs, continue lands on the tax rolls, and avoid maintenance responsibilities. Private donations of land as gifts or bequests have also been important, particularly for wetlands.

Floodplain subject to conservation easement, Black Earth Creek, Wisconsin.
Photo by Jon Kusler.

Most acquisition has been voluntary although a few communities have used eminent domain powers. Local governments have frequently used federal funding sources such as the Department of Interior's Land and Water Conservation Fund and HUD's Community Development Block Grant Program to help pay acquisition costs. State funding sources such as the New Jersey Green Acres Program have also played important roles in a few states.

- Milwaukee County, Wisconsin, acquired most of the county's floodplain as well as its Lake Michigan bluff area for part of its greenway and park corridor system. Milwaukee was one of the first cities in the nation to regulate floodplains, starting in 1936. Acquisition was also begun in the 1930s.
- Sacramento County, California, combined regulations and acquisition to protect the floodplain and provide public recreation areas along much of the county's American River floodplain. Altogether, the city, county, and private organizations have acquired about 3,000 acres along 23 miles of river. A variety of state, local, and private funding sources were used.
- Scottsdale, Arizona, acquired a 4.6 mile-long greenbelt floodway along Indian Bend Wash which runs through the city. A bond issue and the Corps provided the funding.
- In cooperation with the Twin Cities Metropolitan Council, Ramsey County, Minnesota, has acquired much of the Mississippi River floodplain in the town of Lilydale. An estimated $4.4 million in project funding was provided by local and metropolitan sources.
- Dallas, Texas, acquired more than 2,500 acres of floodplain along the Elm Fork of the Trinity River and Oak Creek at an estimated total price of $4.5 million. Funding was from a variety of sources, including local bond issues, the Land and Water Conservation Fund, and HUD open space programs. Some of the floodplain was privately donated to the city.
- The Brandywine Conservancy (a private, nonprofit Pennsylvania corporation) acquired 400 acres in fee and 4,000 acres of easements for critical environmental areas in 20 communities since 1967. Much of the acquired land is floodplain along the Brandywine River. Negotiation with landowners and limited purchase has been applied.

State and federal authorities have also acquired floodplain areas, but on a more limited scale. For example, the Corps of Engineers is purchasing 8,500 acres of floodplain wetlands along the Charles River near Boston to preserve valley storage and prevent increased flood heights in the Boston area. The Corps and the state have agreed that other flood storage areas along the Charles will be regulated by local governments.

REGULATIONS AND PUBLIC FACILITIES PLANNING

In the 1970s, all levels of government made progress in applying flood hazard mitigation policies to new public infrastructure—roads, sewers, bridges, water

supply systems, electric lines and natural gas pipelines. These facilities are not only subject to costly flood damages but influence the location and intensity of private floodplain development. State and local governments have long had the authority to refuse or limit infrastructure in floodplain areas because of their high costs and the threat of recurrent flood damages. Until recently, however, few have done so because of pressure from landowners and lack of coordination between regulatory and public works programs.

The federal executive orders on floodplain management and protection of wetlands issued in 1977 and the NFIP standards pertaining to public uses gave impetus to state and local initiatives. The orders require that federal projects and federally funded state and local projects be located outside the floodplain, unless no alternative exists. If none exists, early notice must be provided to the public and measures must be taken to minimize flood damages and harm to natural values.

Federal agencies are now in the process of implementing these orders. They are reviewing and revising earlier policies for extending facilities into floodplain areas. For example, the Environmental Protection Agency conditioned a sewer grant to Cape May, New Jersey on an agreement that they would limit sewer extensions in flood hazard areas.

Some state statutes and executive orders require control of public works in floodplain areas. The NFIP has required states to control public buildings in order to qualify for flood insurance. In response many states have adopted executive orders.[31] Other states like New Jersey directly regulate state and local public works under floodplain regulatory statutes. Several states regulate public uses in specific hazard areas through coastal zone management statutes or executive orders. For example, in August 1980, Governor King of Massachusetts issued a beach and barrier island executive order prohibiting new construction in front of the dunes on barrier beaches and denying state aid of such activities, including rebuilding of existing structures.[32]

REGULATIONS AND FLOOD WARNING SIGNS

Some states and communities have erected flood warning signs to complement regulations. A single sign along a heavily traveled highway can do much to raise community awareness. Flash flood warning signs are used in Boulder, Colorado, and other Rocky Mountain front range communities. Warning signs have also been adopted by some coastal communities such as Shelter Island, New York. Signs that warn of the flooding threat and give flood heights and dates of past flood events are particularly effective.

REGULATIONS AND TAX INCENTIVES

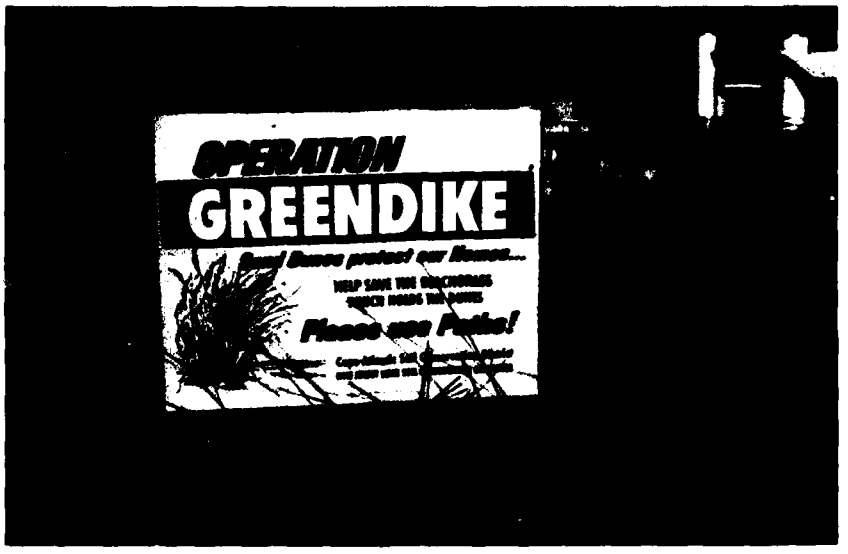
Real estate and other tax incentives have been combined with regulations to encourage open space uses. For example, the New Jersey state floodplain regulatory statute requires that local property tax assessors consider state regulations.[33] A Massachusetts statute authorizes reduced property taxation

for landowners who execute conservation restrictions for floodplains, wetlands, or other similar areas.[34]

At least 43 states offer broad real estate tax incentive programs for lands in agriculture, forestry, and certain other open space uses.[35] Undeveloped floodplains may qualify for reduced taxation pursuant to many of these statutes. Under most statutes, lands entered into programs are assessed at open space value rather than potential development value. If owners subsequently decide to develop the land, they usually must pay taxes (calculated at full development potential) plus interest and, in some instances, a penalty. Despite widespread adoption, open space tax provisions have been only partially successful since many landowners wish to hold their lands in an open condition only temporarily.

California has experimented most extensively with open space tax incentives for agricultural and other open space lands.[36] In this state, lands must be both entered into the open space taxation program and regulated prior to receipt of benefits. Other states with active programs are Maryland, Minnesota, Vermont, and Wisconsin.

Federal and, to some extent state, income tax laws also encourage open space protection. Individuals who donate such lands or open space easements to government units or private nonprofit corporations may deduct the value of the contributions from ordinary income as "charitable contributions."[37] Under present federal tax laws, an individual may deduct up to 30% of adjusted gross income in a tax year, with carryover deductions in the succeeding five years.



Sand Dune Restoration and Protection Project, Avalon, New Jersey. Avalon has combined regulations with acquisition, a sand dune restoration program, and public education in an award-winning beach protection program.
Photo by Jon Kusler.

Private donations to receive income tax deductions are particularly attractive if a parcel of land has substantially appreciated since original purchase or development is contrary to regulations or considered inadvisable by the individual or corporation. The value of the charitable contribution is the present full market value of the land. For an individual or corporation with substantial income, it may be more profitable to donate than to sell floodplain parcels.

REGULATIONS AND PUBLIC EDUCATION

Public education has been essential to developing and implementing floodplain management programs. Education during the 1970s has included distribution of flood maps and brochures; workshops and training sessions; marking flood hazard areas; and one-to-one discussions with floodplain property owners, insurance agents, lenders, lawyers, and others involved in floodplain decision making. State floodplain management programs have developed and distributed brochures, manuals, and model ordinances. States have also conducted floodplain management workshops for local governments, including information on floodproofing and administration of regulations.

One-to-one consultations have been particularly effective at the local level. For example, members of conservation commissions in Concord and Lincoln, Massachusetts, visited landowners to advise them of wetland and floodplain

The Conservation Foundation and Florida Audubon Society conduct a floodplain management training session in St. Augustine, Florida, with funds from FEMA, in May 1979.
Photo by Jon Kusler.

designations and to explain the rationale for the restrictions. Other communities have sent copies of floodplain maps to all property owners. Avalon, New Jersey, included a brochure on dune protection with tax bills sent to property owners throughout the community.

OTHER TECHNIQUES

Regulations have also been combined with other approaches such as flood control works, evacuation plans, and flood warning systems. These are discussed in the next chapter.

Footnotes

1. The concept of "wise use" of the nation's floodplains, taking into account not only flooding but also other, broader values, is contained in the Water Resources Council's **A Unified National Program for Flood Plain Management**. This document calls for "continuing efforts that seek to reduce and keep flood losses at acceptable levels while recognizing, preserving, and restoring the floodplain's natural values through wise use of water and related land resources."

   > Regulations of the National Flood Insurance Program, 41 Fed. Reg. 46,964 (1976), also provide that "in formulating community development goals and in adopting flood plain management regulations, each community shall consider at least the following factors—
   >
   > (1) Human safety;
   >
   > (2) Diversion of development to areas safe from flooding in light of the need to reduce flood damages and in light of the need to prevent environmentally incompatible flood plain use; . . . "

2. Sheaffer and Roland, Inc. (1981) examined 23 communities to quantify the economic, social and environmental effects of regulating the 100-year floodplain. Effects of floodplain regulations were evaluated by projecting development for 1980 and 1990 under three scenarios: (1) no regulations, (2) moderate regulations similar to the current FIA regulations, and (3) stringent regulations forbidding new developments and substantial improvements to existing structures. Some of the results of the study may be summarized as follows:

   > (1) Average annual flood losses were projected to increase sharply (29% by 1980, 71% by 1990) with no regulations. Under moderate regulations, losses would increase somewhat. Under stringent regulations losses would decline 1% by 1990.
   >
   > (2) With no regulations, the number of housing units in the floodplain would increase by 13% by 1980 and 35% by 1990; and population would increase in the 100-year floodplain 12% by 1980 and 29% by 1990. With moderate regulations, housing units would be increased somewhat by 1980 and 1990. With stringent regulations, housing units in the 100-year floodplain would decline 1% by 1980 and 6% by 1990.

3. Burby and French concluded that

   > Flood plain land use management regulations, including those required by the NFIP, have had little effect on the rate of flood plain invasion . . . While staff and funding commitments may indicate that communities are taking steps to see that new construction is at least elevated or flood-proofed so that some protection against flood damage is provided, these data clearly

> show that local flood plain land use management is not halting the continued invasion of flood plains. Furthermore, fostering regulations that are focused on the design of development, such as local regulations required for participation in the National Flood Insurance Program, does not necessarily lead communities to restrict floodplain use (1981, p. 294).

4. See discussion at pages 129-133.
5. 24 C.F.R. §1910.3 (1976).
6. See, *e.g.*, Sheaffer (1977) and Sheaffer and Roland, Inc. (1980).
7. Floods greater than the 100-year flood caused 61% of the losses experienced in the United States between 1959 and 1974 (Sheaffer *et al.* (1976, p. 49).
8. For example, when flooding exceeded levees designed to withstand a 100-year flood in Jackson, Mississippi, in 1978, damage to backlying structures approached ½ billion dollars.
9. See footnote 47, Chapter I.
10. See discussion at footnote 55, Chapter I.
11. 24 C.F.R. §1910.3 (1976).
12. *Id.* §1910.3(d).
13. *Id.*
14. The National Science Foundation (1980), concluded that "[b]uilding in floodways is continuing and increasing the property and lives at risk." The report recommended that

> [f]ederal, state, and local program standards should be changed to prohibit any new development in floodway areas which will increase flood elevations. There may be circumstances requiring exceptions to this prohibition. In such circumstances, a promising solution is for the developer to purchase all necessary property rights from all adversely affected property owners for increased flood damage, increased building costs, increased flood insurance and other costs (p. 215).

15. 41 Fed. Reg. 46,964 (1976).
16. Fla. Stat. Ann. §161.052 (West Supp. 1982).
17. Fla. Stat. Ann. §161.053 (West Supp. 1982).
18. Hawaii Rev. Stat. §§205-32 to 205-37 (1976 and Supp. 1980).
19. See R.I. Gen. Laws §§46-23-1 to 46-23-16 (1980), §§2-1-13 to 2-1-17 (1976), and 11-461-1 (Supp. 1980).
20. Wash. Rev. Code Ann. §§90.58.010 to 90.58.930 (Supp. 1981).
21. Mich. Comp. Laws Ann. §281.631 (1979).
22. 24 C.F.R. §1910.3 (1976).
23. Me. Rev. Stat. Ann. tit. 12 §§4701 to 4758 (1981).
24. R.I. Gen. Laws §§46-23-1 to 46-23-16 (1980); N.C. Gen. Stat. §§113A-100 to 113A-134 (1978).
25. Office of the Chief of Engineers, U.S. Army (1973).
26. See the bibliography.
27. See Sheaffer and Roland, Inc., (1979).
28. See footnote 55, Chapter I.
29. Examples include Hilo, Hawaii; Prairie du Chien, Wisconsin; and Soldiers Grove, Wisconsin.
30. F. discussion of floodplain acquisition see Ralph M. Field Associates (1981).
31. *E.g.*, Rhode Island, Executive Order No. 35, October 23, 1978; Wisconsin, Executive Order No. 67, November 26, 1973; California, Executive Order B-39-77, November 26, 1977.
32. Commonwealth of Massachusetts, Executive Order No. 181, Barrier Beaches, August 13, 1980.
33. N.J. Stat. Ann. §58:16A-61 (1982) provides:

> Local assessors shall consider the impact of rules or regulations issued pursuant to this act in establishing full value of lands designated as floodways or as flood fringe areas.

34. Mass. Gen. Laws. Ann. ch. 59, §11 (West Supp. 1981); ch. 184, §§31-33 (West Supp. 1981). See also N.Y. Envir. Conserv. Law §25-0302-2 (McKinney Supp. 1981-1982); Conn. Gen. Stat. Ann. §22a-45 (1981).

35. Council on Environmental Quality (1976).
36. *Id.* See Cal. Gov't Code §51201 *et seq.* (West 1966).
37. See 26 U.S.C. §170(b)(1)(c) (Supp. 1977); 20 U.S.C. §2055(e)(2) (Supp. 1977); 26 U.S.C. §2522(a)(2) (Supp. 1977).

CHAPTER III

REDUCING LOSSES TO EXISTING USES

Overview

In the 1970s, floodplain regulations, when applied alone, were largely ineffective in reducing flood losses to the 4.5 to six million[1] structures already located in the 100-year floodplain except after severe floods. But they encouraged some voluntary floodproofing by putting landowners on notice as to flood hazard protection needs and elevations. After disasters progress was made in prohibiting alterations and rebuilding in excess of a stated amount. Regulations were used to encourage relocation with flood insurance payments, disaster grants, and loans conditioned on compliance with standards. They were also imposed to establish moratoria on rebuilding until detailed flood maps and recovery and relocation plans were completed.

To further reduce flood losses to existing uses in the 1980s, regulations must be integrated into, or carefully coordinated with, broader community zoning, building codes, housing codes, sanitary codes, and other regulations that apply to existing uses. Amortization provisions should be adopted in some circumstances. Regulations should be coordinated with predisaster planning. In floodways, "substantial improvement criteria" in zoning and other regulations should be clarified and tightened. After a disaster, strict interim or long-term regulations should be applied. Implementation will require not only improvements in state and local regulations, but also federal technical and financial aid, and revisions in federal flood insurance and disaster assistance to act as incentives for private hazard reduction.

Concerted efforts to address existing structures are essential if long-term flood losses are to be reduced. Most existing structures were built before state or local regulation of flood-prone areas and have little or no protection against flooding. In coastal areas, an estimated two to three million structures are located one to 10 feet below the 100-year still water flood elevation. In 1980, four coastal metropolitan areas (Houston/Galveston, New Orleans, Tampa/Fort Myers and Miami/Fort Lauderdale) alone accounted for 680,000 flood insurance policies, or 37.8% of the national total.[2] In many coastal areas the entire floodplain is developed.

TABLE 4
TECHNIQUES TO REDUCE LOSSES TO EXISTING USES

Adoption of Interim Regulations After a Disaster to Prevent Rebuilding Until Flood Studies, Postdisaster Planning, Acquisition, Other Measures are Undertaken

Adoption of Long-term, Upgraded Regulations After Disaster

Adoption and Enforcement of Regulations with Nonconforming Use Provisions

- Regulations requiring floodproofing, etc., when structures are abandoned or damaged
- Amortization provisions requiring short-term or long-term removal of nuisance uses in floodways, floodproofing

Floodproofing of Existing Structures

- Raising structures
- Temporary or permanent waterproofing
- Wet floodproofing
  - Structural design changes
  - Water resistant materials replacements
  - Operation of buildings, including allocation of space

Emergency Evacuation

- Flood forecasting
- Flood warning
- Evacuation planning

Public Acquisition and Relocation

- Purchase, "bargain" sales, land exchanges
- Removal of existing structures

Reduction of Storm Runoff

- Land treatment
- On-site storage requirement

Disaster Assistance and Flood Insurance Conditioned Upon Mitigation

- Floodproofing or relocation after a disaster
- Adoption of flood control measures

Flood Control Measures

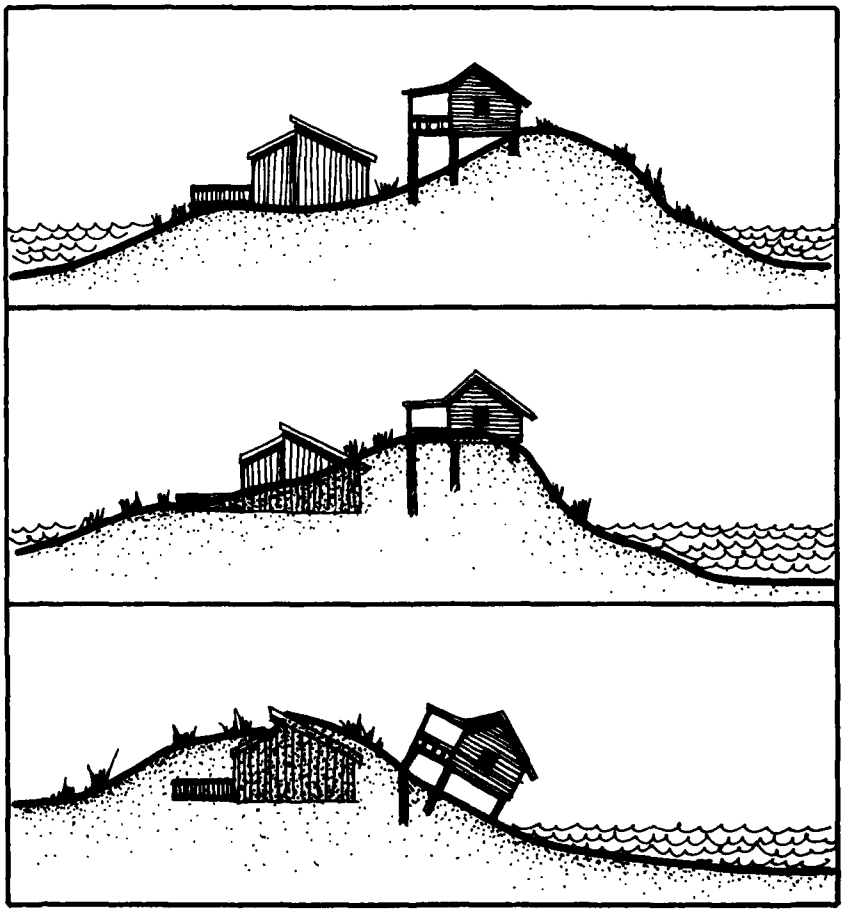
- Dams
- Dikes, levees
- Channel straightening
- Artificial dunes, beaches

Structures below flood elevations are often damaged by flooding, repaired, and damaged again. A study of repetitive flood insurance claims in 1979 revealed that at least 883 structures had two flood insurance claims within five years, with damage at least 25% of structural value.[3] From January 1, 1972

to August 31, 1979, three or more major flood disasters were declared in each of 351 communities.[4]

In urbanizing areas, flood threats to existing structures are increasing. Urbanization increases peak flows from two to six times for smaller floods.[5] Watershed development increases the rate of runoff and decreases infiltration. Floodplain development eliminates flood storage, thereby increasing flood heights. A regulatory "floodway" with development in fringe areas also increases flood heights up to one foot, thereby increasing damages to structures in the 100-year floodplain. In many riverside cities, sedimentation in reservoirs and stream beds is worsening flood conditions.

Combined flooding and erosion threats to existing structures are increasing on barrier islands (*e.g.*, Cape May, New Jersey) due to landward movement of the islands at rates of 300 feet or more per century. Erosion and flooding



MIGRATION OF BARRIER ISLANDS
Drawing by Richard Newton.

problems are also becoming more serious in bluff areas (*e.g.*, the California coast, the Lake Michigan shore), where structures built 50 years ago at some distance from the bluff are now at the edge due to recession.

Private flood losses are not the only problem resulting from the many damage-prone structures in the floodplain. Roads, sewers, water supply systems, and other public services constructed to serve these structures are severely and repeatedly damaged. Repair of a causeway to Dauphin Island, Alabama, damaged by Hurricane Frederic in 1979 cost federal taxpayers $39 million. Repair of roads and bridges damaged by flash flooding in Big Thompson Canyon, Colorado, cost federal taxpayers $28 million.

Loss of tax revenue, loss of jobs, and subtle pressures for publicly funded flood control works are other consequences. Moreover, the presence of extensive nonconforming uses often undermines regulations for new uses. It is difficult to enforce regulations for new uses in areas with dozens or hundreds of adjacent nonconforming structures.

Lack of success in applying regulations alone to reduce losses to existing uses has been due to these factors.

(1) Nonconforming use provisions have not been adequately enforced due to ambiguities in regulatory provisions and the unwillingness of many state agencies and local governments to impose additional burdens upon flood-damaged property owners.

(2) Nonconforming use provisions have not been sufficiently tailored to highly varied flooding problems and the flood protection needs of particular types of nonconforming uses.

(3) Government subsidies for flood control, disaster assistance, and flood insurance provide little incentive for private remedial flood protection.

Nonconforming Use Provisions

State regulatory programs do not require flood protection measures for existing uses except where substantial rebuilding or repair takes place or a damaged structure is abandoned. Local regulatory programs have generally adopted the minimum standards of the NFIP, which also do not require modifications to existing uses unless "substantial improvements" take place.[6] Substantial improvements are defined to include "repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50% of the market value of the structure either, (a) before the improvement or repair started, or (b) if the structure has been damaged and is being restored, before damage occurred."[7]

Although minimal, these provisions have also not been vigorously enforced because of political pressures and difficulty in determining when the triggering "50%" threshold has been crossed. In addition, the preflood value used as the basis for calculations is often difficult to obtain.[8]

After a flood, repairs or alterations are often made incrementally, with none exceeding 50% of the structural value in one year. Periodic additions to structures, none of which exceeds the 50% threshold, can double or triple structural values without provision of flood protection. Interior work, painting, and other finishing touches, which are expensive, are rarely included in calculations. Improvements to comply with health, sanitary or safety code specifications (*e.g.*, a new roof, new plumbing) are also rarely included.

Local governments have been reluctant to regulate existing uses because some zoning enabling acts partially exempt existing uses.[9] However, an increasing number of states have specifically authorized local governments to terminate nonconforming uses under certain conditions.[10] For example, a Missouri statute authorizes counties to adopt "reasonable regulation for the gradual elimination of nonconforming uses from districts zoned for residential use."[11] A Minnesota statute authorizes county boards "to regulate and control or to reduce the number or extent of or the gradual elimination of nonconforming uses and occupancies."[12] Where properly authorized in states like these, local regulations that control and amortize existing uses that are nuisance-like have been upheld by the courts.[13]

The problem, however, is more than legal; questions of equity and political acceptability are involved. It is one matter to require a landowner to elevate or otherwise protect a new structure where the elevation may add 5% to 10% to the cost of construction,[14] but it is another to require the protection of existing structures where the cost of elevation may exceed 40% of existing value.

Despite these problems, some communities have reduced the flood vulnerability of existing uses through innovative nonconforming use provisions.

Brattleboro, Vermont, imposed regulations on a mobile home park in a high-risk floodplain. The regulations require owners expanding their operation outside of the floodplain to remove one home from the high hazard area to gain approval for three added at higher ground. Some communities have effectively combined regulations with public education to encourage private floodproofing. In Wayne Township, New Jersey, an education program for landowners has resulted in more than 50 homes being privately elevated to or above the 100-year flood level. In one neighborhood, code enforcement has eliminated about 75 out of 300 structures. Floodproofing has been required for all renovations, improvements, and additions to structures. In Soldiers Grove, Wisconsin, the community development office has provided financial and technical assistance to individuals wishing to floodproof their structures. For example, one home there was elevated six feet on fill after the 1978 flood. Total cost was approximately $9,500 dollars, with one-half of this paid by the town and one-half by the landowner.

In 1974, the county council in Howard County, Maryland, established a floodproofing loan program. Owners were authorized to borrow up to $6,000 for up to 20 years at an interest rate 1% higher than the average interest rate obtained at the most recent sale of Howard County obligation bonds.

In some areas, private industries have voluntarily floodproofed their structures, partly because of state and local public education efforts. The impressive experience of the Sprout-Waldron Division of the Koppers Company, Inc., of Lycoming County, Pennsylvania, is the subject of a film, slide presentation, and technical manual.[15] In 1972 the main plant, which has 1,250 employees, was flooded to a depth of two to six feet, with flood damages exceeding $3,300,000. The plant was shut down for three months and revenue losses exceeded $2 million. To reduce future damages, the industry developed a flood preparedness plan that combined waterproofing in certain plant areas with removal of damage-prone contents from others. In September 1975, Hurricane Eloise flooded the plant to a depth of one to four feet. That time flood damages were less than $231,000 and the plant was operating at over 80% of its capacity within 18 hours after the flood subsided.

Variations in Flood Loss Potential

Difficulties in reducing the flood damage potential of existing uses through a single nonconforming use formula are caused by variations in flooding threats, types of nonconformity, cost of remedial measures, and incentives for floodproofing or relocation.

OUTER FRINGE AREAS

An estimated three to four million structures are located in outer fringe areas at elevations only one to two feet below the 100-year flood elevation. These include many structures along smaller streams and drainageways and at the periphery of major riverine and coastal floodplains. A 100-year flood may cause minor damage, particularly if the water velocities are low, flooding is of short duration, and warning time is ample. But damages may be substantial for structures with basements containing heating and air conditioning systems, washers and dryers, recreation and storage rooms, or living quarters. In some instances, basements may collapse, endangering the lives of any occupants and damaging or destroying the remainder of the structure.

For structures in these outer fringe areas, damages may be reduced by temporary or permanent dikes and levees, stream channelization and straightening, floodproofing of structures and facilities, flood warning systems, and evacuation plans. At modest cost, small structures without basements may be elevated on fill, pilings, concrete blocks, or concrete foundations. However, elevation of larger structures or small structures constructed of stone, brick, masonry, or concrete is often prohibitively expensive.

Although the greatest potential for floodproofing occurs in outer fringe areas, the incentives are also smallest. Subsidized flood insurance payment gives little incentive for private floodproofing. Flood insurance payments of up to $185,000 may be made for most residential structures and up to $60,000 for

contents for communities in the regular flood insurance program. Structures are rarely damaged more than 50% of their value and, as a consequence, do not require floodproofing as a condition of rebuilding.

Commercial establishments in outer fringe areas have a greater incentive to mitigate flood damage because flood insurance payments for structural damage to a small business cannot exceed $250,000. The amount usually covers only a small portion of the structural damage that may occur to a large commercial structure. Coverage for damage to inventories cannot exceed $300,000 which is only a small portion of many inventories. In addition, commercial and industrial establishments may lose substantial income when forced to close.

FRINGE AREAS SUBJECT TO GREATER FLOOD HEIGHTS

An estimated several million additional structures are located in more seriously flooded areas, particularly along the coast. Some of these are behind low-lying dikes and levees that provide limited protection. Inundation of three to ten feet may be expected during a 100-year flood, with more frequent lower inundation from small floods. Although the anticipation of serious flood damages may create greater incentive for floodproofing, the technical and economic feasibility of elevating or floodproofing these structures to protect from a 100-year flood is less because of the depth of anticipated flooding and the increased hydrostatic pressures.

In a 100-year flood, residences in these areas often suffer structural damage approaching or exceeding 50% of their value, potentially triggering nonconforming use provisions. What is to be done with these structures? Some might be relocated, but not many in densely developed areas such as Miami. Elevation on fill or pilings may be possible for wood structures without basements. Dry floodproofing for such structures is rarely practical because hydrostatic pressures are substantial when inundation exceeds two to three feet. Wet floodproofing maybe an alternative for brick, concrete, or concrete block structures.

STRUCTURES IN INLAND FLOODWAYS AND COASTAL HIGH HAZARD AREAS

An estimated 300,000 to 500,000 structures are located in riverine floodways and coastal high hazard areas. Because of the severity and repetitive nature of floods, costs for disaster assistance and insurance to private structures and public facilities are greatest in these areas. Structures and fill in floodways are not only seriously damaged by flooding, but they also increase flood heights and velocities on other lands. Structures in coastal high hazard areas and in floodways may be swept from their foundations, adding to the destructive force of flood waters.

Structures in these high hazard areas are often subject to nonconforming use provisions after a severe flood. Then relocation of existing structures is most attractive although not always practical. A flood insurance payment often compensates for only a portion of the loss. Dry floodproofing, however, is

rarely sufficient. Studies by the Corps of Engineers show that it is very difficult to floodproof structures against a breaking wave of more than two or three feet, or inland flood velocities of 8 to 12 feet per second. Elevation on pilings and open works may be used in some instances, but damages to public facilities often continue and access may be cut off. Elevation is also impractical in severe erosion areas.

Federal Incentives and Disincentives

Federal flood hazard programs have provided little incentive for self-help measures. Federal flood control measures are typically 100% federally subsidized. Federal flood insurance at subsidized current rates provides slightly more incentive, but the federal government still bears much of the cost of flooding. A tightening of insurance rates to reflect actual risk, as now proposed by FEMA, would remedy this. Tight enforcement of the provisions of the Disaster Relief Act of 1974 would also help. That act requires that before receiving disaster assistance loans or grants, states and localities 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 . . . "[16]

Recognizing such problems in the late 1970s, FEMA undertook research and began to apply a variety of measures to reduce the flood loss potential of existing uses, particularly after disasters. In 1979, FEMA initiated a floodplain acquisition program pursuant to Section 1362 of the National Flood Insurance Act of 1978.[17] Section 1362 provides FEMA with the authority to acquire flood-insured properties that have been severely damaged three or more times or "substantially damaged beyond repair," and where the state or community agrees to accept and manage the property after federal acquisition.

The 1980 program began with acquisition of 94 properties: eight in Scituate, Massachusetts; one in Strathmore, New Hampshire; five in Gulf Shores, Alabama; six in Clay County, Minnesota; 20 in San Bernardino, California; 34 in Arnold, Missouri; four in Phoenix, Arizona; and 16 in Cowlitz, Washington. During 1980, FEMA also funded the relocation of 67 structures in Montgomery County, Texas, through "constructive total loss" payments for structures that could not be repaired or rebuilt due to county nonconforming use provisions.

FEMA was not alone in its concern with existing uses. During 1979, the U.S. Water Resources Council carried out two postdisaster recovery studies: one on postdisaster response[18] and another on floodplain acquisition.[19] WRC also examined federal response in various postdisaster situations.

Based of these studies and on urging from OMB, WRC, and FEMA, federal agencies increased enforcement of the postdisaster hazard mitigation requirements of the 1974 Disaster Protection Act. SBA and other loans were

denied for rebuilding in specific places at Lake Elsinore, California, and Soldiers Grove, Wisconsin. A variety of federal funding was provided to facilitate acquisition of lands and relocate structures in Soldiers Grove and in Gulf Shores, Alabama.

In July 1980, OMB directed 10 agencies involved in disaster response to work together to assess mitigation possibilities within 15 days of a presidentially declared disaster in order to improve coordination of postdisaster response, with FEMA as the lead agency.[20] A mitigation handbook has been prepared to assist the teams in their evaluations.[21]

Other federal programs to reduce losses to existing uses include construction of flood control measures and flood warning systems described below as well as funding for state and local efforts.

Effective State and Local Programs

Some communities and states have adopted programs for existing uses although effective efforts are quite rare.

MORATORIA ON REBUILDING

A number of coastal and inland communities adopted moratoria on rebuilding after flood disasters until relocation plans, flood control measures, or comprehensive floodplain management plans could be prepared and implemented. The best example is Rapid City, South Dakota, where the city planning commission adopted a moratorium on repair and rebuilding in the 10-year floodplain after the flash flood of 1972 killed 238 and damaged or destroyed 824 structures. The South Dakota Supreme Court sustained this moratorium. There are other examples.

- Larimer County, Colorado, adopted a six-month moratorium on rebuilding after flash flooding in the Big Thompson Canyon in 1976 caused $42 million in damage and took 136 lives.
- San Bernardino, California, adopted a moratorium preventing rebuilding in an area that was damaged by mud flows three times in January and February of 1979.
- Lake Elsinore, California, prevented rebuilding below an elevation of the 100-year flood plus five feet after a severe flood in 1978. Some of these damaged properties are now being acquired.
- Cowlitz County, Washington, adopted a moratorium on new development and rebuilding in the 500-year floodplain of the Cowlitz River and within the "mudline" of the Toutle River after severe floods and mud flows resulted from the Mount St. Helens eruption in 1980.

UPGRADED REGULATIONS

Some communities adopted more permanent, upgraded regulations for reconstruction and new development after a disaster. Heightened public awareness and information from the more detailed flood studies, which are typically undertaken after severe floods, made the upgraded regulations politically acceptable. Some typical examples follow.

- Del Norte County, California, adopted highly restrictive floodplain regulations for an area along the Klamath River, which had been flooded in 1927, 1953, 1955, and 1964. Flooding in 1964 destroyed the town of Klamath. These regulations prevented rebuilding and use of the land for permanent buildings. The California Supreme Court sustained the regulations.
- Clay County, Minnesota, prohibited rebuilding in the 100-year floodplain of River Oaks subdivision, which was severely inundated by the Red River twice in 1978.
- Scituate, Massachusetts, adopted a moratorium on rebuilding after a northeaster struck the New England coast on February 6 and 7, 1978. The storm destroyed or seriously damaged 700 structures. This moratorium was subsequently modified to permit rebuilding of structures pursuant to upgraded regulations requiring protection against waves to a height of 21 feet.

National Park Service structure inundated and later destroyed by storm waves at Coast Guard Beach, Cape Cod, Massachusetts
Photo source: Stephen Leatherman.

- Gulf Shores, Alabama, adopted a temporary moratorium on rebuilding after Hurricane Frederic damaged or destroyed 500 structures in September 1979. This moratorium was subsequently modified to permit rebuilding consistent with wave heights.

REGULATIONS WITH ACQUISITION AND RELOCATION

Several states and more than 100 communities acquired structures damaged by severe flooding. Arizona is relocating residents in 10 flood-prone communities, including Hollywood, Duncan, and Allenville, pursuant to a relocation program authorized by the Arizona legislature in 1978. This program includes exchange of public lands for private flood-prone lands and state financial aid for relocation. After the severe 1978 coastal storm, the Massachusetts legislature adopted a $1 million bond issue to help fund local acquisition of floodplain lands.

Some public uses have also been relocated. In 1978, the Minnesota Department of Natural Resources began removal of severely flooded campsites in Whitewater State Park. The state used HUD Disaster Assistance and state park funds for the now completed project.

Some state statutes specifically authorize local acquisition and relocation of existing uses under certain circumstances. For example, North Carolina authorizes a local government "to acquire, by purchase, exchange, or condemnation, such existing artificial obstructions (in floodways) if deemed necessary . . . for the purpose of avoiding flood damages."[22]

Most communities have acquired floodplain lands after a disaster or repeated floods under more general acquisition or redevelopment powers.[23] A combination of flood insurance payments and disaster assistance grants and loans has often been used to meet acquisition costs. Funding has usually been federal, although some acquisition, such as that in Baltimore County, has been funded by both bonds and general revenues. Building moratoria were typically adopted after the disaster to prevent rebuilding before acquisition. There are many examples of acquisition and relocation.

- Prairie du Chien, Wisconsin, is now acquiring 128 residential properties in a repeatedly flooded area along the Mississippi and relocating owners. Funding of $4.5 million is being provided by a HUD Community Development Block Grant and by the Army Corps of Engineers.
- Soldiers Grove, Wisconsin, is in the process of relocating its entire business district after repeated flooding. The most severe flood occurred in 1978, causing $52 million in damages. Funding from several federal, state, and local sources was used. A 190-acre new town site has been purchased and prepared for development to meet multiple objectives of energy conservation and flood loss reduction.
- Dallas, Texas, has acquired 180 properties in two damage-prone subdivisions with funds from bond issues, HUD open space and urban renewal

grant programs, the Land and Water Conservation Fund, and other sources.

- Gulf Shores, Alabama, is combining regulations and acquisition for certain beachfront areas devastated by Hurricane Frederic. The city is acquiring five properties with funding from Section 1362 of the National Flood Insurance Act at an estimated cost of slightly over $1 million. Other properties are being acquired through the Land and Water Conservation Fund and through donation.

Many other communities have cleared structures from floodplain areas as part of urban renewal or open space programs. Denver, Colorado; Austin, Texas; and Pittsburg, Pennsylvania are examples.

FLOOD WARNING SYSTEMS

Flood warning systems to reduce losses to existing uses have been developed or are under development by many communities with the help of the National Weather Service (NWS).[24] The NWS has in effect a flood watch and flood warning system for all coastal and inland waters.

Some communities with flash flood problems have developed more specific warning systems. For instance, Gatlinburg, Tennessee, has developed a specific, supplemental warning system. The West Prong of the Pigeon River, which is subject to severe flash flooding, bisects much of downtown Gatlinburg. Lying at the entrance to Smoky Mountain National Park, the town has many hotels, motels, and restaurants in the flash flood area. A storm in the Smoky Mountains, 20 miles from downtown Gatlinburg, could send 10 feet of water into the town only 15 minutes after the first warning.

The Tennessee Valley Authority (TVA) and the town first studied structural solutions to the flood problem, but found none practical. Regulations were adopted to reduce losses to new uses. For existing uses, a sophisticated flood warning system and evacuation plan were later developed in cooperation with NWS. This system involves automatic rain and river gages, a computer model of the watershed, automatic data processing, and automatic alarms. Both TVA and the town funded the system.

A flash flood warning system combined with regulations has been adopted by Brattleboro, Vermont, which also has severe flash flood problems. A major nursing home is located in one flash flood area along Whetstone Creek. With help from NWS and SCS, the town has implemented a computerized warning system similar to that for Gatlinburg.

Other warning systems are found in Lycoming County, Pennsylvania; Keene, New Hampshire; and Four Mile Run in Alexandria, Virginia.

REGULATIONS AND FLOOD CONTROL MEASURES

Dikes, levees, detention ponds, small dams, and stream channelization projects have been combined with regulations both before and after floods. Federal agencies have often assisted in these efforts.

- Littleton, Colorado, combined flood control measures, acquisition, and regulations to reduce flood losses after a flash flood in 1965 took 13 lives and caused $399 million in damages. The Corps of Engineers constructed an $86 million earthen dam to lessen flood damages in Littleton and downstream communities.
- San Bernardino, California, combined regulation of mud flow areas with acquisition and relocation of selected properties, the construction of mud flow retention walls, and the seeding of upstream canyon walls to reduce mud flows.
- Scottsdale, Arizona, near Phoenix, combined regulations with acquisition and limited flood control measures in a $30 million bond project for 4.5 miles of Indian Bend Wash. A dike was constructed to protect the flood fringe areas.
- Riverside County, California, combined floodplain regulations with various types of levee and channelization projects to reduce stream, alluvial fan, and sheet flow flood problems. Flood control projects have been constructed primarily by the Riverside County Watershed Conservation and Flood Control District and by the Coachella County Valley Water District, with funding from bond issues.
- Palatine, Illinois, combined floodplain regulations with a program to maintain existing floodway channels, build five floodwater retention structures and one multipurpose flood prevention and recreation facility, improve the flow carrying ability of 1.8 miles of stream channel, and purchase 261 acres of floodplain.
- Rockville, Maryland, combined regulations requiring subdividers to provide onsite storage of waters with a local government program to construct onsite stormwater detention ponds. Twenty-four of these ponds have been constructed with 18 more planned or under construction.

Despite their advantages, once flood control measures are proposed or constructed at public expense for one area of a community, local officials have often found it difficult to gain landowner support for nonstructural measures that require landowners to bear the costs of flood protection in other areas. Landowners may also resist regulation in areas partially protected (*e.g.*, to a 25-year flood elevation) by dikes or dams.

EVACUATION MAPS AND PLANS

The National Oceanic and Atmospheric Administration (NOAA), with state and local help, has prepared flood evacuation maps for much of the East Coast. The maps show evacuation routes, safe sites, and various depths of anticipated flooding. They also show historic flood elevations for particular storms. Some communities have prepared more specific flood evacuation plans with help from the Corps, NWS, NOAA, or FEMA. These assess flood hazards, iden-

tify evacuation routes and measures, and suggest flood preparedness measures. Plans have been prepared or are under preparation by Lee, Collier, and Monroe Counties, Florida; Baytown and Galveston, Texas; and other areas.

Footnotes

1. Sheaffer and Roland, Inc. (1978), estimated that 7.9 percent of the 57.3 million occupied housing units in the nation were in special flood hazard areas for a total of 4.5 million housing units. This study also estimated that 325,000 nonresidential units were located in flood hazard areas.

   The report concluded that:

   > In summary, experience to date indicates that the current approach to correcting nonconforming uses through zoning mechanisms is not effective. Nonconforming uses, particularly residences, are allowed to continue even when they are substantially damaged unless they are purchased (p. 10).

   Surveys of state and local programs conducted as part of the present study (see Appendix I and Appendix III) supported this conclusion.
2. Claim data from the National Flood Insurance Program.
3. *Id.*
4. See Platt (1979).
5. See footnote 47, Chapter I.
6. 41 Fed. Reg. 46,963 and 46,964 (1976).
7. *Id.*
8. See, for example, Miller (1980).
9. Zoning statutes specifically exempt nonconforming uses from municipal regulation (cities and villages) in at least 14 states, from county regulation in 15 states, and town or township regulation in 12 states. For a list of these states and more detailed reference, see Strauss and Kusler (1976).
10. Zoning enabling statutes in 14 states specifically authorize the regulation and termination of nonconforming uses. Included are the enabling acts for municipalities in seven states, counties in 10 states, and towns or townships in five states. The enabling acts of the remaining states are silent as to the treatment of nonconforming uses.
11. Mo. Ann. Stat. §64.620 (Vernon 1966).
12. See Minn. Stat. Ann., §394.36 (West Supp. 1982) which provides in part:

    > *Subdivision 2.*—The board may by ordinance as herein provided prescribe such regulations not contrary to law as it deems desirable or necessary to regulate and control, or reduce the number or extent of or the gradual elimination of nonconforming uses and occupancies.

13. In many instances, courts also have supported regulations which require the short-term abatement or alteration of nonconforming uses which are nuisance-like or threaten public safety. See Anderson (1968), sections 6.65-6.71 at 446-471 and cases cited therein. See Hadacheck v. Sebastian, 239 U.S. 392 (1915); Reinman v. Little Rock, 237 U.S. 171 (1915).
14. See footnote 6, Chapter II.
15. See Tressler (1979).
16. Section 406 of the Flood Disaster Relief Act of 1974, P.L. 93-288 (codified at 42 U.S.C.A. §5131(c)(d) (West 1977).
17. Section 1362 of the National Flood Insurance Act of 1974, P.L. 90-44 (codified at 42 U.S.C.A. §§4001-4128 (West 1977)). See also footnote 23.
18. Platt (1979).
19. Kusler (1979b).
20. Memorandum, Office of Management and Budget, July 10, 1980. Guidelines developed by FEMA and directed to 10 agencies provide, in part, the following post-disaster planning process:

To accomplish the objectives of the post-flood recovery efforts, . . . departments and agencies should develop a common policy and enter into an interagency agreement that provides for Federal leadership and participation in interagency, interdisciplinary and intergovernmental hazard mitigation teams. The teams shall be led by a designated FEMA official in cooperation with affected State and local governments. At the time of presidentially-declared disasters, the teams will:

- assess the extent of damage;
- identify riverine floodway and coastal high hazard zones, in which Federal investment to repair or replace structures and facilities should be avoided and the relocation of people and structures out of these areas encouraged;
- identify floodplain fringe areas in which Federal assistance should seek to mitigate hazards through the floodproofing of structures, forecasting-warning-evacuation plans, floodplain regulations, and development and redevelopment policies;
- prepare expeditiously—normally within 15 days—a hazard mitigation report recommending specific recovery actions to be taken by each Federal agency and each non-Federal level of government; Federal agencies shall conform their recovery actions to the recommendations of the report to the fullest extent practicable.

21. Federal Emergency Management Agency (1981).
22. N.C. Gen. Stat. §143-215.55 (1978).
23. See Ralph M. Field Associates (1981); Federal Emergency Management Agency (1981); and other references on floodplain acquisition in the bibliography of this report.
24. See Owen (1977), and Wright *et al.* (1976) who recommends the following elements in a neighborhood watershed flash flood warning system:

    1. Neighborhood Boundary Map
    2. Neighborhood Coordinator
    3. Watershed Rainfall Observation Stations
    4. Neighborhood Alert System
        a. Neighborhood Warning Signal
        b. Neighborhood Telephone Alert System
        c. Mass Media Alert System
    5. Stream and Road Patrols
    6. Neighborhood Damage Reduction
    7. Assistance from Larger Units of Governments
    8. Record Keeping
    9. Training Program

CHAPTER IV

RESOURCE PROTECTION AND HAZARD MITIGATION

Overview

In the last decade, Congress, the states, and local governments have adopted a variety of independent resource protection and management programs that apply in part to floodplains.[1] These programs often contain hazard mitigation standards for new uses or indirectly reduce flood losses by restricting the types, locations, and densities of uses and by protecting flood conveyance and storage. They also protect natural vegetation and control erosion.

Conversely, many floodplain management programs have been adopted or amended to include resource protection and management standards to meet multipurpose community goals such as protection of prime agricultural areas and wetlands. Such provisions have been adopted to promote the wise use of floodplains, as determined at state and local levels. This concern with floodplain resource values is reflected in the NFIP standards and in the Floodplain Management and Wetlands Protection Executive Orders.

Independent resource protection and management programs that apply wholly or in part to floodplain areas include wetland, prime agricultural land, and mineral resource protection programs; coastal zone and shoreland management programs; and "critical area" programs. Many programs have been adopted at the state level as state or cooperative state/local planning and management efforts.

Two types of state and local resource management and floodplain management standards have been applied to protect and conserve natural values. The first—tight control or prohibition of structural development in selected areas—has been applied to highly hazardous or sensitive floodways, wetlands, and habitats for rare and endangered species. This type of regulation is best in small areas where upland sites are available for development.

The second—general performance standards—requires that activities incorporate environmental mitigation measures to reduce project impacts. Mitigation measures of the sort listed in Table 6 are required for permitted uses. Mitigation standards are contained in zoning and subdivision control ordinances and "special permit," grading, floodplain, wetland, and regional impact

TABLE 5

RESOURCE PROTECTION BENEFITS

Regulations, acquisition and other techniques to maintain all or portions of floodplain areas in an open condition can serve the following objectives:

Protect Water Resource Values

Natural Moderation of Floods (Avoid Costs of Flood Control Works)

- reduce flood velocities
- reduce flood peaks
- reduce wind and wave impacts

Water Quality Maintenance (Avoid Costs of Waste Water Treatment)

- remove nitrogen, phosphorous, toxics, litter from runoff before reaching rivers, lakes and streams
- remove pathogens from runoff
- moderate temperature of water
- reduce downstream siltation

Groundwater Recharge (Reduce Costs of Water Supply)

- increase groundwater infiltration for human use and low flow during dry periods
- prevent land subsidence

Maintain Living Resource Values

Protect Flora

- maintain the high biological productivity of floodplain and wetland flora important to animals and people
- maintain the productivity of natural forests and the supply of timber products
- maintain natural crops such as salt marsh hay, blueberries, cranberries

Protect Fauna

- create and enhance wildlife habitats for breeding and feeding of water fowl
- provide migratory flyways for water fowl
- protect habitat of rare and endangered species
- maintain breeding and feeding grounds of fish, shellfish

Maintain Cultural Resource Values

Protect Open Space

- absorb noise
- clean air
- moderate temperatures
- reduce erosion
- preserve historical and archaeological sites

Protect Natural Beauty

- provide variety in the urban pattern
- provide natural greenbelt and forested areas of natural beauty

Protect Scientific Study and Outdoor Education Areas

- serve as an ecological "experiment station"
- facilitate study of the unique wildlife occurring at the interface of land and water
- serve as a classroom for how human and natural systems are linked

Protect Recreation Areas

- provide opportunities for water sports (swimming, boating)
- provide areas for hunting, fishing, and wildlife preservation
- provide wilderness experience areas (in some cases)
- provide areas for hiking, camping, picnicking, bird watching

Maintain Cultivated Resource Values

Protect Agricultural Lands

- renew soil through sediment deposition (periodic flooding) and replenish nutrients in soil for higher productivity
- reduce the need for commercial fertilizer additives
- in some cases, provide uniquely suitable soil for specialty crops

Protect Aquaculture

- provide areas for cultivation of fish, shellfish

Protect Silviculture

- create and preserve valued species that have adapted to naturally moist conditions, especially bottomland hardwoods
- enhance productivity of forest resources and provide opportunity for sound commercial management

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regulations.[2] Environmental impact statements are often required for major projects.

Both resource protection and floodplain management with resource protection provisions protect the nine principal natural resource functions discussed below.

Natural Resource Values

Flooding contributes to the maintenance of special natural resources. Flowing waters shape lands, thereby creating optimum flood conveyance configurations. Flood waters deposit rich soils particularly suited for agriculture. Storm waves create beaches and bars attractive for swimming and other recreation. Fast-moving flood flows deposit sand and gravel needed for roads and industry. Rains and periodic flooding recharge groundwater supplies. High groundwater levels and periodic flooding give rise to "wetland" vegetation and wildlife that contribute to food production, fish spawning, pollution control, bird watching, hunting, fishing, and aesthetic values.

TABLE 6

TYPICAL MITIGATION APPROACHES

1. Minimize impact on natural values by limiting floodplain occupancy to compatible uses.
2. Avoid locating fill and structures within critical wetlands, dunes, beaches, and scientific areas.
3. Reduce impacts on sensitive areas by elevating structures on pilings or other open works.
4. Avoid sensitive areas by routing access roads, sewers, and water supply systems around them.
5. Avoid vegetation removal on dunes, in wetlands, and along stream banks by means of building setbacks and limitations on cutting and grading.
6. Replant wetland and other vegetation where destruction of vegetation cannot be avoided.
7. Protect erosion-prone areas through rip-rap or other measures.
8. Avoid removal of sand, gravel, and other materials from beaches and dunes.
9. Avoid use of off-road vehicles where they may destroy dune and wetland vegetation.
10. Protect fish populations by constructing fish pools in channelization projects and installing fish ladders at dams.
11. Compensate for destroyed areas by constructing new wetlands and other wildlife areas by diking, land acquisition, or other means.
12. Manage game to enhance and reestablish species.
13. Reconstruct disturbed or destroyed natural dunes by planting vegetation, beach nourishment, and other techniques.
14. Control runoff from construction sites by using plastic sheets and similar measures.
15. Reduce sedimentation by constructing detention ponds.
16. Provide sufficient flows for downstream fish and wildlife and periodically flush wetlands by managing dam operations.
17. Limit development densities (e.g., require large lot sizes).
18. Protect sensitive and hazardous areas by clustering development on upland sites.
19. Permit adequate groundwater infiltration by limiting the allowable amount of impermeable surfaces.
20. Avoid disposal of wastes, litter, and debris in wetlands and floodplains.
21. Protect natural vegetation and water quality and reduce erosion by fencing wetlands and floodplains.

Most floodplain natural values such as forestry, wildlife, and pollution control are adjusted to and may depend upon periodic flooding. In contrast, unprotected development at the same sites is subject to flood damage. Protection of development through floodproofing, dikes, levees, channelization, and similar measures is, in the long run, prone to failure because it opposes the natural processes of flow, erosion, scour, sedimentation, and stream and beach migration.

Not all floodplains are characterized by the same natural values, nor have natural resource protection and floodplain management in the 1970s given equal weight to all values.

FLOOD CONVEYANCE

Flood conveyance is a valuable function of river channels and adjacent overbank areas. These areas are shaped by the erosion and deposition accompany-

ing large floods. Fill, structures, and other development in such natural floodways cumulatively increase flood heights and velocities, causing not only increased flood damages on adjacent and upstream lands but also downstream erosion. Plant and animal life in these areas has adapted to and may depend upon periodic flooding.

Protection of flood conveyance was a common objective of shoreland, wild and scenic river, wetland regulatory, and floodplain management programs in the 1970s. Many of these programs were designed to protect the entire natural or "no rise" floodway. The programs assume no permitted increases in flood heights and are more inclusive than the NFIP regulatory floodway.

FLOOD STORAGE

Except in areas characterized by steep terrain and bluffs, most riverine floodplains provide temporary flood storage, thereby lowering downstream flood peaks. One acre of floodplain can hold more than 330,000 gallons of water if flooded to a depth of one foot.

Flood (also termed valley) storage is particularly important in urbanizing areas where even small floods resulting from a five- or a 10-year storm can cause severe flood damage. The flood storage effectiveness of a particular floodplain area depends on its size and hydrologic character, flooding characteristics, the distribution of streams or rivers in the watershed, vegetation and ground cover, and the location of development.

Protection of flood storage was an objective of most inland state and local wetland programs and some shoreland zoning and wild and scenic river programs. Some localities also adopted floodplain or stormwater management regulations to protect storage. NFIP standards do not directly address storage, although floodway restrictions provide some protection. For this reason many wetland and comprehensive flood hazard management policymakers consider the NFIP standards to be inadequate. In order to compensate for this problem, some state and local floodplain regulations use a natural floodway or allow less than the one-foot rise permitted by the NFIP standards.

The federal government has protected some natural storage areas. For example, the Corps of Engineers, after studying the Charles River near Boston in 1965, reversed an earlier recommendation for a flood control structure and instead recommended protection of 17 parcels, constituting 8,500 acres that function as natural storage areas. The Corps has now acquired much of this land. State and local regulations will protect other storage areas along the Charles.

WAVE REDUCTION

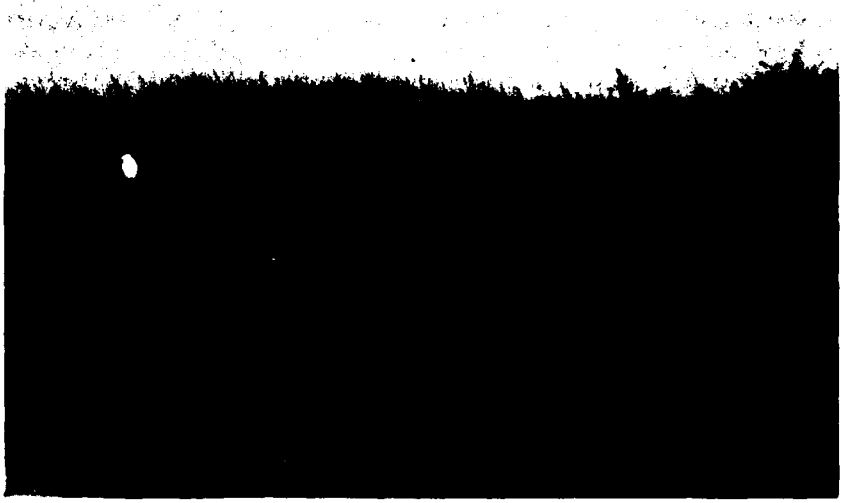
Beaches, bars, dunes, and wetlands act as natural barriers that dissipate coastal waves and protect backlying areas from flooding and erosion. Along the coast, waves may cause severe damage for a distance of 300 to 1,000 feet

inland, depending on topography, vegetation, and manmade or natural barriers. Coastal islands are vulnerable to extensive impacts from storm waves.

Natural barriers form several lines of defense against waves and erosion. Offshore and nearshore bars are the first line of defense. They absorb much of a wave's energy, causing it to "break" and weaken even though it may travel some distance inland. Dredging beaches or bars to replenish dunes may increase wave damage by increasing wave heights. Most coastal states now control dredging, sand removal or other alteration of beaches through floodplain, wetland, and beach protection; shore erosion control; or coastal zone management. Generally, floodplain regulations also prohibit structures below the mean high water line. Federal 404 or Section 10 permits are required for most dredging activities.

Dunes lying behind the beach are the second line of defense against storm waves, although a severe storm may destroy the dunes.[3] In addition to acting as buffers to waves and erosion, they also partially protect against hurricane winds, which may exceed 150 miles per hour. Dune areas are also important for recreation and contain unique plant and animal species. Florida has adopted a beach setback line, designed in part to protect dune areas.[4] North Carolina has adopted dune protection regulations as part of its coastal zone management program.[5] Many local communities have adopted dune protection ordinances, particularly in Massachusetts, New York, North Carolina, and Rhode Island. NFIP standards require protection for dunes where it is shown that any proposed alteration could cause flood damage.

Vegetated coastal wetlands are a third line of defense in estuaries and behind barrier islands.[6] Growth of wetland vegetation is rare in open coast areas. Vegetated wetlands form in backlying areas that are subject only to infrequent



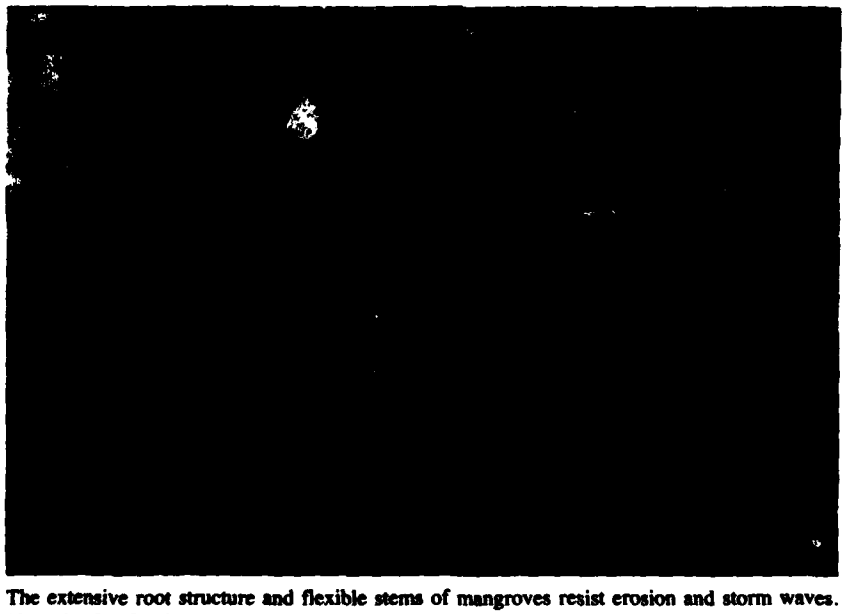
A wetland reestablished on dredge spoil as a mitigation measure. Photo by Dave Davis.

storms such as the 100-year storm. When such events occur, wetland vegetation causes waves to dampen and break, dissipating much of their energy. Root systems of Atlantic coastal vegetation, such as those of *Spartina alternaflora*, bind and protect the soil against erosion.

Mangrove forests found in Florida and, to a lesser extent, Louisiana, are particularly important wave buffers.[7] Red and black mangroves grow to a height of 20 to 35 feet for a distance of 1 to 10 miles inland from the coast. They take root in standing water and have complicated root and above-ground systems. During hurricanes they substantially reduce the force of storm waves and may actually build up the land by trapping sediments. A study of how mangroves retard erosion revealed that when Hurricane Hattie struck the Caribbean in 1961, with 200-mile-per-hour winds and 15-foot tides, islands covered with natural vegetation suffered little permanent damage and in some instances actually accumulated new material from the storm.[8] In contrast, islands cleared of vegetation were severely eroded.

NFIP standards require protection of mangroves within defined velocity zones if it can be shown that any proposed alteration would increase potential flood damage. However, the standards disregard other forms of vegetation that may have the same potential.[9]

Efforts are being made to protect coastal wetlands and mangroves through wetland protection, coastal zone management, and pollution control programs. The Corps generally denies Section 404 permits for alteration of mangroves and other coastal wetlands. Florida is enforcing mangrove protection measures through its setback requirements, pollution permit systems, and similar



The extensive root structure and flexible stems of mangroves resist erosion and storm waves. Photo by Jon Kusler.

measures. Virtually all coastal states have adopted coastal wetland protection measures.

Inland wetlands also reduce wave and erosion damages along lakes and rivers and provide a buffer to pollution associated with flooding. Massachusetts, Rhode Island, and other states regulate activities in inland wetlands. Many local communities, particularly in states like Florida, Massachusetts, and Virginia, have adopted wetland protection ordinances.

WATERFOWL AND WILDLIFE

Due to the abundance of water and vegetation, floodplains provide habitat for much of the nation's wildlife. Wetlands along the Gulf Coast provide nesting and feeding grounds for many species of waterfowl. Mississippi River floodplains are major duck and geese resting and feeding grounds during fall and spring migrations. The prairie potholes of the Midwest are nesting areas for about 50% of the nation's ducks. The vegetated floodplain corridors along western rivers and streams are particularly important to birds and fish. Many animal species such as raccoon, deer, moose, turtles, and salamanders spend a portion of their lives in floodplains. Inland floodplains normally accessible to open water along lakes and streams provide nursery habitat for fish such as northern pike and walleye. Florida mangroves provide protection for shrimp and for the fingerlings of commercial fish such as mullet, snook, and snapper. The value of the nation's nearshore and continental shelf fishing annually exceeds one-half billion dollars. Nine out of 10 commercially important fish species either pass their entire lives in estuaries or require estuaries as nursing grounds.

Canada geese nesting in wetland area.
Photo by Dave Davis.

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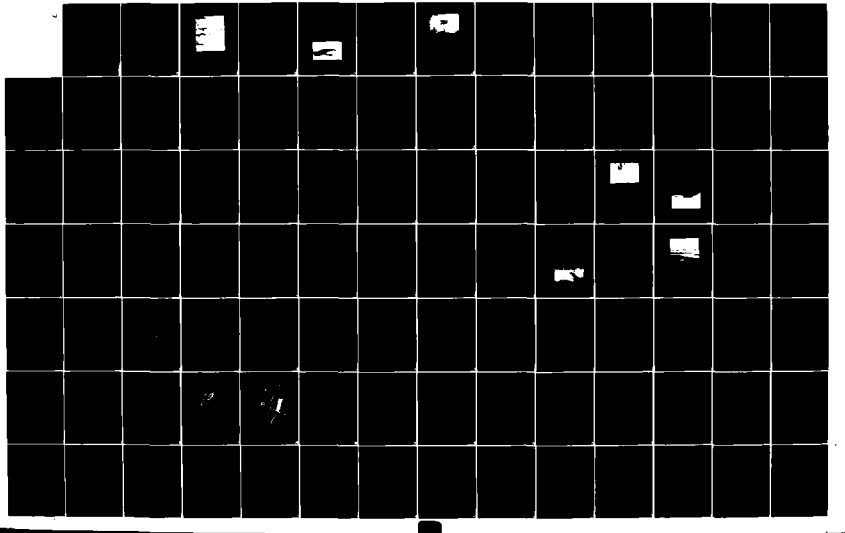
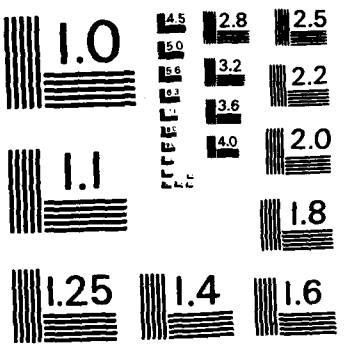




Over 35% of the nation's rare and endangered species live all or a portion of their time in wetland areas.[10] Such species include the Everglade kite, the whooping crane, the Sandhill crane, the bald eagle, the American crocodile, and the Florida panther.

Most state coastal and inland wetland regulation and acquisition programs and the Federal 404 permit program are designed, in part, to protect duck nesting and fish spawning grounds. However, state and federal floodplain regulations rarely emphasize wildlife protection as an objective, although they may incidentally achieve this result by limiting alteration of habitat.

POLLUTION CONTROL

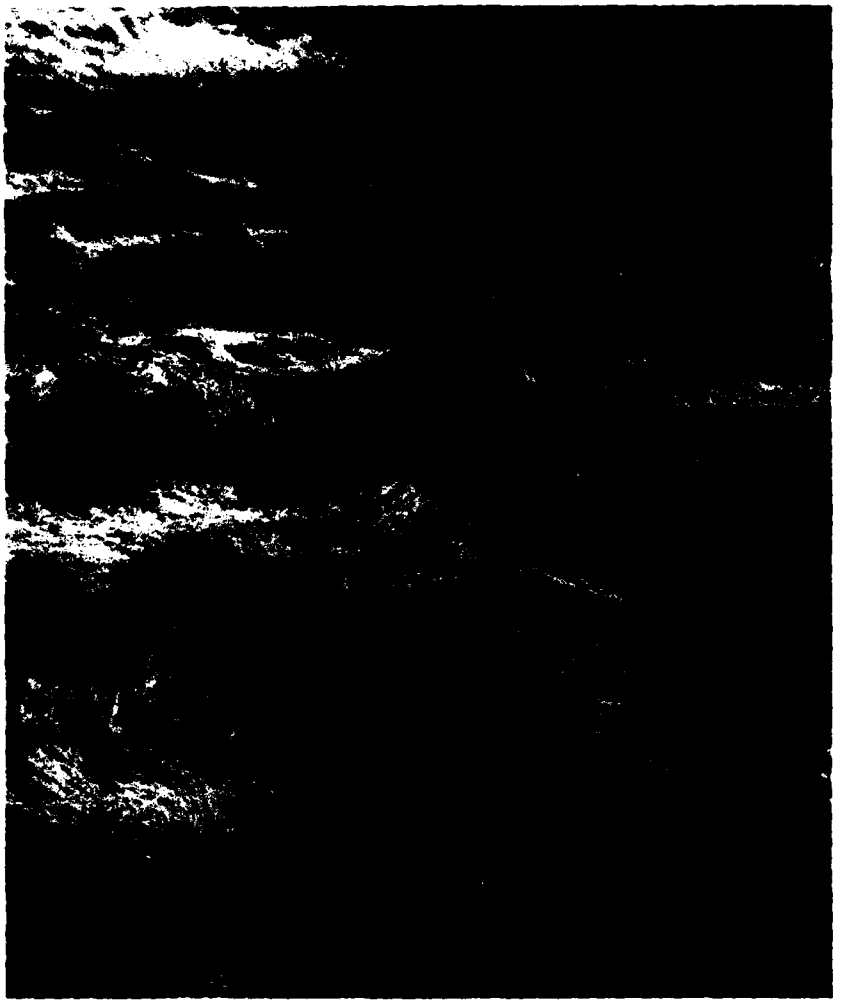
Floodplains buffer rivers, streams, lakes, and estuarine waters from upland sources of pollution. Floodplain vegetation reduces the velocity of sediment-laden flood water, and results in deposition on overbank areas rather than in lakes, reservoirs, and streams. Vegetation also traps sediment and organic particles.

Nutrients, chemicals, and other materials migrating through groundwater or surface water systems are filtered by floodplain soils or degraded by floodplain bacteria. For example, studies of heavily polluted waters flowing through Tinicum Marsh in Pennsylvania revealed significant reductions in biological oxygen demand, phosphorus, and nitrogen within three to five hours.[11] A variety of studies are now under way to investigate the use of wetlands and floodplains for tertiary treatment of domestic and industrial wastes and stormwater runoff.[12]

Federal, state, and local wetland, shoreland zoning, coastal zone management, and wild and scenic river programs are designed, in part, to prevent pollution by providing setbacks and maintaining vegetation. Federal 404 permits are denied for areas that may serve pollution control functions. Although pollution control is often a stated objective of floodplain regulations, regulation of shoreland vegetation removal and control of subtle sources of pollution is rare.

NATURAL CROPS, AGRICULTURE, FORESTRY

Floodplains produce a variety of natural crops that do not depend on fertilizer,[13] for example, blueberries, cranberries, and wild rice. Coastal wetlands have historically been harvested for salt marsh hay. Coastal aquaculture, including propagation of oysters, is carried on in Long Island and the Chesapeake Bay. Research during the 1970s showed that wetland plants could produce biomass suitable for fuel while removing unwanted nutrients from waters.[14] Cattails can also produce alcohol as a supplement to fossil fuels. Some wetland and coastal zone management programs are designed in part to protect natural crops. Floodplain regulatory programs rarely address this issue.



Salt marsh hay, Wellfleet, Massachusetts.
Photo by Jon Kusler.

Inland floodplains along larger rivers are often prime agricultural lands because of their flat terrain, abundant water supplies, and rich alluvial soils which are periodically replenished by flooding. Measures to preserve prime agricultural lands and shape urban growth have been taken in California, Hawaii, Maryland, Massachusetts, New Jersey, and Oregon. Glastonbury, Connecticut; Northampton, Massachusetts; and Walworth County, Wisconsin, have adopted prime agricultural zoning for floodplain areas.

Inland floodplains are often sources of timber. Principal commercial species are cypress, gum, loblolly, tamarack, maple, and spruce. Some wetland and forest protection programs regulate excessive cutting in forest areas.

GROUNDWATER SUPPLY AND RECHARGE

Municipal and private water supply wells are often located in floodplain alluvial deposits. Floodplains and wetlands are an increasingly important source for water supplies. Floodplains are often groundwater recharge areas in the arid west.

Some independent wetland and aquifer recharge protection regulations have been adopted, particularly in Massachusetts and the West. However, floodplain regulations rarely cover groundwater supply and recharge, although they may incidentally serve to protect recharge by limiting impermeable surface.

RECREATION, CULTURAL, HISTORIC VALUES

In many areas of the country, states and localities have acquired floodplains to serve as fishing, hunting, bird watching, picnicking, hiking, jogging, swimming, and boating areas. Coastal and inland floodplains provide fishing sites for many of the 20 million Americans who fish for recreation. Coastal and inland riverine floodplains are principal duck and geese hunting areas. Millions now birdwatch in wetlands and floodplains. A 1978 study of 17 major cities, by the Heritage Conservation and Recreation Service and the National Park Service, revealed that floodplains were often the prime remaining park and recreation sites in major urban areas.[15]

Floodplains also have cultural and historic significance. Many were used by native Americans and the first settlers as fishing and agricultural areas because fish and shellfish, a water supply, and water transport were available. Cities grew up along the major rivers and in coastal bays. Boston, Austin, and Tulsa, to name a few, have focused their major urban renewal and historical preservation and restoration projects on waterfront areas.

Floodplain regulations protect recreation and cultural values by limiting development densities and encouraging such private recreational uses as golf courses, picnic areas, and playing fields.

SAND AND GRAVEL DEPOSITS

Swiftly flowing waters often deposit sand and gravel in inland floodplains. Colorado has adopted mineral protection legislation which applies in part to floodplains.[16] Some communities have also adopted exclusive mineral protection zones to control mining of sand and gravel. Floodplain regulations rarely protect mineral resources as a stated objective although they may incidentally protect deposits from incompatible development by restricting the types and densities of development.

Resource Management Programs

Four principal types of resource management programs were applied to floodplains as well as other lands during the 1970s: wetland, coastal zone

management, shoreland, and "miscellaneous" programs such as wild and scenic river and prime agricultural land protection.

WETLAND PROTECTION PROGRAMS

Wetland regulatory programs are most directly applicable to floodplain management. Wetlands are typically the "wettest" and most hazardous areas of floodplains, and lie within the one-year or two-year floodplain. Wetland areas are characterized by saturated, organic soils (caused by high groundwater, tides, or periodic flooding), and by plant species capable of growing in semi-aquatic or water-rich conditions.[17] Coastal marshes are flooded to elevations of six to 15 feet by the 100-year flood and may be subject to high velocity waves. Inland wetlands along rivers often lie within floodway areas. Wetlands along lakes and isolated wetlands are subject to periodic increases in ground or surface water level which cause flooding of nearby structures, although they may not lie within traditionally defined floodplains.

The placement of material in most wetlands requires a federal permit from the Army Corps of Engineers pursuant to Section 404 of the Water Pollution Control Amendment of 1972, the Clean Water Act of 1977,[18] and Section 10 of the Rivers and Harbors Act of 1899.[19] Flood conveyance, flood storage, and flood damage potential are considered in processing permits.

All coastal states have either adopted separate coastal wetland protection programs or have incorporated wetland regulations in coastal zone management or shoreland management programs.[20] Hazard mitigation is often an objective. Most coastal states have mapped wetlands at scales that range from

Organic soils found in many wetlands compress under pressure, causing structural damage to buildings and roads. They are also unsuitable for onsite sewage disposal.
Photo by Richard Newton.

1″=200′ to 1″=1000′. Permits are required for fill, dredging, and other uses that may destroy or damage wetland areas. Maryland, Massachusetts, New Jersey, and New York have particularly effective programs.

At least seven states have adopted inland wetland protection regulatory statutes.[21] Massachusetts and Rhode Island have amended statutory wetland definitions to require permits for fill and structures in the 100-year floodplain. Aerial photos are usually used for mapping wetlands, although Connecticut uses soils maps. Rhode Island and, to a lesser extent, New Hampshire and Florida require state permits. In Connecticut, Michigan, New York, Virginia, and Wisconsin, local governments issue permits if they have adopted regulations consistent with state standards.

Several thousand local governments have combined wetland protection and floodplain management ordinances. Typically these establish tight protection standards (no fill or dredging) for wetland and floodway areas. Flood protection through elevation of fill or floodproofing is required for structures in outlying areas. In some instances, communities (*e.g.*, Orono, Minnesota; Glastonbury, Connecticut) control development throughout the 100-year or even 500-year floodplain with the intention of protecting wetland areas.

COASTAL ZONE MANAGEMENT PROGRAMS

Congress adopted a national Coastal Zone Management Act in 1972.[22] During the 1970s, all coastal and Great Lakes states provided some regulatory control over coastal zone uses, often through a combination of statutes on beach, "navigable water," and wetland protection.[23] Regulations range from minimal beach setbacks (*e.g.*, Florida and Hawaii) and wetland regulations in 15 states, to comprehensive coastal zone acts (*e.g.*, California, North Carolina). Some wetland and broader programs involve direct state control. However, the Maine, North Carolina, Minnesota, Washington, and Wisconsin programs rely primarily on local control within a framework of state standards.

State statutes define regulated coastal zone areas to include lands within specified distances of the water.[24] Coastal zone boundaries include a narrow, 200-foot shoreline area in Washington; 250 feet in Maine; 1,000 feet in Wisconsin, Minnesota, and Michigan; 1,000 yards in California; and all of the coastal counties in North Carolina. The Delaware and New Jersey coastal zone acts, directed toward industrial development, define coastal zone boundaries by particular roads.

Implementation of coastal zone programs usually involves mapping and more specific regulation of discrete coastal subzones such as wetlands, erosion areas, flood areas, and recreation areas. The Coastal Zone Management Act of 1972 and the basic enabling acts of several states require the identification of subzones of "particular concern," including many types of resource areas.

Some programs emphasize management of flood and erosion areas. Massachusetts has adopted an executive order prohibiting state investment in barrier beaches and it has a state building code incorporating wave heights

Dune protection measures in Lewes, Delaware.
Photo by Jon Kusler.

for coastal hazard areas. It has also mapped erosion hazard areas and barrier islands and provided technical assistance and grants to aid communities.

The Rhode Island Coastal Commission regulates dunes, beaches, and wetlands. With funding from the state coastal zone management program, the University of Rhode Island provides erosion and flood maps and technical assistance to local coastal management programs. Many local governments such as South Kingston and Warwick have adopted flood hazard zoning.

The North Carolina coastal zone program also stresses flood and erosion hazards. It requires local governments to regulate flood and erosion areas of "critical concern." Erosion problems are emphasized in the Michigan shoreline program, which has identified a 30-year erosion setback. The California coastal zone management program has also identified erosion and flood areas.

SHORELAND ZONING PROGRAMS

Six states have adopted special legislation for the protection and management of shoreline areas:[25] Maine, Michigan, Minnesota, Vermont, Washington, and Wisconsin. Legislation adopted in Maine and Washington applies both to inland and ocean shorelines; legislation in Wisconsin and Minnesota applies to the Great Lakes as well as to other lake and stream areas. Statutes in all six states establish standards for local government regulation of shoreland areas. Several thousand communities and counties have adopted regulations pursuant to these statutes. Many contain flood hazard provisions.

States and communities have used two methods to classify shoreland areas more specifically. The first, applied in Wisconsin, identifies individual sub-

zones such as wetlands around lakes. The second, used in Minnesota, classifies lakes in their entirety for "natural environment," "recreational development," and other uses. Varying shoreland use standards for each class apply to lot size, water frontage, building setbacks, and other matters. Both types of classification apply to floodplain maps and standards to supplement the more general classifications.

All shoreland regulatory programs authorize state standard-setting for local zoning, subdivision controls and, in some cases, sanitary codes. The six states have adopted standards to serve multiple goals: prevention of pollution; prevention of increased flood hazards; minimization of land use conflicts; protection of wetlands; protection of wildlife and scenic beauty; and protection and enhancement of recreation values. In general, programs permit low-density residential and recreational uses in shoreland areas. However, they tightly restrict development and fill in wetland areas and flood hazard areas.

Michigan, Minnesota, and Wisconsin emphasize flood and erosion hazards in their shoreline programs. In Washington, the Department of Ecology has developed a detailed coastal zone atlas, including maps of flood and erosion hazard areas.

OTHER RESOURCE MANAGEMENT PROGRAMS

Flood hazard mitigation has been achieved to a greater or lesser extent through a variety of other resource management programs. For example, Michigan communities have adopted combined floodplain and wild and scenic river regulations pursuant to a state "natural rivers" statute.[26] This statute directs the Department of Natural Resources to prepare river corridor plans for "wilderness," "wild scenic," and "country scenic" rivers. Plans are to manage rivers for "floodplain" and other natural values. Local governments are to adopt regulations consistent with state plans. Regulations apply to a 400-foot corridor on both sides of designated rivers. The state will directly regulate this area if local authorities do not. Michigan has prepared plans for 10 rivers and 1,100 miles of river corridor. Wild and scenic river programs have also been adopted in California, Oregon, New York, and other states.

Some communities have also adopted agricultural zoning for floodplains. Flood hazard mitigation is an incidental benefit of "prime agricultural land zoning," which excludes or restricts the density of non-agricultural structures.[27] For example, Northampton, Massachusetts, has placed approximately 1,500 acres of floodplain along the Connecticut River in an exclusive agricultural use district. Glastonbury, Connecticut, has zoned approximately 800 acres along the Connecticut River for agricultural use.

"Riparian" habitat protection programs can also be used to mitigate flood hazards.[28] California communities protect "riparian cover" or habitat along watercourses to reduce bank erosion, increase groundwater infiltration, and provide wildlife habitats. A 1974 ordinance adopted by Napa County, California, protects riparian cover from planting or cutting within specified distances

of streams. Other California counties with riparian habitat protection ordinances are Shasta, Santa Cruz, and Sacramento.

Conflicts and Problems

Although resource protection and flood hazard mitigation standards are usually compatible, conflicts have arisen.[29] Problems are due partly to differences in enabling legislation and program goals. Flood hazard reduction programs have narrowly focused on protection of individual structures from flooding, and on protection against the aggravation of the existing hazard by new development in floodways. In contrast, resource management has a broader goal to protect resource areas or manage their use. For example, floodplain regulatory statutes usually permit fill in outer fringe areas. In contrast, wetland regulatory statutes, which are designed to serve broader wildlife protection and recreation goals, prohibit fill.

The differing philosophies of program managers also lead to conflicts. Floodplain engineers and building inspectors often take a narrow flood hazard reduction approach; community planners and conservation program directors often take an overall resource protection approach. Engineers view flood hazards as "a problem to be solved or avoided." Conservationists see natural values as an asset to be protected, managed, or restored.

Because engineers are often unfamiliar with natural values evaluation, they fear that environmental objectives will weaken floodplain regulatory programs. On the other hand, botanists and others responsible for wetland protection often do not understand engineering. They tend to underemphasize natural hazards because they believe a hazard focus reduces the acceptability of their efforts.

Other problems in coordinating or integrating programs are lack of simple and inexpensive procedures to evaluate values and hazards, of expertise in specific programs, and of resource maps showing the boundary locations of wetlands, prime agricultural lands, and other resource areas. Conflicts in policy appear in all levels of government but are often most severe at the federal level.

COORDINATING HAZARD MITIGATION AND RESOURCE MANAGEMENT

Several measures could reduce conflicts and encourage coordination or integration of hazard mitigation and resource management.

- Local governments should map or inventory wetlands, prime agricultural lands, sand and gravel deposits, habitat for endangered species, and other resources as part of floodplain management or broader land use planning.
- Local and state floodplain management should fully consider resource values in planning and managing floodplains. New development should be guided away from floodplains (not just floodways) having special values.

- Local, state, and federal agencies should widely disseminate resource protection and flood hazard boundary maps and other informational materials.
- Local, state, and federal agencies should more thoroughly cross-reference or integrate floodplain regulations and broader resource protection regulations. For example, wetland protection standards can be incorporated into flood restrictions to prohibit fill and structures in wetland areas. Mitigation of development impact should be required if activities are permitted in wetlands. Similarly, flood standards could be placed in wetland regulations.
- Federal agencies and states should provide resource managers with basic training in flood hazard assessment. Similarly, basic training in assessment and protection of broader resource values should be provided floodplain management staff. A simple guidebook should be developed for evaluating floodplain natural values.
- NFIP standards protecting coastal dunes and mangroves should be clarified and more effectively enforced. NFIP regulations could also be amended to require broader protection of wetlands that are important in reducing flood and erosion damage. Upgraded hazard mitigation standards would also help protect critical resource areas. For example, the incorporation of wave heights and erosion standards in coastal flood hazard standards would increase protection of beach, dune, and wetland areas. More stringent standards for floodway delineation, such as "zero-rise floodways," would help protect wetlands, flood storage areas, and aquifer recharge areas.

Footnotes

1. See Kusler (1980), and the Coastal Barrier Resources Act of 1982 (P.L. 97-348).
2. For a discussion of mitigation approaches see Swanson (1979). See also references at footnote 28.
3. See Nordstrom and Psuty (1979).
4. Fla. Stat. Ann. §§161.052, 161.053 (West Supp. 1982).
5. N.C. Gen. Stat. §§113A-100 to 113A-134 (1978).
6. See Section 4 of Greeson *et al.* (eds.) (1979), and the many papers therein.
7. See for example, Fosberg (1971), Savage (1972), and Teal and Teal (1969).
8. See Teal and Teal (1969).
9. For discussion of the erosion control and wave attentuation functions of other types of wetlands see, for example, Newcombe *et al.* (1979), and Wayne (1974).
10. See Kusler *et al.* (1979).
11. See Grant and Patrick (1970). See also the papers and many references contained in Greeson *et al.*, (eds.) (1979).
12. Greeson *et al.* (eds.) (1979), Section 6, p. 490.
13. Greeson *et al.* (eds.) (1979), Section 8, p. 589.
14. Greeson *et al.* (eds.) (1979), p. 652.
15. U.S. Department of the Interior (1978).
16. Colo. Rev. Stat. §§24-65.1-201 *et seq.* (Supp. 1981).
17. See the references on wetlands in the bibliography.

18. 33 U.S.C. §1344(a) (1978).
19. 33 U.S.C. §403 (1970).
20. See Kusler (1978).
21. *Id.*
22. 16 U.S.C.A. §1454 (West Supp. 1982).
23. For a description of these programs, see references in the bibliography.
24. See Kusler (1980), pp. 30, 187.
25. See Kusler (1980), p. 26.
26. Mich. Comp. Laws Ann. §281.76 (West Supp. 1979).
27. For information on agricultural zoning see the bibliography. See also Toner (1978). U.S. Library of Congress (1978), and Toner (1981).
28. For discussion of riparian habitat protection programs see Johnson and McCormack (coordinators) (1979).
29. See Kusler (1979a), for the conclusions and recommendations of a technical seminar series investigating problems and approaches for better coordination of wetland and floodplain management efforts.

CHAPTER V

STATE PROGRAMS

Overview

The decade of the 1970s was one of growth and redirection in state floodplain management. Arizona, Colorado, Maryland, New York, Oklahoma, Pennsylvania, and Vermont adopted new statutes. Massachusetts and Rhode Island strengthened floodplain regulations by amending wetland protection acts to include the 100-year floodplain. California, Massachusetts, North Carolina, Rhode Island, and Washington incorporated coastal hazard mitigation provisions into state coastal zone management programs. (Examples of innovative state statutes can be found in Appendix II.)

Prior to 1970, 24 states had adopted statutes authorizing either direct state regulation of flood hazard areas or state standard-setting for local regulation. By 1980, with the addition of the seven mentioned above, the number had reached 31, although some programs were limited to selected floodplains. Of the remaining 19 states, at least 10 provided technical assistance to local floodplain regulatory programs. All 50 states appointed coordinators for the National Flood Insurance Program. Under its State Assistance Program, FEMA now provides funds to 48 states to increase state administrative capabilities.

Principal state floodplain management activities during the last decade were varied. A profile of each state's program can be found in Appendix I.

THE NFIP

States aided FEMA in implementing the NFIP. The rapid growth of the NFIP and resultant redirection of state programs has led to the appointment of NFIP state coordinators within each state, and to a shift in program priorities. Prior to 1970, programs in California, Iowa, Minnesota, Washington, and Wisconsin emphasized state regulation and mapping. During the last five years, state program staffs have spent much of their time assisting or acting as contractors for FEMA mapping, distributing literature, answering questions on the NFIP, reviewing ordinances adopted by communities to qualify for the program, preparing manuals, and, in some instances, assisting FEMA in monitoring community performance.

TABLE 7

STATE PROGRAM ACTIVITIES

	Ordinances				Hydrology Hydraulics						Enforcement of Violations	
	Prepare model	Assist in Adoption	Assist in Adm.	Training local Officials	Review	Approval	Insurance Activities	Training Lenders & Agents	Information Distribution	Monitoring Administration	Assist Locals	State Action
Alabama				x	x		x		x			
Alaska	x			x			x					
Arizona	x			x	x	x	x		x	x		x
Arkansas	x	x	x				x		x	x	x	
California		x	x	x					x	x	x	x
Colorado	x			x	x	x			x		x	
Connecticut									x			
Delaware									x	x		
Florida		x		x			x		x			
Georgia		x	x	x					x	x		
Hawaii					x				x			
Idaho	x						x		x	x	x	
Illinois	x	x	x	x	x	x	x		x	x	x	x
Indiana	x	x	x		x	x	x		x		x	x
Iowa	x	x	x	x	x	x			x	x	x	x
Kansas	x		x	x	x	x		x	x		x	x
Kentucky				x	x	x	x	x	x		x	x
Louisiana	x			x	x		x		x	x	x	
Maine	x	x		x			x		x			
Maryland	x		x	x		x	x	x	x	x	x	x
Massachusetts		x							x			
Michigan	x		x		x	x			x	x	x	x
Minnesota	x	x	x	x	x	x	x	x	x	x	x	c
Mississippi	x			x			x		x		x	
Missouri	x								x			
Montana	x	x		x	x				x		x	
Nebraska	x	x	x	x	x	x	x	x	x	x	x	x
Nevada								x	x			
New Hampshire	x	x	x	x					x	x	x	
New Jersey	x			x	x	x	x		x	x	x	x
New Mexico	x								x			
New York	x	x	x	x	x	x	x	x	x	x	x	x
North Carolina	x	x	x	x	x			x	x	x	x	
North Dakota		x	x	x	x		x		x	x	x	
Ohio	x	x		x	x		x	x	x	x		
Oklahoma				x	x		x		x	x	x	
Oregon												
Pennsylvania	x	x	x	x			x		x	x	x	x
Rhode Island	x	x	*	x					x	x		x
South Carolina		x	x						x	x		
South Dakota				x					x			
Tennessee	x			x					x	x		
Texas	x	x	x	x					x			
Utah		x							x			
Vermont	x		x							x		
Virginia		x							x			
West Virginia				x				x	x	x		
Washington				x					x			
Wisconsin	x	x	x	x	x	x	x		x	x	x	x
Wyoming	x			x					x			
Dist. Columbia		x	x	x	x	x			x			x
Puerto Rico				x			x	x	x	x	x	

MAPPING

During the 1970s, states assisted federal floodplain mapping programs by establishing technical map standards (which often exceeded federal standards), and by aiding the NFIP and its contractors in acquiring topographic maps, flood flow information, and other flood-related data. Some states mapped floodplain areas independently at greater scales and higher levels of accuracy than required by FEMA. For example, New Jersey mapped floodplains and floodways at a scale of 1"=400'. Maryland placed NFIP flood boundaries on tax maps at a scale of 1"=600'. Colorado mapped some urban areas at a scale of 1"=200'. Florida, Michigan, and New Jersey defined coastal set-

back lines that accounted for erosion, something not considered in FEMA mapping. Maryland, Minnesota, New Jersey, and Wisconsin formed their own depositories for storage and distribution of flood data.

REGULATION

By 1980, 31 states had established programs that either directly regulated all or a portion of their floodplains, or established standards for local regulation. State regulations were often more restrictive than those of the NFIP. More restrictive standards for delineation of floodway areas were adopted by New Jersey (0.2-foot rise), Maryland (no rise in many circumstances), Wisconsin (zero-rise in most circumstances), Minnesota (variable rise of 0.0- to 0.5-foot), Illinois (0.1-foot rise in rural areas, 0.5-foot rise in urban areas), and Indiana (0.1-foot rise). In addition, many states added freeboard requirements to the 100-year base flood elevation. For example, Wisconsin incorporated one foot of freeboard in mapping the 100-year floodplain.

MODEL ORDINANCES

At least 31 states developed model zoning or subdivision ordinances tailored to state laws and special needs to help localities develop their own regulations. Many models followed the overall framework suggested in Volumes 1 and 2, ***Regulation of Flood Hazard Areas.*** Minnesota and Wisconsin developed a whole series of model ordinances to be used with flood data of various types.

PROCEDURAL MANUALS

At least 18 states adopted procedural manuals to assist local governments in regulation. Manuals addressed adoption and administration of regulations, flood insurance, postdisaster response, and other aspects of floodplain management.

PUBLIC PROJECT REVIEW

Most state programs reviewed state and federal projects in the floodplain through state regulatory permit requirements, state executive order requirements (*e.g.*, California, Wisconsin), A-95 review procedures, or National Environmental Policy Act (NEPA) procedures.

TRAINING AND EDUCATION

At least 36 states conducted workshops and training sessions for local government officials, lenders, landowners, lawyers, and others. Training and education also took place on a one-to-one basis for local government officials and landowners.

PERMIT REVIEW

Many states assisted local governments in evaluating proposed permits and subdivision plats. These evaluations were particularly important for counties and smaller communities without technical staff or those that had only approximate flood maps with no 100-year flood elevations or floodways delineated.

COORDINATION

Some state floodplain management programs (*e.g.* Minnesota and Wisconsin) were closely coordinated with shoreland zoning programs. Other states (*e.g.*, North Carolina and Massachusetts) tied theirs to coastal zone or wetland programs. Coordination with other land and water planning and management programs (such as pollution control) was an increasingly important function in many states.

NONREGULATORY TECHNIQUES

Many state programs combined regulatory and nonregulatory floodplain management techniques. For example, New Jersey appropriated $22 million for a cost-sharing program with local governments to construct flood control works; Pennsylvania allocated money to acquire flood-damaged properties; Maryland supported a cost-sharing program that stressed acquisition and relocation through a $7,500,000 bonding authority; and Wisconsin provided money to local units to upgrade floodplain mapping. Using money from Title II of the Water Resources Planning Act of 1965,[1] several states initiated pilot studies on various floodplain management options. Other innovations to supplement regulations are outlined below:

- Flood Warning Systems
  Pennsylvania has completed a pilot project to use flood insurance studies and maps for flood warning and evacuation.

  Minnesota used money from the Water Resources Planning Act of 1965 to assess the usefulness of various types of flood warning systems in different parts of the state.

- Training and Education
  Louisiana is preparing curriculum materials for university planning schools that stress floodplain management and hazard mitigation

  Illinois has developed manuals on state regulatory programs and the NFIP for local governments. It has also developed a homeowners' self-help manual to deal with flood problems. Plans are under way to develop an extension course on floodplain management for local officials who administer the program.

- Public Awareness
  Maryland has promoted the use of signs to identify the 100-year floodplain or historical high water marks. Anne Arundel and Montgomery Counties have installed such signs.

  Minnesota assisted the City of Crookston to place floodplain signs identifying 100-year flood elevations on street corners.

  Colorado has placed signs in Big Thompson Canyon saying, "In case of flash flood, climb to safety." Signs have also been placed in other high-risk canyons in the Front Range of the Rockies.

  California presented awards to five communities for wise use of floodplains.

- Hazard Mitigation Planning and Implementation
  After a 1979 flood disaster in Indiana, the state assisted two communities in demolishing and relocating severely damaged residences and businesses. The state also helped the communities secure HUD Block Grants to rehabilitate structures.

  Illinois assisted the City of Wilmington in preflood hazard mitigation planning. Several alternatives have been identified and discussed.

  Minnesota is supporting preflood hazard mitigation planning in cities threatened by the failure of emergency levees.

- Floodproofing
  Massachusetts has developed a state floodproofing program in response to the 1978 "northeaster" which destroyed many coastal residences.

  Several states, including Massachusetts, Minnesota, and Virginia, have incorporated floodproofing regulations into their state building codes.

- Acquisition and Relocation
  Pennsylvania provided flood disaster bond money to communities to aid them in acquiring flood damaged properties for open space use.

  Maryland's new bonding authority authorizes funds for flood damage mitigation measures that stress acquisition and relocation and planning for floodplain management on a watershed basis.

  Mississippi used HUD Section 407 funds to relocate 292 low-income family units; 84 units are being rehabilitated and floodproofed.

  Rhode Island has under way a feasibility study for acquisition and relocation of flood-prone properties in several areas.

  In cooperation with the Corps, Arizona is relocating a portion of Allenville and several other flood-prone communities.

  Wisconsin has assisted Soldiers Grove to get funding for relocating its entire business section to a flood-free site.

The Kansas State Floodplain Coordinator's office has been relocated to higher ground from its previous location in the floodplain.

Program Emphasis

Program emphasis varied during the 1970s, depending on state legislation, budgets, and needs. Well-conceived and specific legislation did not necessarily mean strong programs. For example, a highly specific Connecticut statute authorized the State Water Resources Commission to adopt encroachment lines for rivers and streams. Because of budgetary and political considerations, however, none were delineated during the 1971-1980 period. On the other hand, Massachusetts successfully encouraged the adoption of many local floodplain regulations as part of wetland protection programs, despite its lack of clear floodplain regulatory powers. Other programs with small budgets and weak legislation reviewed public projects and provided technical assistance to local governments.

During the first year of a new program, states usually adopt administrative regulations, establish map priorities, and develop procedural manuals for local governments. After a program is well established (*e.g.*, Iowa, Minnesota, New Jersey, and Wisconsin), emphasis shifts to implementation: evaluation of development proposals (permits submitted directly to the state or referred to the state by local governments), more specific mapping, review of local ordinances, and technical assistance to localities. States typically emphasize cooperation and coordination with other state and local programs such as coastal zone management, shoreland, wild and scenic river, and "critical area" programs.

Funding

State program performance varied from state to state, depending on staffing, funding, leadership, support from the governor, frequency of flood disasters, and other similar influences. Examples of staff and funding levels follow:

New Mexico	— 1 part-time person, $5,000 budget.
Texas	— 3 full-time people, $80,000 budget.
California	— 3 full-time people, 1 part-time person, $164,400 budget.
Rhode Island	— 3 part-time people, $14,000 budget.
Iowa	— 10 full-time, 16 part-time people, $400,000 budget.

Problems

Major impediments to the implementation of state programs are much the same for each state.

- Lack of staff—Some states do not have a single full-time staff person assigned to floodplain management. Others have one or two. Only a dozen have more than two, and only five states have more than 10.
- Lack of funds—Funds for salaries, travel, conducting workshops, mapping, computer analysis of permits, and dissemination of materials are often inadequate.
- Lack of expertise—Staff in most states lack expertise in one or more of the subjects important in floodplain management such as floodproofing, regulations, insurance, relocation, and natural areas evaluation. Even where engineering expertise is available, other biological, cartographic, or planning expertise is often lacking.
- Inadequate statutory authority—Many state regulatory statutes are inadequate in one or more respects. Some lack sufficiently broad powers (*e.g.*, statutes applied only to floodways) or are handicapped by exemptions. Enabling authority is totally lacking is some states, particularly in the South and parts of the West.
- Inadequate flood data—Lack of detailed flood maps has been a serious constraint on most programs but most seriously where statutes require detailed mapping prior to direct state regulation or state standard-setting for local regulation. Because of budgetary restraints, most states rely primarily on NFIP maps, even though the state staff considers map scales only partially satisfactory for regulatory purposes.
- Conflicts between state and federal policies—Although many federal programs have aided state floodplain regulations, in some instances federal programs have undercut state policies. NFIP policies are often less stringent than state policies in coastal erosion areas. Subsidized federal flood control assistance has encouraged *in situ* rebuilding after a disaster. In the past, federal grants-in-aid policies for sewers, roads, low-income housing, and other projects did not adequately account for flood hazards. As a result, public floodplain uses or public infrastructure were located in floodplain areas, attracting unprotected private uses.
- Fragmented statutory authority—In many states floodplain management authority is split among several agencies, creating conflicts and leadership questions. Fragmentation of local regulatory authority has also been a problem.
- Problems with existing uses—Existing structures in flood-prone areas are often a major impediment to effective regulations, as discussed in Chapter III.
- State-local political conflicts—Larger cities often oppose state intervention, contending that they have sufficient expertise and personnel to deal with flood problems.

- Lack of landowner awareness—Landowner ignorance of flooding is a serious problem in many communities, particularly along the Florida and Atlantic Coasts, which have not experienced a major hurricane for more than 20 years. Landowner awareness of flood problems is high after a flood, but often falls off sharply in a few months.

Variations in State Regulations

There are three principal state floodplain management approaches: state standard-setting for local floodplain regulation, direct state regulation of flood hazard areas, and state standard-setting and/or direct regulation of flood hazard areas as part of broader resource protection programs.

STATE STANDARD-SETTING FOR LOCAL REGULATION

Many states authorize state standard-setting for local regulation of flood hazard areas. Direct state regulation of uses is usually authorized only if local governments fail to adopt and administer regulations meeting minimum state standards. States using this approach are Arizona, Arkansas, California, Colorado, Michigan, Minnesota, Montana, Nebraska, New York, Vermont, and Wisconsin. Some states, such as California and Nebraska, have standards for or directly regulate only floodway areas.

Several variations on this approach are illustrated below. Wisconsin required communities to adopt regulations by a specified date (January 1, 1968). Minnesota, in a more common approach, requires that communities adopt regulations within a specified time after adequate flood maps become available. California illustrates a third approach, which involves state cost-sharing for flood control measures where communities adopt regulations meeting state standards.

Wisconsin. Wisconsin has under way one of the oldest and most comprehensive floodplain management programs in the nation. The program was established in 1966 by a statute requiring that all communities adopt floodplain zoning by January 1, 1968.[2] The statute was prompted by severe flood problems along the Mississippi River and many smaller rivers such as the Fox and Chippewa. The shores of Lake Michigan and Lake Superior have flooding and erosion problems. Of the approximately 559 flood-prone communities, more than 300 have now adopted zoning ordinances.

The 1966 statute authorized the state to adopt regulations in the event of local inaction. Beginning with two people, the state program staff has grown to 11 headquarters positions and 17 part-time positions in six district offices, with a total 1980 budget of $4 million.

During the 1966-1972 period, the program performed various tasks. First, communities with serious flooding were identified. Administrative regulations with minimum standards for local regulations were then developed. Several

model ordinances and procedural manuals linked to available flood data were developed. Workshops with county boards and local governments were held throughout the state. Assistance in carrying out mapping was sought from the Corps of Engineers, the U.S. Geological Survey, and the Soil Conservation Service.

The Wisconsin floodplain management statute was adopted in conjunction with a shoreland zoning statute that required counties to zone shorelands (defined to include floodplains) to achieve broad, multipurpose objectives such as pollution control and protection of recreation values.[3] Early training sessions, manuals, and other materials addressed shoreland as well as floodplain issues.

The floodplain program at first favored detailed floodplain and floodway mapping for the entire state—some 33,000 miles of rivers and streams—but cost and the prospect of changing watershed conditions discouraged such an ambitious effort. The program staff then recommended, and subsequently implemented, a revised approach relying on two types of maps: approximate flood maps for rural areas, and more detailed ones for urban areas. Approximate flood maps and the regulations linked to them were to be based on historic flood data and soil maps; more detailed maps were to be based on new engineering studies that defined flood profiles and, in some instances, floodways.

Wisconsin has promoted implementation of the NFIP although it has had difficulties with it (as have many other states) since the state standards on freeboard, floodway delineation, and other matters exceed the NFIP's. The Wisconsin program has come to rely on a "natural" floodway concept that allows no appreciable increases in flood heights. However, the NFIP definition of a floodway allows a one-foot rise in flood heights. Moreover, map scales of the NFIP were often too small for effective community or state use. Consequently, the state legislature adopted a cost-sharing program to assist local governments in developing more detailed topographic maps.

The program staff has focused efforts on technical assistance and training and education for rural areas and small communities that lack personnel and expertise. It has assisted communities such as Prairie du Chien and Soldiers Grove in supplementing regulations with acquisition and relocation. The Southeastern Wisconsin Regional Planning Commission has played the principal role in technical assistance and mapping for urban Wisconsin in the seven southeastern counties near Milwaukee.

Community regulations resemble state models in most areas. However, a significant number of communities exclude all development from wetland and floodplain areas. Southeastern Wisconsin communities have adopted "environmental corridors" to protect not only floodplains but also wetlands, slopes, and bluffs within river corridors.

Problems with the Wisconsin program are insufficient staff and funds, inadequate flood data, and ambiguous enabling authority.

Minnesota. Flooding in the 87 Minnesota counties has been severe along the Mississippi River, the Red River of the North, the St. Croix, and many tributary streams. Floods in 1965 and 1969 caused $160 million in damages.

Lakeshore flooding caused by short- and long-term water level fluctuations was also a problem along many lakes in western and northern Minnesota. Approximately 645 Minnesota communities are flood-prone.

To reduce future flood losses, the Minnesota legislature adopted in 1969 a state floodplain management program in conjunction with a shore land zoning program much like Wisconsin's.[4] This program now operates with an annual budget of $200,000, two full-time headquarters staff people, and a part-time field staff of 25. At the local level, 210 communities have adopted ordinances; another 100 communities are under study and will be adopting ordinances in the near future.

The Minnesota statute, like Wisconsin's, authorizes the state Department of Natural Resources to establish standards for local regulation of floodplain areas. Most communities were required to adopt regulations within six months of receiving technical flood data and maps from the state. State regulation was to take place only in the event of local inaction. Basing the deadline on the availability of maps added another step to regulation and reinforced the need for mapping. Nebraska and Montana statutes have similar deadlines.

In 1973, Minnesota amended its floodplain management statute to require flood-prone communities identified by the Department of Natural Resources to qualify for the NFIP by adopting regulations.[5] The intent of the statute was multipurpose: to afford floodplain occupants the opportunity to purchase flood insurance, to accelerate floodplain mapping, and to require some form of local floodplain regulation.

The history of Minnesota's program is similar to Wisconsin's. It began with drafting of administrative regulations, model ordinances, and manuals. Workshops were held throughout the state. Standards for local regulations were adopted in 1970 and a state floodproofing code was adopted as part of the state building codes in 1975. The state also continued its active training, education, and technical assistance programs. It is presently assisting local governments to supplement regulations with land acquisition, relocation, and flood warning signs.

Problems with the Minnesota program include conflicts between state and less restrictive federal standards and insufficient personnel and funds.

California. California has had a wide variety of flooding, mudslide, and erosion problems. Although much of the coast consists of bluffs and is subject primarily to erosion hazards, flooding from tsunamis and coastal storms is severe in Humboldt Bay and some other areas. Inland flooding occurs along the Sacramento and other major rivers. Flooding from rainfall and snowmelt in the mountains along dry channels is a serious problem in southern California. Approximately 435 communities are subject to significant flooding.

To address these problems, the California legislature adopted a variety of programs to establish standards for state or local regulation of flood hazard areas.[6] A floodplain management law (the Colby-Alquist Act) was adopted in 1965. This statute authorized the Department of Natural Resources to map floodway areas and to establish minimum standards for local regulations. The

state will share the cost of land acquisition for flood control if local governments adopt and administer satisfactory regulations. The 1980 funding for the program was $164,600, with three full-time and one half-time staff members for each of the four district offices.

During its early phases, the program emphasized mapping. Later, emphasis shifted to training and education, permit evaluation, and technical assistance. Approximately 200 communities have adopted regulations on their own initiative to comply with state law or to qualify for the NFIP. Through onsite visits, the staff monitors community compliance with regulatory standards.

Other programs also address flooding problems. The State Department of Real Estate and affected local governments must approve residential land subdivision.[7] Subdividers must investigate flood potential: development of unsafe sites is prohibited.

The 1972 state wild and scenic river program also reduces development in some flood-prone areas.[8] This program requires that counties with designated rivers develop management plans for the watershed areas in cooperation with the state.

Coastal communities are required to adopt hazard regulations by still another statute—the Coastal Zone Management Act of 1972.[9] The Coastal Commission issues the guidelines for local regulations. Pursuant to this program, communities such as Santa Barbara have adopted building setbacks for bluff areas.

Problems in the California program are fragmentation of authority, severe development pressures, lack of detailed flood maps, and insufficient personnel and funding.

DIRECT STATE REGULATION

Ten states have directly regulated flood hazard areas. Washington regulates selected floodways, Michigan and Montana regulate floodplains and floodways throughout the state, Illinois regulates selected floodways and floodplains, Indiana, Kentucky and New Jersey regulate floodways, Maryland and Rhode Island regulate floodways and inland floodplains, and Florida, Maine, and Vermont regulate large-scale development in floodplains and floodways. The last three states also authorize optional local regulations.

Three types of direct state regulation are discussed below: direct state regulation of floodway areas with optional local regulation of other areas (Washington State), direct state regulation of floodways with mandatory local regulation of flood fringe areas (New Jersey), and direct state regulation of both floodway and flood fringe areas (Maryland).

Washington. Washington is subject to severe flooding along the Columbia, Cowlitz, and other rivers. In addition, its coast is periodically flooded by storms and tsunamis. Approximately 270 communities have flood problems; of these, 85 have adopted floodplain zoning ordinances.

Washington adopted one of the first state floodway regulatory programs in 1935, when the legislature adopted a channel encroachment law in response

to severe flooding. In 1936, the state adopted a broader Flood Control Zone Act that authorized the Department of Water Resources to identify and regulate flood hazard zones.[10] Between 1936 and 1970, the state identified hazard zones in 93 communities along 18 streams: state permits are required for development in these zones. No new hazard zones have been identified since 1970.

The Washington legislature also authorized local zoning of floodplain areas and authorized the Department of Water Resources to delegate permit powers for state-identified zones to communities. To date, only four localities have permit powers—King, Clark, and Cowlitz Counties, and the City of Kelso.

The state program is staffed by five professionals and has funding of $100,000 annually. Its principal duties are to process permits for proposals in state flood control zones, monitor development proposals, assist FEMA in mapping floodplains, and provide technical assistance to communities.

As in Wisconsin and Minnesota, the 1971 Washington legislature also authorized cooperative state/local shoreland zoning.[11] Shorelands were defined to include all areas within 2,000 feet of coastal or estuarine waters, 200 feet of lakes, and 200 feet of streams. Floodplains were also included. All local governments were required to adopt "master programs" for these areas. State standards require that protection against flooding be included as one element of the programs. Particularly strong emphasis has been placed on flood and erosion along the 2,400 miles of coast in 15 counties. The state has prepared a coastal atlas showing the 100-year frequency tide level, wave action and erosion areas, and geologically unstable zones.

Problems with the program include its small staff, insufficient funds, and inadequate flood data.

New Jersey. New Jersey is subject to severe inland and coastal flood problems. A 1954 hurricane caused extensive loss of life and property damage along 127 miles of beach. Winter storms such as the severe Ash Wednesday storm of 1962 are also a source of damage. Approximately 550 communities are flood-prone.

In 1929, New Jersey became one of the first states to regulate channel encroachments. In 1962, the legislature broadened floodplain management to include the delineation and marking of flood hazard areas. In 1972, the legislature adopted a comprehensive regulatory statute authorizing the State Water Resources Board to map floodplain areas, directly regulate floodways, and establish standards for local regulation of flood fringe areas.[12] The Board is authorized to regulate flood fringe areas directly if local governments fail to regulate these areas according to minimum state standards within 12 months of receiving the state maps. The statute also requires local tax assessors to reduce property taxes in state-delineated floodplain areas.

A staff of 10 people is implementing the program. Mapping is a principal activity. Working as a contractor to FEMA, the state has prepared maps at a scale of 1"=200' with five-foot contour intervals. Over 1,000 miles of stream have been mapped with floodways reflecting no greater than a 0.2-foot rise in surface water elevation. Monitoring is also emphasized. The staff plans to

visit all of its flood-prone communities in 1981. Other program activities include permit processing, development of model ordinances, and training and education.

Floodplain regulations are supplemented by nonregulatory measures. A 1978 Emergency Flood Control Bond Act established a three-year program providing the New Jersey Department of Environmental Protection with $22 million in matching funds to assist local governments to construct flood control works on a 50-50 basis and $3 million to prepare a statewide flood control master plan and assist with development of regional flood control plans.[13]

New Jersey has not adopted floodplain regulations for coastal areas; however, the 1970 legislature adopted a coastal wetland protection act that requires permits from a regulatory agency for fill or dredging.[14] Very little development is permitted in wetlands. In addition, the legislature adopted the Coastal Area Facility Review Act of 1973 that authorizes the division of coastal resources to regulate residential development of more than 25 units and major public and industrial facilities.[15] A 1980 coastal zone management plan emphasizes flood hazard reduction.

Maryland. Maryland has storm surge and wave problems along its 5,000 miles of coast and the Chesapeake Bay, inland flooding along major rivers, and flash flooding along mountain streams in the west. Approximately 115 communities are flood-prone; 51 of these have adopted floodplain regulations in compliance with the regular phase of the NFIP.

In 1967, the state first adopted regulations for the 50-year floodplain as part of its state water pollution control program. Expanded legislation in 1976 required state permits for development within the 100-year inland floodplain.[16] The State Water Resources Administration was also directed to map and mark floodplains. Communities were authorized to regulate floodplain areas and to adopt comprehensive floodplain management plans.[17]

Pursuant to this statute, the state has established a very active implementation program with a staff of 35 in the floodplain management and watershed permit divisions and a yearly budget of $550,000. Principal activities include evaluation of 800 floodplain permits each year, mapping, technical assistance, coordination of state, federal, and local programs, and monitoring of floodplain activities. The state has prepared maps at a scale of 1″=600′ with tax maps as a base. Rather than using the NFIP encroachment standard, Maryland has developed a "tractive force" floodway which has taken into consideration the velocity and erosive force of water.

Because direct state regulations apply to all inland areas, the NFIP has permitted Maryland communities with nontidal streams and floodplains to enforce state floodplain regulations through adoption by reference. Both state and local approval is required for permits. Many communities such as Baltimore, Howard County, and Prince Georges County have adopted regulations exceeding NFIP standards, including prohibition of development within the 100-year floodplain and stormwater management regulations.

The state is also assisting communities with nonregulatory measures such as floodproofing and comprehensive stormwater management. It has begun comprehensive watershed management plans. The legislature adopted a $7.5 million bond issue in 1980 to assist communities in implementing flood hazard mitigation projects. Communities are to emphasize acquisition and relocation. In 1981, the legislature approved use of those funds for watershed and hazard reduction planning.

State floodplain regulations do not apply to coastal areas, but Maryland has adopted a statute that requires permits for filling and construction in coastal wetlands from its Water Resources Administration.[18] Flooding is one consideration used in evaluating permits. In addition, the Maryland Tidewater Administration provides grants-in-aid and technical assistance on flood hazard mitigation to coastal communities.

Problems with the program are lack of regulatory powers for coastal areas, lack of maps for some areas, and insufficient personnel for monitoring.

FLOOD HAZARD REGULATION AS PART OF BROADER RESOURCE MANAGEMENT

Many states either directly regulate selected floodplain areas or establish standards for local regulation pursuant to planning or resource protection statutes. California, Oregon, and Nevada mandate local planning and regulation with natural hazards protection as one component. Many coastal and some inland states directly regulate or establish standards for local regulation of wetland areas. Other states include floodplain management as part of coastal zone management programs.

Three ways in which flood hazards are regulated through broader resource management programs are illustrated below: regulation of inland and coastal flood hazard areas through a combination of wetland and coastal zone management (Massachusetts), regulation of inland floodplains through a combination of state encroachment lines and wetland regulations defined by soil type (Connecticut), and regulation of coastal flood hazard areas through a coastal zone management statute (North Carolina).

Massachusetts. Much of the 1,200 miles of Massachusetts coast is subject to severe hurricane and "northeaster" flood problems. Flooding is also a problem along rivers in the central portions of the state and in the central and western mountains. A coastal storm in February of 1978 killed 29 and destroyed or damaged 11,000 structures.

Massachusetts has not adopted a comprehensive floodplain management statute, but does have a number of specific statutes that provide considerable state and local control over both inland and coastal floodplains. In 1961, the legislature authorized state encroachment lines for the Assabet River, but not for other rivers. It also authorized a state permit system for coastal wetlands in 1963,[19] the first such system in the country. From 1965 to 1980, the state made considerable progress in adopting coastal wetland protection orders pur-

suant to this and later statutes. The orders apply to many of the most seriously flooded coastal areas. Restrictions are recorded on deeds, and permits for structures and fill within these areas must consider flooding.

In 1973, the legislature authorized local conservation commissions to regulate coastal and inland wetlands.[20] The real strength of the Massachusetts program for inland areas lies in this statute. In a 1975 amendment, wetlands were defined to include the 100-year floodplain.[21] Local regulation of wetlands is supervised by conservation commissions in each Massachusetts town. These appointed commissions are often highly conscientious and function with much greater expertise in evaluating wetlands permits than do traditional zoning boards. Denial or issuance of local permits may be appealed to a state appeal board.

In evaluating permits, local commissions consider how a proposed use will affect flooding. In general, local commissions deny permits in wetland or floodplain areas. In addition to wetland regulations, many flood-prone Massachusetts communities have adopted floodplain regulations with standards equaling or exceeding those of the NFIP.

The Massachusetts Coastal Zone Program has also addressed flood and erosion hazards. All coastal wetlands and barrier islands have been mapped. Through this program, the state provides community assistance grants (totaling $241,000 in fiscal 1981) to coastal communities. Technical assistance is also provided.

Other state hazard reduction initiatives resulted from the severe winter storm of 1978. After this storm, a disaster task force was formed to guide recovery efforts. Floodproofing standards accounting for wave heights were incorporated into the state building code. The state adopted a bond issue to provide funds to local governments for acquisition of floodplain lands. In August 1980, the governor issued an executive order declaring a general state protection policy for coastal beaches and prohibiting the use of state funds for development in beach areas.[22]

The fragmentation of regulatory powers has complicated floodplain management in Massachusetts; nevertheless, the resulting "package" of programs appears to be quite effective. Other problems are inadequate maps, lack of expertise, and strong development pressures. The NFIP is also viewed as a mixed blessing because FEMA standards are less restrictive than those of most communities and because subsidized insurance creates pressures for development.

Connecticut. Hurricanes caused severe loss of life and property damage along the Connecticut coast during 1938 and 1954. There is inland flooding along the Connecticut and other major rivers. Approximately 170 communities are subject to flooding.

Connecticut was one of the first states to implement a floodway encroachment statute when the legislature in 1955 authorized the Water Resources Commission to identify and require permits for development in floodway areas.[23] The state has identified approximately 300 miles of floodway.

Although some measure of direct control over floodplains continues under this statute, staffing (two person-years) and budget ($35,000) are small. The most extensive state program for inland floodplains is the Wetland Regulation Program, authorized by the state legislature in 1972. Wetlands are defined by statute to include alluvial, poorly drained, and very poorly drained soils. Between 20%-25% of the state, including much of the floodplain, is encompassed by this broad definition. Wetlands throughout the state have been mapped with the help of the Soil Conservation Service.

The 1972 Inland Wetland Law requires that local governments regulate inland areas according to state standards.[24] The Department of Environmental Protection is authorized to regulate directly wetland areas in the event of local inaction. To date, 116 communities have complied with state standards. The Department directly regulates wetlands in the remaining 53 towns. Under this statute, development or filling is strongly discouraged. Many towns also adopted separate floodplain regulations in order to qualify for the NFIP. Combined wetland and floodplain standards are usually more restrictive than those required by the NFIP.

The state also directly regulates coastal wetlands under a coastal wetland statute adopted by the legislature in 1971. Flooding threats are considered in permit evaluation.[25]

To facilitate wetland, floodplain, and other land management efforts, the state has established a centralized natural resource data gathering and mapping program. This program coordinates topographic, floodplain, wetland, and other mapping elements and supplies maps and interpretive materials to localities. Detailed air photos, soils maps, and topographic maps (7.5-minute quadrangles) are now available for the entire state. Separate pamphlets listing data sources have been compiled for each community.

Problems with the Connecticut program are fragmented enabling authority, lack of direct state floodplain regulatory powers for coastal areas, and inadequate staffing and funding.

North Carolina. Hurricane and storm flooding and associated erosion along the "outer banks" and behind barrier islands affect the entire North Carolina coast. Flooding occurs along rivers in the coastal plain, and flash floods and other high velocity floods are a problem in the western mountains. Approximately 410 communities are subject to flooding.

In 1971, the legislature adopted a statute authorizing and directing local governments to regulate the 100-year floodplain.[26] The Board of Water and Air Resources was authorized to map floodplain areas and assist local governments in mapping. However, the Board was not granted regulatory powers.

Although the state inland floodplain management program has no regulatory powers, it has assisted communities and FEMA in developing flood insurance study maps and encouraged communities to enroll in the NFIP. A nine-person field staff provides technical assistance.

More floodplain management has been implemented along the coast. In 1968, the legislature adopted a dune protection statute that required counties to adopt

regulations to control vegetation removal in dune areas.[27] All six coastal counties have adopted dune protection ordinances. In 1969, the legislature adopted a state-administered coastal wetland protection act regulating dredging or filling activities in coastal areas.[28]

In 1973, the legislature adopted a comprehensive coastal zone management act that required local governments to identify coastal areas of environmental concern and to adopt regulatory standards consistent with state criteria.[29] Areas of environmental concern are defined to include (but are not limited to) sand dunes, beaches, floodplains, and erosion areas. The program formulated coastal hazard mitigation standards that required not only elevation to the 100-year flood protection level plus freeboard, but also erosion setbacks and protection for dune systems.[30] Flood and erosion maps are being prepared for the entire coast, as is an erosion control manual.

Problems in North Carolina's program are inadequate enabling authority, the lack of detailed flood and erosion data, federal standards that fail to account for erosion, inadequate monitoring and extensive existing development. The state, like most others, needs strengthened implementation. To accomplish this continued federal mapping is desirable if not essential.

Footnotes

1. Title III of the Water Resources Planning Act of 1965, P.L. 89-80, (codified at 42 U.S.C.A. §1962d-1 (West 1981)).
2. Wis. Stat. Ann. §87.30 (West 1975).
3. Wis. Stat. Ann. §§59.97(1), 144.26 (West 1975).
4. Minn. Stat. Ann. §§104.01 to 104.07 (West 1978).
5. Minn. Stat. Ann. §104.08 (West 1978).
6. Cal. Water Code §8400 to 8415 (West 1971).
7. Cal. Bus. & Prof. Code §11000 *et seq.* (West 1964). See particularly §§11018.4 and 11025.
8. Cal. Pub. Res. Code §§5093.50 *et seq.* (West Supp. 1982).
9. Cal. Pub. Res. Code §§30300 *et seq.* (West 1977).
10. Wash. Rev. Code Ann. §86.16.010 *et seq.* (1981).
11. Wash. Rev. Code Ann. §§90.58.010 *et seq.* (1981).
12. N.J. Stat. Ann. §§58:16A-50 *et seq.* (1982).
13. N.J. Stat. Ann. §58:16A-55.4 (1982). See also 1978 N.J. Laws ch. 78, "Emergency Flood Control Bond Act".
14. N.J. Stat. Ann. §§13:9A-1 *et seq.* (1979).
15. N.J. Stat. Ann. §§13.19-4 *et seq.* (1979).
16. Md. Nat. Res. Code Ann. §8-9A-01 *et seq.* (Supp. 1981).
17. *Id.*
18. Md. Nat. Res. Code Ann. §9-102 *et seq.* (1974).
19. Mass. Ann. Laws ch. 130, §105 (Michie/Law Co-op 1981).
20. Mass. Ann. Laws ch. 131, §(Michie/Law Co-op 1981).
21. Mass. Ann. Laws ch. 131 §40 (Michie Law Co-op 1981).
22. Commonwealth of Massachusetts Executive Order No. 181, August 13, 1980.
23. Conn. Gen. Stat. §§25-4a *et seq.* (1981).
24. Conn. Gen. Stat. §§22a-36 *et seq.* (1981).
25. Conn. Gen. Stat. §§22a-28 *et seq.* (1981).
26. N.C. Gen. Stat. §§143-215.51 *et seq.* (1978).

27. N.C. Gen. Stat. §§1048-3 (repealed 1979 N.C. Sess. Laws ch. 141, §1.
28. N.C. Gen. Stat. §§113-229 *et seq.* (1978).
29. N.C. Gen. Stat. §§113A-100 *et seq.* (1978).
30. N.C. Gen. Stat. §§113A-113 (1978).

CHAPTER VI

LOCAL PROGRAMS

Status of Programs

As noted in Chapter I, the 1970s witnessed much growth in local floodplain management and increasing sophistication in the application of regulations in combination with other hazard reduction techniques. More than 17,000 cities, towns, villages, and counties have adopted or shown an intent to adopt regulations to qualify for the NFIP or to satisfy state floodplain management requirements.

Local regulation of floodplain areas is largely a phenomenon of the 1970s, although some cities, such as Milwaukee, adopted regulations in the 1940s and 1950s. A 1957 national assessment of floodplain regulations by Francis C. Murphy at the University of Chicago identified only 35 local governments with regulations.[1] He considered most of these programs ineffective.

By 1970, several hundred communities had adopted regulations. A University of Wisconsin survey of local regulations in 1968-1969 identified 183 municipalities and 71 counties with floodplain zoning, and 167 municipalities and 27 counties with flood-related subdivision regulations.[2] These communities were centered in two areas of the nation: the Tennessee Valley, where TVA had provided flood hazard maps and technical assistance since 1953; and the midwestern states of Iowa, Wisconsin, and Minnesota. In the late 1960s, the latter two states had adopted state floodplain statutes mandating local regulations.

Rapid local adoption of floodplain regulations since 1970 is attributable primarily to the incentives of the NFIP, although other various forces have also been important: serious and widely publicized floods such as those resulting from Hurricane Agnes, widespread availability of flood maps, the development of model ordinances and floodplain regulation guidebooks, technical assistance from state and federal agencies, state statutes authorizing and often requiring floodplain regulations, concern with floodplain environmental values, and increased community land use planning and control capability. In general, local governments have adopted the minimum standards of the NFIP except where state standards are more restrictive. Descriptions of some of the most

innovative local programs are provided in Appendix III. Examples of local ordinances can be found in Appendix IV.

Differences in Rural, Urban, and Metropolitan Areas

RURAL AREAS

Many rural communities and counties have adopted a resolution requiring floodplain development permits from a planning commission or board of adjustment. Others have adopted a single district floodplain zoning ordinance of the sort proposed in Volumes 1 and 2, **Regulation of Flood Hazard Areas**. Approximate flood maps developed by the USGS, historic flood maps, and soils maps provide the basis for regulation.

Rural communities are often handicapped in regulation by lack of detailed maps, personnel, funds, and expertise. State technical assistance has been particularly important for rural areas since state programs often provide model ordinances and manuals, training, and case-by-case review of permits. Regional planning agencies have also provided important technical assistance.

Highly restrictive rural regulations are most common in riverine areas of the Northeast, Midwest, and the mid-Atlantic states. In these areas, permanent dwellings are sometimes prohibited in the entire floodplain. Single-district zoning regulations are often combined with subdivision controls and sanitary regulations. Some subdivision regulations are combined with sanitary code provisions that prohibit septic tanks in hazard areas in order to control some development without zoning.

Often "resource protection" regulations are adopted for all or portions of rural floodplains. As discussed in Chapter V, inland wetland protection regulations have been widely adopted in Connecticut, Massachusetts, New York, and Rhode Island. State or local coastal wetland protection regulations have been applied in all coastal states. Shoreland regulations have been adopted in Maine, Michigan, Minnesota, New Hampshire, Wisconsin, and Washington State. Agricultural zoning has been adopted for some floodplain areas in California, Oregon, and Massachusetts. Wild and scenic river zoning with floodplain components has been applied to selected rivers in Maryland, Michigan, Minnesota, New York, Oregon, and Wisconsin. Some Colorado communities have adopted zoning to protect sand and gravel resources in floodplain areas.

URBAN AREAS

Many small and medium-sized cities have two-district floodplain zoning (floodway or coastal high hazard area and a flood fringe), subdivision control, and building code regulations. Two-district zoning is often applied to developed urban areas. Single-district zoning is common for smaller streams

or those without detailed flood studies. Two-district regulations usually resemble the models set forth in Volume 1, **Regulation of Flood Hazard Areas**.[3] Subdivision regulations often contain drainage requirements. Building codes establishing minimum protection elevations without zoning are common in coastal areas. Urban areas usually adopt floodplain regulations as part of broader zoning and land use controls.

Expertise and staffing are problems for smaller cities, but less so than for rural areas. Detailed flood maps are available for some but not all urban areas. State assistance in mapping and project review has been somewhat less important for urban areas than for rural ones.

METROPOLITAN AREAS

Large cities and metropolitan areas have adopted the most sophisticated floodplain management programs and regulations. Two-district floodplain zoning is common; however, some large cities such as Baltimore and Milwaukee exclude new development from the floodplain. Subdivision regulations with flood hazard and storm drainage provisions are found in many cities. Building codes may incorporate flood hazard provisions.

These areas have often developed more detailed flood maps with scales of 1″=100′ to 1″=400′ with 2-foot to 4-foot contour intervals. Mapping on a watershed basis is common: future watershed conditions are often considered. Sewer maps, topographic maps, and other large-scale maps may be used as bases.

Large cities and metropolitan areas often have engineering and planning staffs with some expertise in floodplain management. Regulations are sometimes combined with acquisition, flood control works, and urban renewal policies. Integrated floodplain and stormwater management regulations may be provided for smaller streams.

Program Characteristics

The most extensive survey of local floodplain regulation during the 1970s was conducted by the Center for Urban and Regional Studies at the University of North Carolina. In April of 1979, with funding from the National Science Foundation,[4] the Center sent questionnaires to 1,515 local governments and 648 regional agencies. The results of the survey are summarized below.

LOCAL GOVERNMENT RESPONSES

The 1,515 surveyed communities included 926 communities in the regular program of the NFIP and 489 in the emergency program. Community response to the questionnaire was an excellent 85%.

Regulatory objectives. As one might expect, most communities in both the regular phase and emergency phase adopted regulations to reduce property

loss from flooding (73% and 53%, respectively) and to prevent threats to safety (69% and 50%). Reduction in erosion and sedimentation was also a major objective (43% and 36%), as was preservation of natural areas (41% and 35%).

Techniques. The regulatory techniques used for both phases were similar, but with different emphases. Both groups relied heavily on elevation requirements (84% and 63%) as part of permit systems, zoning, or other regulations. However, as one might expect, regular program communities, because they have more detailed flood maps, made greater use of elevation requirements. Subdivision regulations, which shift much of the data-gathering burden to developers and thus can be used with approximate flood data, were used with about the same frequency (76% and 75%). Both groups used zoning regulations (77% and 71%), which is somewhat surprising since other information suggests that zoning is more common in regular program communities. Floodproofing requirements were used more frequently in regular program communities (68% to 40%) because more detailed flood data and the personnel needed to evaluate development proposals are available there. As expected, floodway regulations were more common for regular program communities (60% to 35%), since floodway maps are usually available only for them.

Most communities devoted limited resources to program implementation. Fifty percent spent less than $1,000 a year on implementation (44% and 58%), and an additional one-quarter spent less than $5,000 (27% and 22%). Fifty percent spent less than one hour of staff time each week on regulations (44% and 62%) and another one-third spent less than seven hours per week (41% and 29%).

Several circumstances contributed to the development of comprehensive programs: severe flood hazard, higher perception of flood hazard, and community concern for the problems. Community land use control experience and financial resources were also important.

Program effectiveness. After analysis of the number of permits issued in regular and emergency phase flood insurance program communities, the researchers concluded that local floodplain management programs were not halting continued development of floodplains. This was to be expected since most communities followed minimum NFIP and state standards which permit flood-protected structures in outer fringe areas. However, flood protection through elevation on pilings or fill was routinely required.

Local officials rated their floodplain management programs very effective in dealing with new development (62% and 49%). However, only 15% and 14%, respectively, rated their programs as effective in dealing with existing development.

Floodplain regulations were considered very effective in protecting natural areas for about one-fourth of the communities (30% and 23%) and moderately effective in an additional one-half (51% and 53%). This low response rate could be expected since most regulations permit development within outer fringe

areas and, in some instances, in floodways, providing flood flows are not substantially increased.

Negative effects of regulations were reported in some communities. Increased construction costs were cited in fewer than one-half of the communities (50% and 36%). Reduced land values were cited in fewer than one-quarter (22% and 15%). Slowed economic growth affected fewer than one-sixth (16% and 13%) and reduced tax base about one-tenth (13% and 9%). On the other hand, some communities (10% and 5%) cited increased value of existing structures outside of the floodplain.

Problems. Communities cited several major obstacles to effective management: the general populace did not perceive floods as a problem (35% and 46%), land development interests opposed regulations (36% and 31%), sufficient state or federal financial support was lacking (32% and 35%), floodplain occupants opposed efforts (27% and 20%), qualified personnel were lacking (19% and 24%), and public officials were insufficiently interested (17% and 23%).

REGIONAL COUNCIL RESPONSES

The North Carolina group also sent a questionnaire to all 648 members of the National Association of Regional Councils. Ninety percent responded.

The floodplain management objectives reported by the regional councils were similar to those reported by local communities; however, 47% also reported maintenance of good water quality as a goal—reflecting the influence of the Environmental Protection Agency Section 208 Areawide Water Quality Management Program. Many councils were concerned with inadequate storm drainage (58%) and increased runoff from impervious surfaces (48%). This also could be expected, since regional planning agencies often deal with regional hydrology and drainage problems.

The majority of the regional councils used five floodplain management methods: (1) providing technical assistance to local governments (82%), (2) incorporating flood hazard reduction measures in regional planning (75%), (3) using the A-95 review process to discourage public investment in floodplains (61%), (4) making the public aware of flood hazards (16%), and (5) coordinating local programs (44%). A principal technical assistance and educational role could be expected since regional planning agencies usually lack regulatory and implementation powers.

Although the agencies were interested in floodplain management, most (84%) spent less than one-half person-day per week on the subject. When asked to evaluate the overall effectiveness of programs within their jurisdiction, only 7% rated programs as very effective.

Regional councils identified five major obstacles to expanded regional action in floodplain management: lack of financial support (81%), lack of public support (72%), member agency resistance to areawide policies (61%), lack of interest by policy board (59%), and failure of the public to perceive flooding as a regional problem (57%).

Both local governments and regional councils gave high marks to state floodplain management. Seventy-eight percent of local respondents said that their states were active in floodplain management. Of this 78%, 80% rated the state programs as moderately or very effective. State agencies had provided technical assistance to 40% of the surveyed communities.

Sixty-one percent of the regional agencies reported that the NFIP was having the most significant impact of any federal program on protecting lives and property from flood losses. An overwhelming majority of local governments also reported that they had received technical assistance from the NFIP. However, 37% reported that they needed better maps, and 23% said they needed more help in calculating elevations for new development.[5]

Problems

The North Carolina study and the present study identified major problems in implementing local programs. Many have already been discussed.

- Lack of personnel and funds (particularly in small communities).
- Lack of expertise in floodplain management techniques and the use of flood data.
- Lack of familiarity with or understanding of NFIP requirements for basements, floodproofing, and base flood elevations.
- Inadequate maps (no copies, not completed, inadequate scale, no floodways, inaccuracies, lack of adequate topographic base).
- Existing nonconforming uses.
- Exemptions in regulations.
- Problems with mobile homes.
- Inadequate procedures for monitoring development.
- Special flood problems such as erosion, alluvial fan flooding, and lake flooding, that are not addressed by NFIP standards.
- Federal, state, and local public projects (*e.g.*, low-income housing) in the floodplain.
- Conflicts between federal and state standards.
- Development pressures and lack of flood-free construction sites.
- Court cases or threats of litigation.
- Inadequate enabling authority.
- Communities' boundaries too small to deal with the source of flood problems (*e.g.*, uncontrolled development in headwater areas in other political jurisdictions).

- Federal subsidies for flood control works.
- Federal flood insurance subsidies encouraging development in barrier islands, beach areas, wetlands, and other floodplain areas.
- Lack of landowner and community awareness of the severity of flood problems.

Innovative Programs

TYPES OF INNOVATION

Some communities have adopted innovative regulations to cope with the above problems, or to deal with other needs such as allocating lands throughout communities to their most cost-effective uses.[6] California, Connecticut, Massachusetts, New Jersey, New York, and Wisconsin have many innovative local programs. These programs often serve as examples for new programs in other communities. Innovations are of several major types, many of which have been described in preceding chapters:

- Building moratoria adopted after a disaster.
- Coastal regulations incorporating wave heights or freeboard, particularly strict dune and beach and vegetative protection standards, and wetlands protection provisions.
- Inland regulations exceeding NFIP and state standards, including zero-rise floodways, regulations to a lower frequency of flooding (*e.g.*, the 500-year level), freeboard requirements, and storm drainage requirements.
- Regulations that reduce flood losses but also serve broader objectives such as protection of prime agricultural lands, mineral deposits, forestry areas, and wetlands.
- Regulations combined with flood warning systems, acquisition, relocation, flood control works, and flood warning signs to reduce losses to future and existing uses and, in some instances, to serve broader objectives.

FACTORS ENCOURAGING INNOVATION

Innovations were most common when one or more of the following factors were present.

Most innovative programs were located in inland communities with recurrent and serious flood problems (*e.g.*, Warwick, Rhode Island; Klamath, California). Innovation was less common in coastal communities with severe flooding, perhaps because of offsetting development pressures. Although severe flooding was the principal motivation for innovation, environmental problems also fostered some programs.

Because of a serious flood threat and a high level of community awareness, innovative communities often adopted regulations before the NFIP came into

existence or a state floodplain program was initiated. Regulations were often adopted within two weeks to six months of a particularly serious flood. In several instances, such as Lilydale, Minnesota, regulations were quickly adopted in anticipation of a severe flood so that the community could qualify for the NFIP.

Recent innovative programs were often encouraged by federal and state maps, technical assistance, grants in aid, flood control works, flood insurance, and other assistance. However, many innovations were initiated before federal or state assistance was available.

Strong local leadership was evident in the most innovative programs. A local planner, architect, engineer, the mayor, or a city council member often provided key leadership, although interested citizens and elected officials were important in some programs. The extreme nature of the flood problems created a political climate conducive to such leadership.

Multipurpose planning and creative thinking were evident in most programs. "Larger thinking" that goes beyond dealing with the flood threat characterized most innovative programs. Urban renewal, recreation, wildlife protection, and open space protection were common additional concerns.

Examples of Community Approaches

Broad thinking and community acceptance of responsibility for the future economic, social, and environmental well-being of its residents underpin many of the innovations profiled below.

RESOURCE-BASED REGULATIONS FOR A RURAL FLOODPLAIN (GLASTONBURY, CONNECTICUT)

Glastonbury, a rural New England town of 25,000, has been repeatedly and severely flooded by the Connecticut River, which flows through the town for 7.5 miles. About 1,900 acres, much of them in agriculture and open space, lie within the 500-year floodplain.

Prompted by a general awareness of flood problems and environmental concerns, in 1963 the town adopted restrictive, resource-based regulations to reduce future flood losses and protect valued resources. A floodplain zoning ordinance controlled land use and prohibited almost all permanent structures and fill in the 500-year floodplain. The town adopted a density transfer scheme, which permits the shifting of development rights from one part of a parcel to another with a shift of one unit per acre. The state also regulated some of the floodplain pursuant to a state floodway encroachment statute.

In 1974, local floodplain regulations were supplemented by wetland regulations which apply to most floodplain areas. Wetlands were mapped at a scale of 1"=100'. Fill and structures were prohibited in wetland areas. Restrictive agricultural zoning was also adopted for some areas.

Glastonbury, Connecticut, excludes structures from the 500-year floodplain along the Connecticut River which is zoned for wetland, agriculture and open-space use.
Photo by Jon Kusler.

The city supplemented floodplain regulations by acquiring some areas and providing tax incentives for open space uses. A group of private citizens formed the Glastonbury Trust to acquire floodplains and wetlands.

Keys to the success of this program include motivated and aware citizens, sound flood and wetland data, responsive government officials and staff, and a creative combination of regulations and nonregulatory techniques.

REGULATIONS COMBINED WITH ACQUISITION (SACRAMENTO COUNTY, CALIFORNIA)

Sacramento County is an urbanizing area that includes the City of Sacramento and its 800,000 residents. Floods along the American River, the Sacramento River, and a number of smaller creeks have damaged the city and the county repeatedly. These damages and a concern for recreation and other values led to planning, floodplain acquisition and the adoption of regulations.

The county first adopted floodplain regulations in the mid-1960s requiring that residences be three feet above the 10-year flood elevation. This standard was later amended to one foot above the 100-year flood. The county also adopted subdivision and storm drainage regulations: a natural stream plan incorporates highly restrictive standards for one area of the county.

Extensive lands along the American River have been acquired. A greenbelt plan for the river dates from 1915, but it was essentially unimplemented until the 1960s. In 1961, after the County Planning Commission approved subdivi-

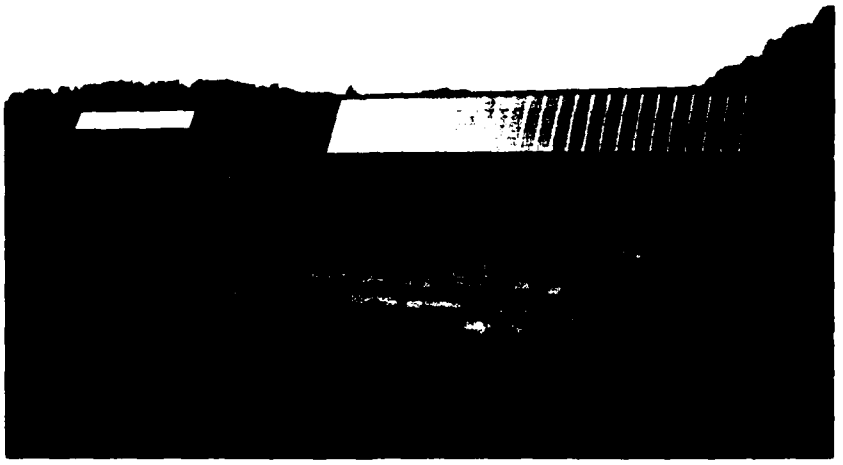
sion plans for a portion of the American River floodplain, citizens reacted strongly and formed the Save the River Association. Public pressure forced the county board to adopt a parkway plan. Funding from a variety of sources, including a county bond issue, has been used to acquire more than 3,000 acres along 23 miles of the river. The remaining 1,900 acres in mixed public-private ownership are controlled through leases and special arrangements. A County Park Corridor Overlay Zone prevents incompatible adjacent development.

The regulations and acquisitions have been successful because of timely regulations and acquisition before development could occur, high public awareness, an active citizen lobby, effective staff leadership, and available funding.

REGULATIONS COMBINED WITH POSTDISASTER RELOCATION (SOLDIERS GROVE, WISCONSIN)

Soldiers Grove is a small southwestern Wisconsin town (population 680) which has been subject to repeated flooding by the Kickapoo River. Prior to 1978, the Corps of Engineers had constructed levees adjacent to the river, but these provided only partial protection from flooding. The Corps also began construction of a 9,500 acre upstream dam and reservoir, but public opposition throughout the state halted the project.

In 1978, the town adopted floodplain regulations requiring that new structures be elevated one foot above the 100-year flood level. The town redevelopment authority also prepared a relocation plan. Later that year a severe flood overtopped the levees and flooded the entire town, causing $52 million in damages. Upgraded floodplain regulations prohibited rebuilding in the Kickapoo River floodway which includes most of the downtown. After this



In relocating its flood-prone business district after the severe flood in 1978, Soldiers Grove, Wisconsin, also required passive solar construction for its new buildings in the new town. Photo by Jon Kusler.

event, the redevelopment authority prepared a new relocation plan and the town adopted it. With a variety of funding sources, a 190-acre site for a new town was acquired and sewer and water supply facilities were installed.

The relocation plan is presently being implemented at an estimated total cost of $5.75 million with 60% federal and 40% nonfederal cost-sharing. Thirteen structures have been constructed at the new town site. Passive solar heating is required by ordinance as part of wider resource planning measures and to increase available grant sources. In addition, several residential structures in outer flood fringe areas have been elevated on fill or floodproofed with technical assistance and financial help from the town.

The success of this program has been due to the severity of the flood threat, strong leadership by the local redevelopment authority, education regarding the cost effectiveness of floodplain management, and the packaging of federal funds. This is among the most innovative of all local programs. It combines the objective of flood loss reduction with provisions for urban renewal, open space, and energy conservation. It demonstrates the importance of preflood planning that makes mitigation programs available for quick implementation when a flood occurs.

FLOODPLAIN REGULATIONS COMBINED WITH STORMWATER MANAGEMENT REGULATIONS (DALLAS, TEXAS)

Dallas is a rapidly growing city of nearly one million residents. There has been repeated severe flooding, with a particularly serious flood in 1964. Because of flood problems and the need for recreation and open space, the city adopted a comprehensive floodplain regulation, stormwater management, acquisition, and relocation program.

Floodplain zoning was first adopted in 1965. In 1968, the city adopted regulations for the 100-year floodplain. In 1977, regulations were upgraded so that the city now allows only minor floodplain changes that will cause no increase in flood heights. Restrictions were imposed on nonconforming uses. A permit from the board of adjustment is required for any alteration or improvement valued over $300. The city also adopted subdivision and stormwater management regulations.

To implement regulations and facilitate watershed planning, detailed flood maps for 35 to 40 creeks at scales of 1"=50' to 1"=200' were developed on an orthophoto base with one- or two-foot contour intervals. These maps were based on flood flow projections assuming fully urbanized conditions consistent with land use planning and regulatory densities.

When a residential subdivision is developed, the subdivider ordinarily must dedicate the floodplain to the city as a condition to plat approval. Flood boundaries must be indicated on plats and marked on the ground.

The floodplain may not be used as a building site for apartments. However, floodplain portions of broader parcels intended for apartment use may be used as common open space if a floodway easement is dedicated to the city. Densi-

ty bonuses are given for floodplain protection. Certain residential subdivisions have also been permitted to retain title to floodplain areas where a homeowners' association agrees to hold and maintain the land as open space.

Regulations have been supplemented by acquisition of more than 2,500 acres of undeveloped floodplain. Funding has been received from a variety of sources, including local bond issues; one landowner donated 400 acres. In addition to acquisition of undeveloped areas, the city acquired approximately 180 structures in two seriously flooded subdivisions through a voluntary relocation program. HUD Community Development Block Grant monies and other funds were used.

The city has undertaken some channelization to reduce flooding threats to existing uses, and it is acquiring and constructing stormwater retention basins.

The success of this program has been due to severe flooding problems, motivated and informed citizens, effective city council leadership and staff, high quality flood maps, and multiple funding sources.

MULTIJURISDICTIONAL FLOODPLAIN MANAGEMENT (DENVER METROPOLITAN AREA)[7]

The Denver metropolitan region consists of 34 units of local government with 1,100 miles of floodplain, a population of more than 1,200,000, and a total area of about 1,200 square miles. The area has been subject to repeated and severe floods along the Platte River and Cherry Creek.

In 1969, the Colorado Legislature created the Denver Urban Drainage and Flood Control District to address drainage and flood control problems on a metropolitan basis. Individual local entities were unable to deal with multijurisdictional flood and drainage problems. The District includes Denver and the urban portions of Adams, Arapahoe, Douglas and Jefferson Counties. The District is governed by a 15-member board of directors. Funds are obtained by a tax levy.

The District is authorized to regulate floodplain areas but has chosen, instead, to establish standards for local regulation by the 28 local governments with flood problems. All 28 communities adopted regulations by a deadline the District established; they are also enrolled in the NFIP.

The District has prepared detailed flood maps and master drainage plans for most areas. The drainage plans identify present and anticipated basin problems, flood flows based on projected urbanized watershed conditions, and measures needed to reduce flood problems. Thirty-one master plans had been prepared as of December 13, 1979. Planning is under way for six other areas.

Other District activities are the design and construction of drainage and flood control facilities, provision of technical assistance to local government, collection of flood and water quality data, preparation of flood disaster plans, and education of landowners.

Floodplain management activities have received strong support from citizen groups such as the Platte River Development Committee, which has lobbied

for the protection and restoration of the Platte River. In 1974, the District prepared a "greenway" plan for that part of the river flowing through downtown Denver. The plan is now being implemented to improve water quality, enhance recreational opportunities, provide open space, and reduce flood losses. Over 350 acres of greenway along 10 miles of the river have been acquired with public and private funds. The Greenway Foundation, a nonprofit corporation, has played a major role in public relations and fund-raising for the program.

Success with the greenway plan has been due to a high level of awareness of flood problems, special enabling legislation, citizen support, effective staff, a thorough public education effort, and careful coordination of activities.

TWO-ZONE MANAGEMENT OF COASTAL FLOOD PROBLEMS (EAST PROVIDENCE, RHODE ISLAND)

East Providence is a city of 52,000 with estuarine flooding on the Seekonk River. The waterfront suffered severe flood damage from hurricanes in 1938 and 1954. Following recommendations of a governor's task force on hurricane flood problems in 1955, the city adopted regulations prohibiting structures on lands less than 10 feet above mean sea level. If protected from flooding, structures for human occupancy were permitted in backlying areas between 10 and 15 feet above sea level. These regulations are still in effect.

The city acquired some floodplain areas for public use after the 1954 flooding. In 1974, it prepared a waterfront plan for the 14.4 miles of city waterfront. Additional park acquisition is recommended by the plan.

The success of this program has been due to the severity of flood problems, an active city planning office and conservation commission, and state coastal zone and wetland regulations that reinforce local controls. East Providence illustrates one of the oldest approaches to "high hazard area" and "low hazard area" coastal flooding in the nation.

COASTAL FLOOD HAZARD REDUCTION AND RESOURCE PROTECTION (VIRGINIA BEACH, VIRGINIA)

Virginia Beach is a coastal community of 285,000 with a large coastal floodplain and some riverine flooding. There was severe flooding in 1933 and 1962.

The city first adopted floodplain regulations in 1973, requiring permits for all activities involving fill, grading, or structures. First floors must be elevated one foot above the 100-year flood elevation. Development is prohibited in areas less than six feet above mean sea level. In one beachfront area subject to wave action, first floors must be elevated 18.5 feet. The community has adopted its own flood maps at a scale of 1"=100'.

The city has also adopted coastal wetland regulations and sand dune protection regulations that require building setbacks. Four coastal inspectors have

been hired by the city to monitor and enforce regulations. In addition, private citizens have helped by reporting violations.

Success in this program has been due to community awareness of flood and environmental problems, support by the city administration, and detailed flood maps. Virginia Beach illustrates a successful combination of floodplain and wetland regulations to achieve multipurpose floodplain management goals.

MUD FLOWS (SAN BERNARDINO, CALIFORNIA)

San Bernardino is a southern California community of 170,000 residents. A 1979 forest fire north of the city denuded 750 acres in and adjacent to a canyon with unstable slopes. This, combined with heavy rainfall, caused increased runoff and mud flows. One area of the city was subject to four mud flows in January and February of 1979; 25 structures were seriously damaged.

Because of safety concerns, the city passed an emergency ordinance declaring the area unsafe and prohibiting new building or repair of damaged structures. Acquisition of damaged structures was made possible by funding from FEMA's Section 1362 program and loans from the Small Business Administration. The vacated land will be used as a city park. To contain future flows, retaining walls were constructed adjacent to the properties. In addition, the city has undertaken erosion control work in headwaters of the canyon.

Success of this program has been due to the severity of the problems, public awareness, support of the city council and mayor, public education, and federal financial assistance. San Bernardino illustrates one community's approach to a "special" flood problem using a combination of management techniques.

Similar floodplain management programs tailored to mud flows, alluvial fan flooding, long-term ground water fluctuations, high velocity flows, combined erosion and flooding and other special flood problems are needed in thousands of communities. These could be encouraged by state and federal technical assistance and "special" mapping.

Footnotes

1. Murphy (1958).
2. U.S. Water Resources Council *et al.*, (1970).
3. *Id.*
4. French and Burby (1981).
5. *Id.*
6. Sanibel, Florida; Lake County, Illinois; and Lincoln, Massachusetts, are examples of such broader resource management efforts that include floodplain management as one component.
7. For other examples see Platt *et al.* (1980)

CHAPTER VII

FLOODPLAIN REGULATIONS AND THE COURTS

Introduction

Between 1970 and 1980, judicial support for floodplain regulations was overwhelming. State supreme or appellate courts issued at least 55 reported decisions on floodplain regulations and 25 on wetland regulations. Federal courts addressed flood insurance issues in at least 25 decisions and Section 404 permit issues at least 20 times. The goals and techniques of floodplain regulation (outlined in Table 8) were unanimously endorsed. Problems, where they arose, concerned procedural matters and lack of data in evaluating permits. Courts held denial of a specific permit invalid in only seven cases, and those took place early in the decade. Even in these cases, the courts supported the general validity of regulations. In six of these there was either lack of evidence of flooding or a failure to show that the proposed use would have adverse individual or cumulative effects on flooding.[1] (Citations and holdings of cases decided during the decade are presented in Appendix V.)

Floodplain regulations raise constitutional issues similar to those involved in broader land use regulatory efforts. In determining the constitutional validity of regulations, courts look first at the general validity of the regulations and then at their specific validity as applied to a particular landowner. They first decide whether the unit of government or agency adopting the regulation was authorized to do so by an act of Congress or a state statute, and whether statutory procedures were followed. Having found sufficient statutory powers and compliance with statutory procedures, they then decide whether the regulations (1) serve valid police power objectives, (2) have a reasonable tendency to achieve or aid in the achievement of those objectives, (3) afford equal treatment to similarly situated landowners, and (4) permit reasonable private use of land so that a "taking" of private property does not occur.

During the last decade, most lawsuits contesting floodplain regulations did not challenge the general validity of restrictions (adequacy of basic power and compliance with statutory procedures), but rather contested the constitutionality of regulations as applied to a particular property in the context of these four basic tests. This "pinpoint" approach to the determination of constitutionality derives in part from two U.S. Supreme Court decisions issued in the 1920s.

TABLE 8

REGULATORY GOALS AND TECHNIQUES

Goal	Regulatory Techniques
1. Prevent land uses that will increase flood heights or velocities, resulting in flood damage.	1. State and local regulations requiring permits for dams, levees, channel straightening, structures, or fill in floodway areas 2. Zoning, subdivision and encroachment regulations *preventing* obstruction of floodways 3. Zoning ordinances controlling the types and densities of uses in flood storage areas 4. Subdivision or drainage regulations controlling drainage design 5. Soil conservation regulations requiring land treatment (soil and water conservation practices)
2. Prevent land uses which will cause other nuisances	1. Zoning, building codes, and other regulations controlling hazardous uses of the floodplain such as chemical treatment plants, oil and gas storage facilities, and *nuclear power plants which may* cause fires or other hazards during floods 2. Zoning and other regulations restricting storage of materials, placement of mobile homes, construction of wooden residences or other uses involving material that may be carried by flood waters onto other lands thereby increasing the force of flood waters and causing debris problems 3. Zoning and other ordinances regulating uses with water pollution potential such as sewage treatment plants, chemical plants, and solid-waste disposal sites

Goal	Regulatory Techniques
3. Prevent victimization and fraud	1. State and federal interstate land sale acts requiring that an accurate descriptive statement of the land be filed with appropriate regulatory agencies and prospective buyers 2. Zoning, building codes, state permits and subdivision review acts requiring that lands be physically suitable for intended uses

4. Reduce the costs of community services	1. State and local capital improvement plans that restrict sewers, water lines, roads or other public facilities in flood hazard areas or require floodproofing of them
	2. Zoning regulations requiring that utility connections to private structures be elevated to the flood level or protected in some other manner
	3. Subdivision regulations requiring that developers install floodproofed facilities in new subdivisions
5. Promotes most suitable use of land throughout a community, region or state	1. Community-wide planning and zoning regulations based on land suitability guiding development away from sensitive areas
	2. State or local regulations protecting prime agricultural lands, mineral resources and coastal areas
	3. State statutes and local ordinances requiring environmental impact statements for development or subdivisions

In *Village of Euclid v. Ambler Realty Co.*[2] the Court upheld the basic concept of zoning—the division of a community into various districts and the application of different land use standards to each of the districts. Two years later, in *Nectow v. City of Cambridge*[3] the Court again endorsed the general concept of zoning, but held that the regulations at issue were invalid as applied to particular lands. In this case, the Court faced a difficult dilemma. To have struck down the ordinance as a whole would have left the community without zoning and would have invalidated the regulations even where they made sense. Taking a compromise position, the Court held that zoning regulations could be valid in general but invalid as applied to particular property.

This approach has been followed by courts across the nation in floodplain and other cases. When arguing their claims, landowners may concede the general validity of a floodplain, wetland, or other regulation but argue that it is irrational, arbitrary, or capricious as applied to their land or that it "takes" their property without "just compensation". A court may find that the regulation is in fact unconstitutional as applied to particular property, but this will not stand as a determination of the constitutionality of the regulation as applied to other lands. A pinpoint approach favors general judicial acceptance of floodplain regulations; however, it has led to a fair amount of litigation.

General Judicial Responses

In 1969 and 1970 when Volumes 1 and 2 of **Regulation of Flood Hazard Areas To Reduce Flood Losses** were prepared, a considerable number of

floodplain cases and more than 12,000 land use control cases had already been decided.[4] From these it was possible to identify general trends in judicial decisions and to suggest how courts would likely treat floodplain issues that had not yet been resolved. Even so, many issues needed clarification and the issue of "taking" had not yet been widely litigated, particularly for open space flood fringe regulations. How well has the legal analysis of Volumes 1 and 2 fared? What clarifications have been provided or new directions developed in the past decade?

During the 1970s courts responded to the following general legal requirements for floodplain and resource protection regulations.

(1) *The agency or local government adopting regulations must be authorized to do so by an enabling statute or home rule powers*. Inadequately authorized regulations fail to meet due process requirements; they are considered *ultra vires* and invalid by the courts. Volumes 1 and 2 concluded that statutes authorizing local zoning, subdivision controls, building and other codes were sufficient to authorize floodplain zoning, subdivision control, or other regulations in virtually all states.[5]

In the 1970s no court invalidated regulations for lack of enabling authority. In fact, several cases commented upon the sufficiency of general enabling statutes, and several upheld the power of special districts to adopt regulations. In addition, some courts held that local units had a duty to adopt floodplain regulations or consider flooding when required to do so by a particular statute: those courts directed compliance with the statutes.

(2) *Statutory procedures for adoption and amendment of regulations must be carefully followed*, otherwise regulations violate due process requirements and are *ultra vires*. Volumes 1 and 2 concluded that prior comprehensive planning was not required for most floodplain regulations but that other procedural requirements must be followed.[6]

This general requirement was adhered to in the 1970s. One court held that an informally adopted floodplain "resolution" did not regulate because the local government had not followed procedures required for a formal ordinance. Several cases held the denial or approval of a special exception permit invalid because statutory procedures had not been followed. A Minnesota court, however, upheld adoption of an ordinance in an emergency without statutory notice and hearing because of the extraordinary conditions involved (flood waters were rising and the community needed to qualify for flood insurance).

(3) *State land use regulations must not, in general, pertain to matters of exclusively local concern*, otherwise state regulations may contravene local home rule statutes or constitutional provisions adopted in at least 35 states.[7] Volumes 1 and 2 concluded that state or state-supervised floodplain regulations do not violate home rule powers because flooding is a multijurisdictional issue and of more than local concern.[8]

In the 1970s no court invalidated state regulations as violating local home rule powers. Courts in at least three cases specifically upheld regulations against

claims that state regulations violated home rule provisions, concluding that flooding is a matter of greater than local concern. In addition, courts in at least six cases have upheld state coastal zone, wild and scenic river, and similar resource regulations against home rule arguments with no adverse decisions for such resource-based state regulations.

(4) *Regulations must serve legitimate police power objectives.* Regulations that fail to do so violate due process requirements. Volumes 1 and 2 concluded that regulations designed to prevent landowners from increasing flood damages on other lands, threatening public safety, or causing victimization were clearly designed to serve valid objectives.[9] The reduction of losses to the landowners themselves (which indirectly affect society) and the reduction of the need for flood control works at public expense were also considered valid objectives, although few cases had yet been decided on these points.[10]

Cases in the 1970s provided strong support for protection of public safety, and prevention of nuisances and victimization. Courts in some cases endorsed not only these traditional objectives but also regulations adopted to protect owners from flooding, protect flood storage, qualify a community for flood insurance, reduce flood losses, protect floodways until public purchase was possible, and reduce the cost of public services. No floodplain case invalidated regulations for failing to promote valid objectives; a number of cases specifically endorsed broad objectives.

Based on case law at that time, Volumes 1 and 2 gave guarded support to floodplain regulations adopted to serve wetland protection objectives.[11] This underestimated judicial response: cases in the 1970s gave overwhelming legal support for wetland and other environmental regulations. Floodplain regulations may now be adopted, with some confidence, to achieve not only hazard reduction but also wetland protection, dune protection, coastal zone management, and erosion control.

(5) *Regulations must be reasonable; that is, the regulatory standards and procedures must have some tendency to accomplish the regulatory goals such as reduction in flood losses.* If regulations are not reasonable, they violate due process requirements. Volumes 1 and 2 concluded that, in order to avoid due process problems, regulations must be based on sound flood data;[12] the degree of restriction must be reasonably related to the actual threat of flooding;[13] and the restrictions must have some real tendency to reduce flood problems.[14]

Courts in the 1970s examined the factual base for regulations more carefully than in the preceding decade. Cases suggest that maps must be reasonably accurate but need not be at very large scale, particularly where procedures are available for refining data as individual permits are considered. Under most enabling authorities, regulatory agencies may consider the cumulative impacts of development in carrying out flood studies and determining floodway limits. Courts in five states specifically endorsed the determination of flood heights or floodway boundaries or the evaluation of development impacts that take into account cumulative impact of projected floodplain or watershed develop-

ment. Regulations requiring protection to the 100-year flood level were specifically endorsed in several cases. However, courts in several other cases held the denial of a particular permit invalid in specific circumstances due to lack of sufficient evidence of flooding or erosion.

(6) *Standards for agency action must not be vague or indefinite*, otherwise regulations violate due process requirements. Volumes 1 and 2 concluded that broad hazard reduction standards were sufficient for issuance of special permits and variances by local zoning boards, planning boards, and state and federal agencies.[15]

In the 1970s courts sustained broad statutory and ordinance standards for issuance of special permits and variances when they were challenged. However, as noted above, some courts have found an insufficient factual basis (of erosion or flooding, for example) to deny or justify issuance of permits.

(7) *Regulations must not discriminate between similarly situated landowners*, otherwise regulations violate 14th Amendment due process requirements. Volumes 1 and 2 suggested that floodway regulations might need to provide equal conveyance of floodwaters along both sides of a stream to avoid due process problems and that similarly situated landowners may be required to elevate to similar elevations.[16] However, Volumes 1 and 2 concluded that new uses could validly be treated differently from existing uses.[17]

In only a few floodplain cases were discrimination questions specifically considered. None invalidated regulations on this ground, although some suggested that regulations would be held invalid if found to be discriminatory. Courts strongly endorsed equal degree of encroachment and cumulative impact standards in floodway restrictions and quite often focused on equity considerations in deciding whether regulations were a taking of private property.

(8) *Regulations must not "take" private property without payment of just compensation*, otherwise regulations violate 14th Amendment and 5th Amendment requirements of due process and prohibitions against taking. Volumes 1 and 2 concluded that floodway and coastal high hazard area restrictions, subdivision regulations to prevent victimization, and elevation requirements for outer flood fringe areas do not take property, even where such restrictions severely affect private landowners.[18] However, based upon cases up to that time, Volumes 1 and 2 warned that very strict regulation of outer fringe areas and "wetland restrictions" might be held a taking.[19]

With few exceptions, in the 1970s courts upheld floodplain regulations against taking challenges. Restrictions upheld included highly restrictive regulations for outer areas as well as for floodway and coastal high hazard zones.

(9) *Units of government may not, under most circumstances, increase flooding or flood damages to private lands*. Volumes 1 and 2 concluded that units of government ordinarily are not responsible for flood damages resulting from natural causes nor are they required to adopt regulations, provide insurance, undertake flood control works, or provide utilities.[20] However, under certain circumstances, government bodies may be responsible for increased

flood damage on private lands under theories such as taking, nuisance, and trespass when the governmental unit constructs, operates or maintains flood control works, roads, or other public structures or facilities.

Despite a growing trend during the 1970s to hold governments responsible for positive actions resulting in increased flood losses, governments were not held responsible for failing to provide flood insurance, disaster assistance, flood control works, or floodplain regulations. Several federal court decisions refused to hold the Federal Insurance Administration liable for failure to broadly advertise the National Flood Insurance Program (NFIP). The courts held that the program had been adequately advertised. A relatively large number of decisions have addressed NFIP responsibility for payment of local insurance claims. Most of these involved interpretation of the flood insurance statutes.

A court held that individual members of a city council were not responsible for adopting floodplain regulations. Similarly, courts denied liability for operation of dams when damage resulted from an extremely severe flood. However, some courts have found local governments liable for operation and maintenance of inadequate drainage facilities, including those constructed by a subdivider and dedicated to the city.

In conclusion, the cases within the last decade have been, with minor exceptions, consistent with the legal analyses and conclusions of Volumes 1 and 2. Some points have been clarified. Most important, judicial support for floodplain and other resource management programs has been even stronger than expected. Appendix V presents the citations and holdings of major cases decided during the 1970s.

Cases From The 1970s

What sorts of floodplain regulations have been litigated in the 1970s? Have the standards of the National Flood Insurance Program (NFIP)—which have become minimum standards for more than 17,000 communities—been widely contested?

The NFIP standards that require protection of floodway areas (where floodway maps are available) so that development will not increase flood heights more than one foot, and those that require elevation of structures in coastal and riverine flood areas to the 100-year flood elevation have not been widely litigated. Apparently, landowners or their attorneys have considered the chances of successful litigation remote. Instead, many of the 55 cases brought in the last decade have addressed regulations more restrictive than those required by the NFIP. As noted earlier, all but six decisions sustained the regulations and even these endorsed the concept, disagreeing only with the denial of a particular permit. In light of this overwhelming support, future disapproval of minimum NFIP standards is unlikely.

FLOODWAY REGULATIONS

Many states and localities have adopted restrictions for floodway areas that equal or exceed NFIP standards, which permit a one-foot increase in the height of the 100-year flood. Floodways as well as floodplains are calculated according to existing watershed conditions. Floodway restrictions, including some more restrictive than those of the NFIP, have been contested in several cases.

In *Krahl v. Nine Mile Creek Watershed District*,[21] the Minnesota Supreme Court sustained a watershed district's floodway regulations that were intended to preserve flood storage and conveyance. The regulations required that encroachments in the floodplain not exceed 20% of the total floodplain area.

In *Young Plumbing and Heating Co. v. Iowa Natural Resources Council*,[22] the Iowa Supreme Court sustained state regulations which required removal of a structure in a 200-foot-wide floodway where an individual structure and fill would have increased flood heights about .3 foot with a 1.7 foot calculated increase, assuming equal degrees of encroachment.

In *Subaru of New England, Inc. v. Board of Appeals*,[23] the Massachusetts Appeals Court sustained floodplain and floodway regulations designed to protect flood storage in the town of Canton where there was evidence that, although the particular development would have increased flood heights only 1/4 inch, potential cumulative impact might have been significant.

In *Foreman v. State Department of Natural Resources*,[24] the Indiana Court of Appeals sustained restrictive floodway regulations. Calculated flood heights took into account future watershed conditions.

The Iowa Supreme Court in *Young Plumbing and Heating Co.* sustained the Iowa Natural Resources Council's refusal to issue a permit and ordered removal of this condominium, which was built without permit in a floodway. The condominium was subsequently torn down.
Photo source: Iowa Natural Resources Council.

In *Maple Leaf Investors, Inc. v. State Department of Ecology*,[25] the Washington Supreme Court upheld denial of a state permit for proposed houses in the floodway of the Cedar River pursuant to state regulations that prohibited habitable structures in floodway areas.

In *Usdin v. State Department of Environmental Protection*,[26] a New Jersey Superior Court upheld state restrictions prohibiting construction within a floodway area.

CONTROL OF BOTH FLOODWAY AND FRINGE AREAS

Courts upheld floodplain regulations exceeding NFIP standards by prohibiting or virtually prohibiting development in entire floodplains in several instances.

The Massachusetts Supreme Court in *Turnpike Realty Co. v. Town of Dedham*[27] sustained Dedham's floodplain regulations which restricted repeatedly flooded areas to open space uses such as "woodland, grassland, wetland, agricultural, horticultural, or recreational use." However, landowners could apply for special exception permits. The landowner argued that the regulations were a taking of private property since there was testimony that the land was worth $431,000 before regulations and $35,000 after regulations. The court disagreed.

In *Dur-Bar Realty Co. v. City of Utica*,[28] a New York court sustained highly restrictive regulations for a Utica floodplain conservancy area. The regulations limited uses to farming and agriculture, parks, golf courses, athletic fields, essential services, disposal facilities, landfill operations, and marinas.

In *S. Kemble Fisher Realty Trust v. Board of Appeals*,[29] a Massachusetts court upheld regulations that limited property to open space conservancy uses.

Similarly, in *Turner v. County of Del Norte*,[30] a California court upheld regulations that prevented permanent dwellings in a severely flooded area. Open space uses and seasonal camping were permitted.

DUNE AND BEACH REGULATIONS

Several cases addressed the validity of highly restrictive dune and beach setback regulations. In *Spiegle v. Borough of Beach Haven*,[31] the Superior Court of New Jersey sustained a beach setback line for an area subject to severe storm damage and held that the line did not constitute a taking as applied to most properties. A lower New York court in *Lemp v. Town Board*[32] held that dune regulations were invalid (although not a taking) as applied to a property in an area for which a permit had been issued and a later attempt made to revoke it.

INTERIM REGULATIONS

Courts sustained interim floodplain regulations in several cases. In *Capture Realty Corp. v. Board of Adjustments*,[33] the New Jersey Superior Court upheld highly restrictive regulations until flood problems could be more thoroughly assessed. In *Lindquist v. Omaha Realty, Inc.*,[34] the South Dakota Supreme

Devastation at Klamath, California, after flooding in 1962; in *Turner v. County of Del Norte*, a California court upheld regulations prohibiting building of permanent structures in the area. Photo source: U.S. Army Corps of Engineers.

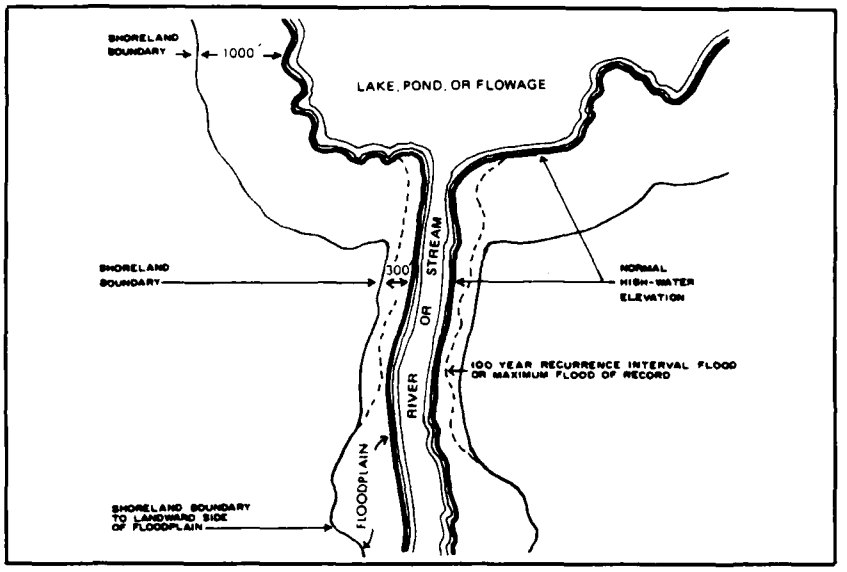
Court sustained restrictive regulations which prevented rebuilding in a devastated area of Rapid City after the disastrous 1972 flood.

WETLAND REGULATIONS

Both federal and state courts were asked to address a variety of wetland regulations controlling fill or dredging in wetlands. Federal courts, in a long line of decisions beginning with *Zabel v. Tabb*,[35] upheld denial of Federal Section 10 and Section 404 permits for development in coastal wetlands. Several cases involved denials of permits for dredging and filling in Florida mangroves,[36] which play important hazard reduction roles. Several decisions also addressed Federal 404 permit requirements for inland waters. One decision required Section 404 permits for agricultural activities in bottomland hardwoods along the Mississippi.[37] Flood storage was noted as a reason for protecting these areas. Other decisions held that permits are also required for development in wetlands along inland lakes.[38]

Many state decisions also addressed wetland regulations. Most sustained restrictive regulations, particularly in the late 1970s. For example, a Maryland court in *Potomac Sand and Gravel Co. v. Governor of Maryland*[39] sustained the denial of a permit for dredging coastal wetlands in Charles County. The Rhode Island Supreme Court in *J.M. Mills, Inc. v. Murphy*[40] sustained wetland

regulations for areas defined to include the 50-year floodplain. The Wisconsin Supreme Court in *Just v. Marinette County*,[41] the most famous of the wetland decisions, strongly supported state-supervised shoreland zoning regulations adopted by Marinette County. These regulations placed lakeshore wetlands in conservancy districts. The New Hampshire Supreme Court in *Sibson v. State*[42] upheld tight coastal wetland regulations, citing the *Just* case. In *Graham v. Estuary Properties, Inc.*,[43] the Florida Supreme Court upheld county refusal of a permit that would have resulted in the filling of 1,800 acres of red mangroves on Marco Island.



The Wisconsin Supreme Court in *Just v. Marinette County* upheld county conservancy zoning for wetland areas adopted pursuant to a "shoreland zoning act."
Source: Southeastern Wisconsin Regional Planning Commission, *Floodland and Shoreland Development Guide*. Planning Guide #5, Waukesha, Wisconsin, 1968.

SPECIAL PERMITS

More than a dozen decisions focused on the adequacy of standards for issuance of special permits or the adequacy of the factual basis for issuance or denial of special exceptions, variances, or other special permits. Courts universally upheld the regulatory standards as providing sufficient guidance to regulatory boards. For example, in *Dur-Bar Realty Co.*,[44] a New York court upheld an ordinance which directed the board of adjustment to consider the impacts of the proposed uses on flood heights.

However, in several decisions courts found that local permitting boards lacked sufficient data to justify granting or denying specific permits. For example, in *Pope v. City of Atlanta*[45] the Georgia Supreme Court strongly endorsed a river protection act, including the standards for evaluating permits, but held

that denial of a permit for a tennis court based on an argument of cumulative impact on runoff lacked factual support. On the other hand, courts in several jurisdictions found that permits had been invalidly granted because flood problems had not been adequately considered.[46]

SUBDIVISION REGULATIONS AND STORMWATER DRAINAGE

Several courts upheld flood and drainage standards in subdivision ordinances. In *Brown v. City of Joliet*,[47] the Illinois Appellate Court held that refusal to approve a plat was justified where a subdivider failed to include adequate plans for drainage and there was evidence that without such provision the subdivision not only would have increased drainage problems in surrounding areas but also would have been subject to them itself. The court noted that "the storm water problem which would be created in this case would be uniquely attributable to plaintiff's subdividing and development."[48]

In *Hamlin v. Matarazzo*,[49] the Superior Court of New Jersey held that in giving tentative approval to a subdivision for 43 homes on a 28-acre tract of undeveloped farmland, a planning board had improperly failed to consider effects of drainage and flooding. Drainage from the tract flowed onto plaintiff's land. A professional engineer testified that construction of the 43 homes would reduce stormwater absorption by 60% to 70%, substantially increasing erosion.

In *Metropolitan St. Louis Sewer District v. Zykan*,[50] the Missouri Supreme Court upheld sewer district regulations requiring construction of drainage facilities in subdivisions and ordered both construction of the facilities and payment of damages for failure to install facilities agreed to by the subdivider.

However, in *Kessler v. Town of Shelter Island Planning Board*,[51] a New York court held that refusal to approve a subdivision subject to flooding was invalid because the subdivider was willing to fill the area to protect against flooding as required by the planning board, and because the planning board's ulterior goal was to preserve the entire area for recreational use. However, the court conceded that the subdivider might be required either to provide recreation areas on the site or to pay the town for park purposes.

REGULATIONS IN ANTICIPATION OF ACQUISITION

Floodplain regulations were quite often adopted for areas that were later to be publicly acquired for flood control, parks, or other public purposes. Courts sustained such regulations where the principal objective was to prevent flood damages, not to reduce property values.[52]

Judicial Response to Specific Challenges

A variety of specific legal challenges were posed to floodplain regulations in the cases discussed above.

ADEQUACY OF ENABLING AUTHORITY

In a few cases, landowners challenged the basic power of a local government to adopt floodplain regulations. Despite adoption of regulations by 17,000 communities between 1969 and 1980, no court invalidated regulations on the grounds of inadequate basic enabling authority: courts found sufficient powers in all cases where the issue was raised. For example, in *Turnpike Realty*,[53] the Massachusetts Supreme Court held that adoption of a floodplain zoning ordinance was valid pursuant to a Massachusetts statute authorizing towns to adopt zoning providing "that lands deemed subject to seasonal or periodic flooding shall not be used for residence or other purposes in such a manner as to endanger the health or safety of the occupants thereof."[54] The court noted that, even before the enabling act had been amended to include specific reference to flood, "we believe that a municipality could validly have enacted a floodplain zoning bylaw under the general grant of authority . . . (to promote the health, safety, convenience, morals, or welfare), and for the reasons . . . (to secure safety from fire, panic, and other dangers)."[55] A concurring opinion of the Oklahoma Supreme Court similarly concluded that municipalities had sufficient power to adopt floodplain zoning under a broad zoning enabling act.[56]

The Colorado Supreme Court held that a county had sufficient power to adopt floodplain and mineral conservation zones under a broad enabling statute.[57] The Washington Supreme Court held that a statute authorizing a state agency to regulate flood hazard areas was sufficiently broad to justify denial of permits for residences in floodways.[58] The South Dakota Supreme Court held that Rapid City was exercising a valid use of police powers when it adopted regulations prohibiting issuance of building permits for an area devastated by the June 12, 1972 flood, until a planning study was complete.[59]

Courts in several jurisdictions held that the powers of special districts were sufficiently broad to authorize adoption of floodplain regulations. In *Metropolitan St. Louis Sewer District*[60] the Missouri Supreme Court upheld sewer districts regulations requiring construction of drainage facilities in subdivisions. The regulations had been adopted pursuant to a broad grant of powers to deal with sewage. Similarly, in *Krahl*,[61] the Minnesota Supreme Court upheld the floodplain encroachment and elevation requirements of the watershed district since the district had a general grant of power to deal with problems of water use.

In *County of Ramsey v. Stevens*,[62] the Minnesota court went beyond a mere affirmation of local powers when it sustained a lower court decision ordering a local community (Lilydale) to adopt regulations. A special statute required that communities designated by the Minnesota Department of Natural Resources adopt regulations to qualify for the NFIP, but Lilydale had failed to comply with this statute.

In *Hamlin*,[63] the New Jersey Supreme Court held that not only were local subdivision review powers sufficiently broad to require drainage facilities, but

also they imposed an affirmative duty upon the local planning board to consider flooding. The court held that a planning board had improperly failed to consider effects of drainage and flooding when it gave tentative approval to a subdivision for 43 homes on a 28-acre tract of undeveloped farmland and ordered the board to do so.

THE NEED TO FOLLOW STATUTORY PROCEDURES

In a few cases, landowners argued that state or local regulations had not been adopted or administered in a manner consistent with statutory procedures. Several cases held regulations partially or wholly invalid where adoption procedures were not followed. In *Jefferson County v. Johnson*,[64] the Alabama Supreme Court held that a county building code and a county resolution adopted to qualify for the NFIP were not sufficient in themselves to authorize the county engineer to deny a permit for construction in a floodway area: a more formal zoning regulation was needed. In *Morland Development Co. v. City of Tulsa*,[65] the Oklahoma Supreme Court held that floodplain zoning adopted as an amendment to other zoning was invalid because it was adopted without notifying landowners in writing as the zoning enabling act required for zoning amendments. In *A.H. Smith Sand and Gravel Co. v. Department of Natural Resources*,[66] the Maryland Court of Appeals strongly endorsed the concept of state floodplain regulations, but held that the regulations in this case had been based improperly on data that assumed future "developed" watershed conditions. The statute required consideration only of existing conditions. The court did not invalidate the regulations, but it did require a recalculation of flood elevations. Later the state statute was changed to explicitly permit the consideration of future watershed conditions.

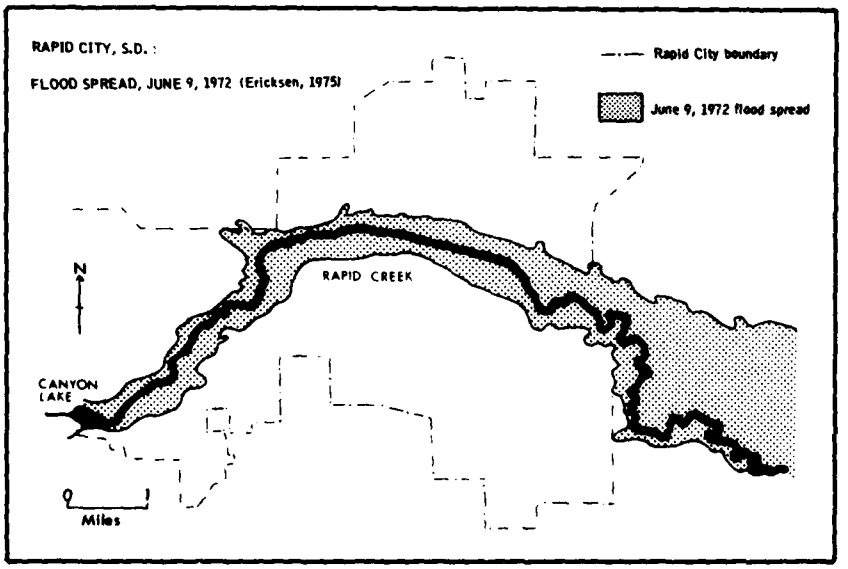
The Minnesota court in *County of Ramsey*[67] permitted minor irregularities in statutory procedures. The court held that regulations adopted by the city of Lilydale to qualify for flood insurance, under an order of a lower court to adopt such regulations within 72 hours, were valid despite the failure of the city to provide public notice of the regulations as required by state zoning laws. The regulations were adopted while rising waters threatened to flood the area. The court noted that statutory notice and hearing procedures would have been so time-consuming that the flood would have occurred before the regulations were adopted negating, in part, the reason for their adoption. The court stated that failure to comply with statutory procedures could only be justified in emergency circumstances. In addition, the court found no real denial of due process since the landowner contesting the regulations was in fact aware of their impending adoption.

VALIDITY OF INTERIM REGULATIONS

In several cases, landowners challenged interim regulations as not having been specifically authorized or adopted pursuant to statutory procedures. Interim regulations are specifically authorized only in some of the states. There

has been some question, therefore, whether such regulations exceed the scope of local powers or fail to follow prescribed procedures. As noted above, an Alabama court held that a resolution intended as an interim regulation was not a valid basis for denying a building permit. Courts in three other decisions supported more formal interim floodplain regulations.

In *Cappture Realty Corp.*[68] the Superior Court of New Jersey upheld a moratorium for construction on flood-prone lands until a flood control plan could be prepared. The moratorium had been adopted in October 1971 and extended for yearly periods until November 1974. All statutory procedures had been followed in adopting the ordinance. Under the terms of the ordinance, special permits could be obtained, providing construction did not generate any additional surface runoff. An exception had been denied in the case.



In *Lindquist v. Omaha Realty Inc.*, the South Dakota Supreme Court upheld a moratorium against rebuilding in this area along Rapid Creek.
Source: Adapted from Ericksen (1975).

In *Lindquist*[69] the South Dakota Supreme Court held that adoption of a resolution by the City Council of Rapid City was a valid exercise of police powers. After the devastating flood of June 12, 1972, the resolution prohibited issuance of building permits for one block on either side of Rapid Creek until a study was completed by the planning commission. The resolution and subsequent "notice of intent to acquire" issued by the city in September 1974 did not take property under eminent domain. The court observed:

> This appears to be a legitimate government interest when we consider the situation at the time the resolution was adopted, that is, widespread destruction and a need for some emergency action.[70]

Again, all procedures for adoption of a resolution had apparently been followed.

In *Beckendorff v. Harris-Galveston Coastal Subsidence District*,[71] the Texas Supreme Court upheld the issuance of temporary groundwater withdrawal permits for an area subject to subsidence-induced coastal flooding until a comprehensive plan could be prepared.

Courts have widely upheld interim resource management regulations in analogous contexts where statutory procedures were followed. These include interim regulations adopted pursuant to the California[72] and North Carolina[73] Coastal Zone Management Acts and interim wetland protection regulations adopted under the New York Coastal Wetlands Protection Act.[74]

VALIDITY OF STATE FLOODPLAIN REGULATIONS

All decisions have upheld contested state floodplain regulations as within the scope of statutory powers. The sufficiency of state floodway statutes was sustained by courts in Iowa,[75] Washington,[76] Indiana,[77] and New Jersey.[78] The Maryland Court of Appeals in *A.H. Smith Sand and Gravel Co.*[79] held that the state had sufficient power to adopt state floodplain regulations pursuant to a broad pollution control statute. In *State v. Crown Zellerbach Corp.*,[80] a Washington court upheld the power of a state agency to attach conditions to permits for structures in streams in order to ensure compliance with pollution control standards within three years.

Several courts sustained state or state-supervised local regulations against claims that they violated local home rule powers. In *Pope*,[81] the Georgia Supreme Court held that the Metropolitan River Protection Act was valid and did not violate local home rule powers or constitute state zoning. The act required permits for development in the stream corridor (all land within 2,000 feet of the stream) and the 50-year floodplain to protect the flow of flood waters and prevent erosion, siltation, and water pollution. The court held that flooding was a matter of statewide concern. Similarly, local home rule arguments were rejected in the Washington and Indiana floodway cases.

Courts unanimously upheld other types of state resource management regulations against local home rule arguments including the Oregon State Wild and Scenic River Act,[82] which requires state permits for uses within the river corridor; the Minnesota State Wild and Scenic River Act[83] and state standards adopted for local regulation; the California Coastal Zone Management Act,[84] which requires permits from regional councils; the New Jersey[85] and North Carolina[86] Coastal Zone Management Acts; and New York's regulations for its Adirondack Park.[87] The reasoning was similar in each case: the matter was of more than local concern. In addition to these cases, a New York court sustained county wetland regulations adopted pursuant to a statute that authorized the county to act if towns failed to pass appropriate ordinances.[88] A town argued that county regulations for a town without controls violated home rule powers. This argument was rejected, again based on the rationale that wetland protection was of more than local concern.

ADEQUACY OF REGULATORY OBJECTIVES

Landowners challenged the validity of floodplain management objectives in a few cases. During the decade, courts endorsed six major flood loss reduction goals.

(1) *Preventing increases in flood heights and damages.* Courts in California,[89] Indiana,[90] Iowa,[91] and Washington[92] strongly endorsed regulations designed to protect flood flow capacity and prevent landowners from increasing flood heights or velocities on other lands. Several of these cases specifically endorsed the consideration in the regulations of cumulative impacts and future development.

(2) *Protecting flood storage.* The Supreme Court of Minnesota sustained watershed district regulations designed to protect flood storage.[93] Similarly, a Massachusetts court sustained regulations to protect storage along the Neponset River, even where there was evidence that a proposed use would have raised flood heights only 1/4 inch.[94] On the other hand, an Illinois court held that certain storage restrictions that prevented all private use of lands were unreasonable, although it generally endorsed the storage concept.[95]

(3) *Protecting buyers from victimization caused by subdivision and sale of flood-prone lands.* Illinois,[96] Missouri,[97] and New Jersey[98] courts sustained subdivision regulations requiring storm sewers. The New Jersey court determined that a planning board's decision to approve a plat without taking into account possible problems with drainage was invalid since consideration of drainage was an affirmative duty.[99]

(4) *Protecting landowners from flood losses due to their own use of the floodplain.* In *Turnpike Realty*,[100] the Massachusetts Supreme Court endorsed as basic policy "the protection of individuals who might choose, despite the flood dangers, to develop or occupy land on a floodplain."[101] A New York court cited and quoted this language and held that "[i]t is beyond question that these objectives which correspond closely to the stated purposes of present ordinance, may be the subject of a legitimate exercise of the police power . . ."[102]

(5) *Protecting and promoting the general welfare, including reduction in public flood-related expenses.* The Massachusetts court in *Turnpike* also strongly endorsed the reduction in public costs. It stated that a principal objective for floodplain regulations was "the protection of the entire community from individual choices of land use which require subsequent public expenditures for public works and disaster relief."[103] A New York court also endorsed this goal and language.[104]

DISCRIMINATION

Courts considered arguments that regulations discriminated between similarly situated landowners in several cases. In *Beckendorff*[105] a Texas court held that

interim regulations controlling the withdrawal of ground water to prevent subsidence and flooding were valid and nondiscriminatory despite their application to only two counties. The appellant argued that all landowners who might contribute to the problem should be regulated. Noting the regulations could be expanded in the future to other areas, the court held that "the legislature may implement their programs step by step, adopting regulations that only partially ameliorate a perceived evil and deferring complete elimination of the evil to future regulations."[106] This ruling gives support to community and local efforts to map and regulate the most seriously threatened flood hazard areas first and provide for the gradual inclusion of other areas over time. Regulatory approaches addressing some but not all areas have also been sustained for regulations applying to coastal but not inland wetlands[107] and wetlands in a particular coastal area but not another.[108]

REASONABLENESS OF REGULATIONS

In many cases, courts considered the reasonableness of regulations, that is, whether the regulatory standards had some reasonable tendency to accomplish the regulatory goals.

Frequency of Flooding. What frequency of flooding should be used to determine floodways or flood fringe elevations? What degree of restriction is justified for particular flood frequencies? The "frequency" question has not been widely litigated, although courts have sustained regulations for particular frequencies of flooding in several cases. The Washington Supreme Court sustained encroachment restrictions for an area identified by the Corps of Engineers and the state as the 100-year floodway.[109] Similar restrictions were sustained for 100-year floodway areas in Indiana[110] and Iowa[111] The Maryland Supreme Court generally endorsed state regulations for the 50-year floodplain.[112] The Rhode Island Supreme Court sustained state permit requirements for activities in wetlands, defined to include the 50-year floodplain.[113]

Courts sustained restrictive controls based on historic flood data in a number of cases, although no frequency was assigned to the flooding. In *Turner*,[114] a California court sustained open space zoning for an area devastated by flooding in 1962 and which had been flooded four times since 1936. In *Turnpike Realty*,[115] the Massachusetts Supreme Court sustained open space regulations for an area which had been flooded at least three times since 1936. A New York court upheld a floodplain zoning ordinance which required that 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," in *Wolfram v. Abbey*.[116] The court found that the reference in the ordinance to "previous flood records"[117] was sufficiently specific since flood records for the subject area had been officially compiled by the Corps of Engineers and the town board had adopted these as part of the town's official floodplain plan.

From these cases it is clear that courts are willing to sustain highly restrictive regulations for frequently flooded areas. Quantified estimates of flooding are desirable but not essential.

Accuracy of mapping. In one case, a Michigan court of appeals held that floodplain regulations were invalid because they were applied to an area where "there was no evidence of flooding."[118] But this is the only case that invalidated a floodplain regulation outright for lack of data and the court did so apparently because the regulation was applied to an area without any historical or theoretical evidence of flooding.

On the other hand, the Iowa Supreme Court upheld a state floodplain permit requirement for a property where there were no maps but there was evidence of flooding.[119] The Iowa statute required that landowners seek state permits for structures or obstructions in the floodplain but did not require state floodplain mapping. A landowner in this case claimed that he should not have been left to his own devices to determine whether he was in the floodplain. The court disagreed, noting that since the landowner had constructed a levee at the site he must have suspected or known he was in the floodplain.

Map scale apparently has not been litigated, but the issue of minor inaccuracies has been raised. In *Turnpike Realty*,[120] the Massachusetts Supreme Court upheld the sufficiency of Dedham's floodplain zoning map which incorrectly included in the floodplain two knolls with a combined area of 3.4 acres. However, for other areas, there was substantial evidence of flooding, including photographs and exhibits of flooding from 1954 and 1967 and testimony of an expert hydrologist. Flood levels had been reached in 1936, 1938, 1955, and 1968. The court held that inclusion of the knolls was "inadvertent."[121] This minor inaccuracy did not invalidate the regulation since the owner could seek a special permit for such areas under ordinance provisions allowing a landowner to demonstrate that a particular area was not subject to flooding.

In *Just*,[122] a Wisconsin court upheld a procedure for remedying map inaccuracies through field inspections and the application of written criteria to the wetlands in question.

Several courts have sustained suspensions of communities from the NFIP because of failure to adopt adequate regulations, despite community arguments that because of map inaccuracies they should not be required to adopt them. In *Roberts v. Secretary, Department of Housing and Urban Development*,[123] a federal district court granted summary judgment for FIA, sustaining flood boundary maps and subsequent regulations based on them. The floodway and floodplain areas had been mapped according to present and historical conditions rather than conditions expected to exist after completion of a flood control project and other public works. The community argued that future conditions should be considered.

In a second case, *Town of Falmouth v. Hunter*,[124] a federal district court similarly ruled that Falmouth, Massachusetts could be suspended from participation in the flood insurance program. The town claimed that coastal maps

included in the flood insurance study were inaccurate. Falmouth had entered the emergency program in 1971. The Corps of Engineers completed the flood insurance study in 1972 and the town entered the regular program in 1973. In 1974 the town appealed the flood insurance study, claiming that boundaries were arbitrary and unsupported by sound data and scientific principles. FIA conceded some errors, made modifications, and issued revised elevations in 1975. New elevations went into effect in April 1976. The town proposed an alternative method for determining elevations and requested six months to carry out studies applying the new approach. FIA rejected this proposal and began action to suspend the town's participation in the NFIP. The town initiated a suit to prevent suspension. The court sustained the suspension, reasoning that the community could adopt the required regulations while it was carrying out its own studies.

Standards for floodway areas. In several decisions courts sustained criteria used for defining floodway areas. In *Young Plumbing and Heating Co.*,[125] the Iowa Supreme Court upheld the Iowa Natural Resources Council's denial of a permit for a condominium within a 100-year floodway which was 200 feet wide. The condominium would have increased flooding by .3 of a foot, but the cumulative impact (assuming an equal degree of encroachment) would have been 1.7 feet. The court ordered that the building be removed, despite arguments by the landowner that he should be allowed to channel the stream to provide compensatory increases in flow capacity.

In *Krahl*,[126] the Minnesota Supreme Court sustained a water district's regulations based on a concept of floodway delineation which involved permitting encroachments to extend "approximately 20% of the distance between the flood zone contour and the creek channel."

In *Subaru of New England*,[127] a Massachusetts court sustained the town's highly restrictive floodplain regulations which were designed to protect natural valley storage of the Neponset River. The court sustained the regulations despite evidence that the proposed development would raise flood heights only 1/4 inch.

Cumulative impacts. Several courts sustained state and local consideration of the "cumulative impact" of development in evaluating development proposals or determining encroachment lines. In the *Young*[128] decision the Iowa Supreme Court sustained consideration of cumulative impacts. The Georgia Supreme Court in *Pope*,[129] endorsed consideration of cumulative impacts even though the court found insufficient evidence of cumulative impact in this instance. In *Subaru of New England*,[130] a Massachusetts court, in upholding restrictions, strongly endorsed a cumulative impact argument. In *Beckendorff*,[131] the Texas Supreme Court held that regulation of individual groundwater extractions to prevent cumulative subsidence and flooding effects was justified. It noted:

> An individual's action may be lawfully regulated when it operates in concert with others' actions to produce an effect, even though the individual action of itself would be incapable of achieving the effect.[132]

Despite judicial approval for consideration of cumulative impacts, several courts held that in specific factual situations, evidence of cumulative impacts was insufficient to justify withholding a permit. These include a Massachusetts coastal wetlands case[133] in which it was argued that filling would have detrimental impact on flooding and erosion but little evidence was provided to support this conclusion; *Pope*,[134] in which generalized testimony on the impact of impervious surface was held insufficient to justify denial of a permit for a tennis court; and a New Jersey case in which the court held that a 2-acre minimum lot size throughout the town to reduce runoff and increase infiltration was not justified by the evidence.[135]

Consideration of present versus future conditions. Several courts considered the sufficiency of flood maps based on existing versus projected watershed conditions.

In *A.H. Smith Sand and Gravel Co.*[136] a Maryland court sustained state floodplain regulations, but held that flood maps were to be based on existing rather than future watershed conditions and ordered the modification of flood boundaries. The enabling statute required that existing conditions be considered. The Maryland legislature later amended the statute to authorize mapping based on future watershed conditions.

As noted above, a federal district court in *Roberts*[137] sustained the suspension of a community from the NFIP for failure to adopt "regular program" regulations, despite a claim by the community that the flood maps were inadequate. This case sustained federal mapping of floodplains based on existing conditions. However, the court might also have sustained maps based upon future conditions had FIA taken this approach.

In *Young Plumbing and Heating Co.*,[138] discussed above, the Iowa Supreme Court strongly endorsed efforts of the Iowa Natural Resources Council to take into account anticipated future development in determining encroachment limits. With regard to the argument that damages to adjacent landowners were "anticipatory," the court held that the Council had properly looked to the future:

> One function of the Council is to facilitate flood control through planning . . . Part of this function involves projecting the occurrence of floods. In this sense the actions of the Council are always anticipatory as to floods, the effect of channel modifications on adjacent lands, and future development on adjacent lands. Regardless of whether like construction or development were to be undertaken on the opposite bank, the proposed construction and the accompanying channel modifications will reduce the number of potential uses and the corresponding value of the adjacent land due to increased susceptibility to flooding. The effect of adjacent lands being a consideration mandated by the legislature, and planning being a delegated function of the Council, the anticipatory nature of the Council's findings does not work against their reasonableness.[139]

Similarly, In *Pope*[140] it was held that under the Georgia River Protection Act, the metropolitan council could take into account future conditions.

Judicial review of reasonableness. Courts deferred to legislative or agency determinations on factual matters[141] if there was any evidence to support them. Judicial deference to agency fact-finding is due in part to courts' reluctance

to act as experts and in part to their endorsement of the separation of judicial, legislative, and executive powers.

Iowa's *Young*[142] decision represents the most common judicial approach for review of federal, state, and local agency decisions, including data gathering and analysis and the selection of data-gathering and analysis techniques. Here the court held that an agency decision will be reversed only where it is "unsupported by substantial evidence in the record made before the agency when the record is viewed as a whole."[143] The court applied the following standards of review to determine whether there was substantial evidence:

> Evidence is substantial when a reasonable mind would accept it as adequate to reach a conclusion . . . [T]he entire record must be considered in determining whether the challenged finding has sufficient support. Nonetheless, the possibility of drawing two inconsistent conclusions from the evidence does not prevent an administrative agency's findings from being supported by substantial evidence . . .[144]

Finding a basis for the Iowa Natural Resources Council's conclusions in the record and stressing the impact of the proposed use on adjacent lands, the court upheld the Council. The court further noted:

> The conclusion of the Council is further supported by the deference with which a reviewing court should approach agency action due to the Council's particular expertise . . . Still a court reviewing agency action must scrutinize the whole record to evaluate any alleged statutory grounds for invalidation.[145]

Judicial support for decision making by special agencies or boards occurred in many cases.[146] California[147] and Massachusetts[148] courts gave particular deference to local decision making.

However, as noted above, several courts held that agency decisions in specific contexts were not based on sufficient data.[149] In requiring the upgrading of flood maps after new flood data became available, the Maryland court noted that "[t]he conclusions reached by an administrative agency, with all of its expertise, can be no more sound than the factual basis upon which it rests."[150]

SPECIAL EXCEPTIONS AND VARIANCES

Courts widely sustained special permit approaches, which were often applied to floodways or river corridors.[151] In *Pope*,[152] the Georgia Supreme Court upheld the Metropolitan River Protection Act's requirement that permits be sought for development within 2,000 feet of streams. This act more specifically provided that uses within 150 feet of the river and the 50-year floodplain were restricted to those "not harmful to the water and land resources of the stream corridor . . . [which do not] significantly impede the natural flow of flood waters, and [which] will not result in significant land erosion, stream bank erosion, siltation or water pollution."[153] Grading and vegetation clearance permits were required; cut and fill operations that would alter the natural flow of waters were prohibited; and only 20% of the floodplain could be covered with impervious surfaces.

Several courts deemed that the potential for issuance of a special permit was significant in deciding whether regulations were a taking of private property. These decisions included a landmark Wisconsin wetland protection decision,[154] a Washington Supreme Court decision sustaining encroachment regulations[155] and a Massachusetts Supreme Court decision supporting the validity of local restrictions for a floodplain area.[156]

Courts sustained the adequacy of standards for special permits in all cases addressing the issue. In *Dur-Bar Realty Co.*[157] a New York court held valid an ordinance that permitted no floodplain uses by right and required a local board to evaluate proposed uses to determine their impact on flood heights and safety from flooding.

In *Wolfram*, [158] a New York court upheld a floodplain zoning ordinance that authorized the zoning administrator to determine flood hazard areas with data from the Corps. Special permits were to be obtained from the zoning board of appeals, which was also authorized to require "[a]ny other controls or restrictions which are deemed necessary to minimize or eliminate damage to buildings and structures from flood waters."[159]

Data base for permit approval or denial. Several courts held that permits were invalidly denied in particular circumstances because of an insufficient factual basis for such denial. In *MacGibbon v. Board of Appeals*,[160] the Massachusetts Supreme Court held that a permit for fill in a coastal wetland had been invalidly denied on flooding and erosion grounds, both because there was lack of evidence of such problems and because adequate measures could be taken to deal with flooding and erosion.

In *Pope*,[161] denial of a permit for a tennis court based on an argument of cumulative effect on flooding was not supported by sufficient evidence. The landowner introduced evidence from the director of Atlanta's Bureau of Buildings that construction of the tennis court would not significantly affect the river. The only rebuttal was testimony of an environmental planner with the Atlanta Regional Commission who had never inspected the proposed construction site.

Several courts upheld the denial of variances for floodplain areas. In *Kraiser v. Zoning Hearing Board*,[162] a Pennsylvania court sustained denial of a variance for a residential duplex in a floodplain conservation area. The court noted that, based on engineering testimony, "it can be properly concluded that building on the floodplain would increase flood height and conceivably increase the hazard to the inhabitants of other buildings both on and away from the zoned areas."[163]

The court also noted, "Kraiser's puzzlement is understandable. If he complies with the permitted conditional uses under the Floodplain Ordinance he finds himself for all practical purposes stuck with a useless property. But in the interests of all the residents, he must suffer along with other property owners who are likewise affected by the ordinance."[164]

Similarly, in *National Merritt, Inc. v. Weist*[165] the New York Court of Appeals held that a zoning board of adjustment properly denied a property owner's

request for an area variance for a 19 3/4-acre parcel to be used as a shopping center. The decision was due in part to a finding that the shopping center would create flooding and drainage problems for the area. The court noted:

> Considerable evidence, also unrebutted, was introduced to demonstrate that the leveling of the property and its conversion into an area almost completely covered by structures and asphalt pavement would result in severe flooding and drainage problems . . . Both the United States Department of Agriculture and the Westchester County Soil and Conservation Service advised the parties that petitioner's plans did not adequately provide for the control of storm water and erosion.[166]

In contrast, one court held that a variance for a liquid propane gas tank was acceptable in a wetland area subject to flooding where there was no evidence of adverse impacts.[167]

In *Green's Bottom Sportsmen, Inc. v. St. Charles County Board of Adjustment*,[168] a Missouri court held that a zoning board of adjustment could revoke a permit that was incorrectly issued by a zoning commission. The permit was for a gun club on a 49-acre tract of floodplain near the Missouri River where county floodplain regulations did not permit such uses. Nearby landowners appealed the permit to the board several months after the commission issued it. Prior to this they had been unaware of the club.

THE TAKING ISSUE

In 36 of the 55 floodplain regulation cases in the last decade, a "taking" was one of the issues addressed. The courts in 34 of these cases held that there had been no taking. A taking was found in each of two cases where the regulations were subject to other deficiencies such as inadequate data.[169] Both were lower court decisions; in each, the court endorsed the general concept of regulations yet disapproved of them as applied to the specific property in question. This resounding support for floodplain, wetland, coastal zone, and other regulations against claims of taking may explain why courts now focus more closely on the reasonableness issue and other aspects of regulations and why "taking" is now rarely the major issue.

U.S. Supreme Court Cases. During the 1970s the U.S. Supreme Court considered the taking issue in zoning cases for the first time since the 1920s. One case involved regulations for a flood area although the court did not make a decision on the merits. Because U.S. Supreme Court decisions are important to all lower courts, its treatment of the taking issue will be examined.

In the first of these cases, *Penn Central Transportation Co. v. City of New York*,[170] the Court upheld New York City's Landmarks Preservation Law to protect landmarks and neighborhoods. This law, combined with applicable zoning ordinances, permitted that individual structures be designated as "landmarks" and the blocks containing the structures as "sites". Owners of designated structures were required to keep exterior features in good repair. Exterior alterations require approval by a commission. Accompanying zon-

ing bylaws permitted owners of designated buildings to transfer development rights to other lots on the block.

In analyzing the law, the Court noted that "this Court, quite simply, has been unable to develop any set formula for determining when justice and fairness require that economic injuries caused by public action be compensated by government, rather than remain disproportionately concentrated on a few persons."[171] The Court analyzed the public need for the law and the severity of the impact on Penn Central, the landowner. It found that Penn Central had not been unfairly burdened by the regulations, which affected all landmarked property. The Court concluded that Penn Central had a reasonable return on its investment in light of the use now being made of the structure and similar uses in the area owned by Penn Central. Although the Court did not consider the constitutionality of the development rights scheme *per se*, it noted that the rights "were valuable" and served to mitigate the impact of the regulations.

In a second case, *Agins v City of Tiburon*,[172] the Court generally sustained "residential planned development and open space" zoning regulations for a section of Tiburon, California. The regulations had been adopted pursuant to a state law that required California communities to prepare a plan governing both land use and development of open space. The contested regulations were designed to discourage the "premature and unnecessary conversion of open-space land to urban uses." One of the ordinance's objectives was to prevent premature conversion of open space, "thereby protecting against the resultant adverse impacts such as . . . disturbance of the ecology and the environment, hazards related to geology, fire and flood . . ."[173] The Court did not extensively discuss the taking issue since the landowner had not applied for a permit under the ordinance, but had rather attacked the general validity of the regulations. The Court strongly endorsed the regulatory objectives—to discourage premature conversion of open space. It held that the landowner had not shown that he was deprived of economic use of his land. Noting that benefits as well as burdens from the regulations would accrue to the landowner and that this was relevant to a consideration of taking, the Court noted:

> Appellants therefore will share with other owners the benefits and burdens of the city's exercise of police power. In assessing the fairness of the zoning ordinance, those benefits must be considered along with any diminution in market value that the appellants might suffer.[174]

The Court here, as in *Penn Central*, did not concentrate on the diminution in value caused by the regulations but on whether some value remained for the entire parcel of land.

In a third decision, *San Diego Gas and Electric Co. v. City of San Diego*,[175] the Supreme Court dismissed an appeal by a utility company which claimed that "downzoning" of a 214-acre tract (some of it floodplain) by the city of San Diego was a taking by inverse condemnation. The Court dismissed the appeal because a final judgment had not been made in the case since further proceedings were contemplated at the trial court level. Nevertheless, Justice

Brennan filed a vigorous dissent joined by Justices Stewart, Marshall, and Powell.

The decision is of interest despite dismissal of the appeal because the strong dissent indicates a potential willingness on the part of the Court to review state and local land use regulation cases as violative of 5th Amendment as well as 14th Amendment guarantees. However, it is to be noted that regulations were apparently being used to lower land values prior to acquisition—a traditionally invalid use of police powers.

The appellant in the case had acquired 214 acres of marshy floodplain land in 1966 when it was zoned for industrial and agricultural uses. In 1973, San Diego downzoned a portion of the land from industrial to agricultural and increased the minimum lot sizes. The city also incorporated the land into an open space plan and designated it for potential acquisition. The appellant filed suit, claiming damages of $6,150,000 in inverse condemnation, and seeking mandamus and declaratory relief as well. The trial court granted judgment for the appellant. The California Court of Appeals affirmed, holding, in part, that the purpose of the downzoning was to lower property values. The California Supreme Court granted the city's petition for hearing but transferred the case to the Court of Appeals for rehearing in light of the intervening *Agins* decision. There, the California Supreme Court had held that an owner deprived of substantially all beneficial use of the land by zoning regulation is not entitled to an award of damages in inverse condemnation, but only to invalidation of the regulation in an action for mandamus or declaratory relief. The California Supreme Court denied further review and the matter was appealed to the U.S. Supreme Court.

Justice Blackmun, speaking for the majority of the Supreme Court, dismissed the appeal because the lower court's decision was not final, but he warned that "we are frank to say that the federal constitutional aspects of that [the taking] issue are not to be cast aside lightly . . . "[176] Justice Brennan, in his dissent, argued that the decision by the California Court of Appeals holding that a state regulation could not be a taking under federal law was a final judgment on this matter, subject to Supreme Court review. He argued further that the Court of Appeals had applied a misinterpretation of federal law and that "once a court finds a police power regulation has effected a 'taking', and ending on the date the government entity chooses to rescind or otherwise amend the regulation."[177]

Tests for a taking. Federal and state court decisions during the decade emphasized similar factors in deciding whether a taking had occurred. Several tests were often simultaneously applied. The taking issue was not usually addressed in isolation but in combination with questions about the validity of the regulatory objectives, the reasonableness, basic fairness (due process) and nondiscriminatory nature of the regulations.[178] Regulations that were deficient in other aspects were in several instances held to be a taking.[179] The usual final test was, Did the regulations prevent all economic or reasonable use of the land? The entire parcel was generally examined, not just the area subject

to flooding.[180] Regulations which confined property to open space uses were sustained in a number of important decisions.[181]

Preventing nuisances—Without exception, courts held that prevention of nuisances on private lands was not a taking. Regulations controlling uses that would be "nuisance like" in causing damage to adjacent lands or threatening public safety do not take any property right because landowners have no right to make nuisances of themselves. During the 1970s many cases upheld floodway and other regulations designed to prevent offsite nuisance-like effects even when those regulations prohibited all or essentially all economic use of lands.[182]

Physical interference with private lands—In contrast with the decisions on nuisance prevention, courts have almost always held that public activities which physically interfere with private lands constitute a taking. For example, public construction of a dune on private land which had been damaged by a severe storm in March 1962, was held to be a taking.[183] But several courts held that because regulations do not physically interfere with private lands, they do not constitute takings.[184]

"Public use" of private land—Courts have usually held that natural conveyance of flood flows, flood storage, erosion control, and other passive flood hazard reduction functions are not public uses of private land that require compensation.[185] As one court in a floodplain case noted, "[T]he State has not placed appellant's land in the path of floods, nature has."[186] Floodplain regulations do not enhance any government enterprise.[187]

Balancing private and public interests—Courts generally have balanced society's need for regulations against the impact of regulations on private landowners: severe impact on individual property owners can be justified when the public need is great. In recent years courts have come to rely increasingly on the legislative process to balance the needs and impacts and have minimized judicial oversight.[188]

Equity in the distribution of benefits and burdens—Courts noted that government actions which "unfairly" burden a few for the good of the many may be held a taking, although during the decade no floodplain regulations were held invalid on equitable grounds alone. Two Supreme Court decisions cited above and many lower court decisions on takings have stressed the need for equity in regulations.[189] However, a Massachusetts decision[190] upheld regulations for a wetland flood storage area to prevent increased downstream flood losses despite arguments that regulations benefited downstream property owners without reciprocal benefits to upstream owners. The court held that "as long as the restrictions are reasonably related to the implementation of a policy . . . expected to produce a widespread public benefit and applicable to all similarly situated property," they need not produce a reciprocal benefit.[191]

Regulations adopted to serve regional, statewide, or national needs and which apply uniformly to flood-prone properties are less likely to be held a taking. In finding that no taking had occurred, several courts emphasized the role of regulations as part of a broader plan or program.[192]

Diminution in value—Courts held that regulations may diminish property values, but that at some point such diminution will constitute a taking. This test has been cited in many cases during the last decade, but rarely has it been more than one of several factors considered.[193] Instead, courts have paid more attention to whether the regulations deny all reasonable use of the land.

Denial of all reasonable or economic use of land—The most common "final" test for taking during the decade was whether regulations denied all "reasonable" or "economic" use of land. A detailed economic analysis was rarely undertaken. In a number of cases, courts have found that agriculture, forestry, and other open space uses were "reasonable" in certain contexts.[194] Courts also held that the regulation's impact on an individual's entire property, not just the floodplain portion, must be considered in deciding whether reasonable uses remain.[195] Although courts emphasized, as a matter of principle, that regulations must not prohibit all reasonable use, in several cases they held that proposed uses that would increase flood heights or would be subject to severe flood damages were not reasonable, despite few remaining economic uses for the land.[196]

No right to destroy the natural suitability of the land—Several courts held that landowners had no right to destroy the natural suitability or capability of lands. Hence, prohibition of uses threatening such suitability was not considered a taking. In one wetland case,[197] the court sustained the constitutionality of state-supervised shoreland regulations. The decision was based in part on the public trust in waters and also on the theory that a landowner has no right to destroy the natural suitability of the land when such uses will injure the public: no right was "taken" by the regulations. In effect, paramount public interests were recognized in private wetlands.

Wetland and other resource protection regulations. Restrictive wetland regulations have been widely litigated over the last decade, primarily on the taking issue. Most courts have sustained restrictive regulations, particularly in the last five years.[198] Before 1970, most decisions were adverse to highly restrictive wetland regulations, giving rise to the caveats in Volumes 1 and 2[199] that careful distinctions be drawn between floodplain regulations related to hazard reduction and wetland controls designed to protect wildlife and environmental resources. Continued distinction between hazard reduction and environmental regulations may be desirable in some instances to provide independent but interrelated bases for permit evaluation and support for regulations. However, regulations combined to reduce flood losses and protect wetlands may be mutually supportive in a legal context.

Decisions favorable to wetland protection include federal court cases sustaining Corps denials of Section 10 and Section 404 permits for dredging and filling in wetlands because the material could adversely affect wildlife, water quality, and other environmental values. For example, in *Deltona Corp. v. United States*,[200] the U.S. Court of Claims held that the denial of a permit by the Corps of Engineers to dredge and fill a mangrove wetland in Florida

did not take private property. The court noted that denial of the permit would affect the usefulness of only a portion of the property.

State court decisions have been increasingly favorable as well. In *Just*,[201] the most famous of these, the Wisconsin Supreme Court flatly rejected earlier precedents from other jurisdictions that invalidated wetland controls and it upheld state-supervised county shoreland zoning restrictions as nonconfiscatory. Tight restrictions were not a taking, the court argued, because the landowner had no absolute right to improve the land:

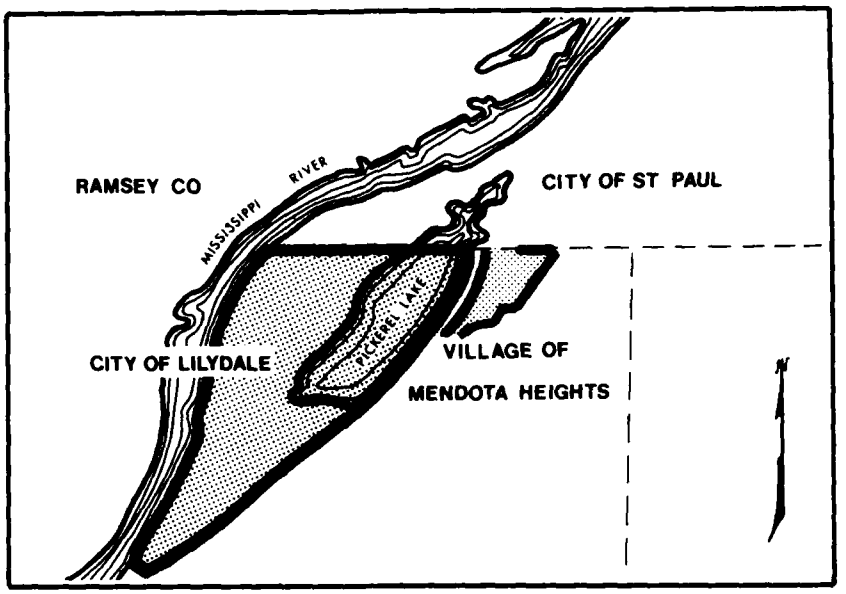
> Is the ownership of a parcel of land so absolute that man can change its nature to suit any of his purposes? The great forests of our state were stripped on the theory man's ownership was unlimited. But in forestry, the land at least was used naturally, only the natural fruit of the land (the trees) were taken. The despoilage was in failure to look to the future and provide for the restoration of the land. An owner of land has no absolute and unlimited right to change the essential character of his land so as to use it for a purpose for which it was unsuited in its natural state and which injures the rights of others.[202]

In *Potomac Sand and Gravel Co.*,[203] the Maryland Court of Appeals upheld a statute prohibiting dredging of coastal wetlands in Charles County. In *Sands Point Harbor, Inc. v Sullivan*,[204] the New Jersey Supreme Court held that the New Jersey Coastal Wetland Act and an administrative order adopted pursuant to it served valid objectives, did not discriminate between similarly situated landowners, and did not take private property.

Courts have broadly endorsed a wide range of other resource protection and management regulations that apply, to a greater or lesser extent, to floodplains. Courts in Minnesota[205] and Oregon[206] have sustained special state or state-supervised regulations for recreational wild and scenic rivers or river corridors. Courts in California,[207] New Jersey,[208] and North Carolina[209] have sustained coastal zone management programs. Courts in many states have sustained agricultural zoning.[210] The courts of Wisconsin[211] and Washington State[212] have sustained shoreland regulations for lake and stream shores.

Relationship of regulations to acquisition. In several decisions, courts have considered the validity of floodplain regulations where public purchase of land was contemplated in the future. In *County of Ramsey*,[213] the Minnesota Supreme Court sustained floodplain regulations for severely flooded land intended for future park acquisition. The court held that minimization of flood damages and purchase of flood insurance were valid independent objectives, but warned that regulations designed solely to reduce property values would be a taking. Courts from other jurisdictions have endorsed a similar rule.[214] Zoning or other regulations (except official mapping of streets) solely to reduce future condemnation costs are a taking, but not regulations based on valid independent objectives that reduce land values only incidentally.

In *Turner*,[215] a California court sustained highly restrictive regulations in an area for which the Corps of Engineers had recommended acquisition of flowage easements. The court rejected arguments that payment should be pro-



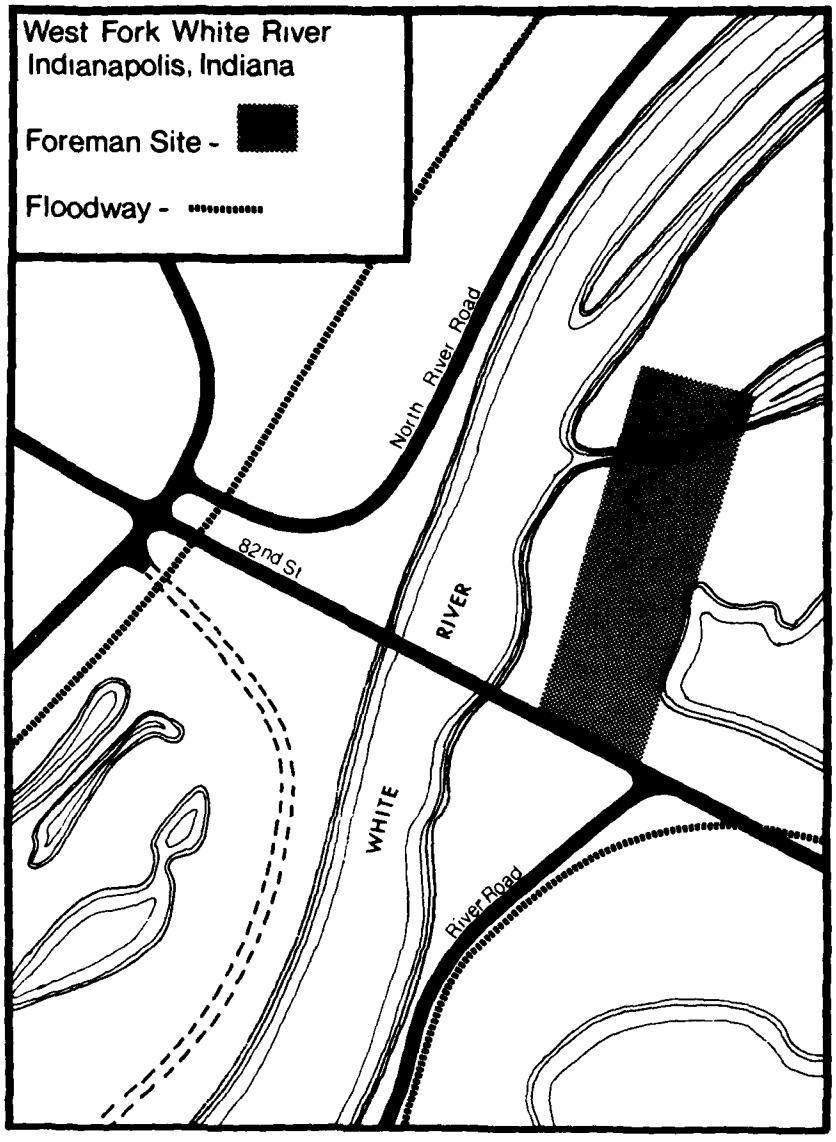
The Minnesota Supreme Court in *County of Ramsey v. Stevens* upheld floodplain zoning as applied to this relocation area.

vided for the restrictions and noted that it was the option of the government body to regulate rather than to acquire the lands.

In *Foreman*[216] a floodplain landowner questioned the validity of state encroachment regulations based in part on an argument that flood easements should have been acquired instead because the state encroachment statute authorized both regulations and easements. The court rejected the landowner's contention and held that the state had the option either to regulate or to acquire the lands.

In both the *Turner* and *Foreman* cases, the landowners argued either that the regulations were invalid as a taking or that payments should be awarded for reduction in land values if the regulations were found valid (i.e., inverse condemnation). These arguments were rejected there and also in *Zisk v. City of Roseville*,[217] in which a California court held that a landowner could not claim compensation for floodplain restrictions while at the same time contesting the restrictions. Rather, he should have initiated a suit in eminent domain. A Pennsylvania case took a similar position.[218] Although no court awarded damages for floodplain restrictions, a Minnesota court warned that damages might be awarded in a case where the impact of regulations was too great.[219]

A New York court held that floodplain regulations with the ulterior motive of maintaining private land as a park were a taking where the owner offered



In *Foreman v. State Department of Natural Resources*, an Indiana court upheld the state's encroachment regulations.

to comply with applicable floodplain regulations.[220] The floodplain regulations were not, in themselves, an issue.

Cases invalidating regulations as a taking. Only two cases in the decade held that floodplain regulations were a taking. Both occurred in the early 1970s and were lower state court decisions. In both instances, the regulations were subject to other defects.

In *Sturdy Homes, Inc. v. Township of Redford*,[221] a Michigan court held that regulations were confiscatory when they were applied to an area with "no evidence of flooding." In *American National Bank and Trust Co. of Chicago v. Village of Winfield*,[222] an Illinois court generally supported the concept of regulation to protect aquifer recharge, flood storage, and open space, but it stated that restriction of a 32-acre parcel (70% within the floodplain) to single-family residences was unreasonable. Fill for such residences would have cost $4,192 to $12,577 an acre. The land was only worth $6,000 and acre for single-family use.

A lower court case from New York also held that denial of a permit under a dune protection ordinance (not a floodplain ordinance *per se*) was invalid, although the regulations were not, *per se*, a taking.[223] The irregular procedures followed by the town may have had much to do with the holding, however. The town board had first issued a permit for a dwelling on a dune and then denied it pursuant to a dune protection ordinance. Construction had already commenced after the permit was issued.

GOVERNMENTAL LIABILITY FOR FLOOD DAMAGES

Courts traditionally have not held federal, state, or local governments liable for flood damage except where land has been permanently flooded because of dam construction or other government projects. However, this position has changed as Congress and state legislatures have made units of government responsible for some types of flood damages. For example, in adopting the NFIP, Congress has made the federal government responsible for payment of flood insurance claims. Based on common law theories of liability, courts have also been willing to hold governments liable for certain types of flood damages that result from construction of drainage facilities.

Liability for flood control and drainage measures. Courts have held that governments have no affirmative duty to construct flood control works and are not responsible for flood damages if dams, levees, or other protection works fail to provide flood protection.[224] This is generally true even if the works were operated negligently.[225] However, courts have found liability in certain circumstances. For example, a court held a government body liable for construction of a dam that caused flooding that was "natural and probable," even though not intended, because the dam increased groundwater levels.[226]

In some jurisdictions, courts have held governments liable for construction of storm sewers that increased flooding on downstream land. For example, In *Masley v. City of Lorain*,[227] the Ohio Supreme Court held that the development of a portion of a creek as a stormwater system that increased flooding was a taking of property. Courts have also held municipalities liable for flood damages resulting from improperly designed storm sewer systems constructed by landowners and dedicated to the city.[228]

Liability for adoption of regulations. No court has held a government responsible for increased flood damages caused by adoption of regulations or failure

to adopt regulations. Whether such a holding will occur at some time in the future in light of courts' liberalized positions on government responsibility remains to be seen. The court in *Turner*[229] hinted that a government unit might be liable for increased flood damages if regulations substantially increased damages beyond those naturally occurring. In addition, the Minnesota Supreme Court in *County of Ramsey*[230] held that a community must adopt floodplain regulations pursuant to a state statute specifically requiring such adoption. Moreover, the court specifically ordered a noncomplying community to adopt regulations within 72 hours, although it stopped short of holding that financial liability would accrue from failure to do so. Even if a government unit was responsible, individual government officials would not be. In *Gaebel v. Thornbury*,[231] a Pennsylvania court held that individual council members were not personally responsible for the decrease in value caused by regulations.

Flood insurance payments. At least 25 cases have addressed some aspect of the National Flood Insurance Program. Although none has focused specifically on NFIP standards for floodplain regulations, the cases will be discussed briefly because the program is pertinent to state and local regulations.

In the best known of these cases, *Texas Landowners Rights Association v. Harris*,[232] a group of landowners and municipalities attacked the basic validity of the statutory framework of the NFIP pursuant to which FEMA establishes land use control standards as a condition to purchase of federally subsidized flood insurance. The District Court for the District of Columbia upheld the program and its regulations and issued a declaratory judgment, reasoning that subsidized flood insurance was a benefit and not a property right. A community could not claim a taking of property if insurance (benefits) or disaster relief (benefits) were denied for failure to comply with standards. The court also rejected arguments that the program violated the 10th Amendment by legislating matters exclusively within the prerogative of the states.

Although this was a lower federal court decision and, as such, does not act as a bar to later cases contesting particular aspects of the NFIP, it gives considerable support to the program's basic validity.

In another important decision, *Commonwealth of Pennsylvania v. National Association of Flood Insurers*,[233] a federal district court in Pennsylvania rejected a billion dollar claim against FIA by the Commonwealth of Pennsylvania after Hurricane Agnes. Pennsylvania argued that FIA had not publicized the National Flood Insurance Program, as required by statute. The court held that FIA had distributed brochures and carried out other public information activities.

Two federal court decisions sustained FIA suspension of communities from the NFIP because they failed to adopt "regular" program regulations. In both cases the community contested the accuracy of the flood maps prepared by FIA. In one, *Roberts v. Secretary, Department of Housing and Urban Development*,[234] the district court held that maps taking into account existing conditions were sufficient. In the second, *City of Falmouth*,[235] the district court noted that the normal map appeal procedure had been followed and that if a

community wanted further review, it could adopt the necessary ordinances required for the regular program while additional analysis was taking place.

Other decisions have addressed the payment of flood insurance claims. One court denied a claim for damage to construction materials placed on the ground without cover and damaged by flooding from Lake Erie.[236] Another court held that under the terms of the statute and insurance policies, a rug damaged when a patio was flooded was not "flood damage" compensable under the flood insurance act.[237] Similarly, another court held that damage to a house from gradual beach erosion not associated with severe storms was not compensable.[238] In contrast, one court held that damage to a slab foundation and patio for a beachfront cottage undermined by a hurricane was compensable because it was due primarily to a single severe event.[239]

Another court decided that damage to houses built on filled wetlands in Louisiana,[240] which was caused by flood-related soil compaction, was not compensable even though flooding in the area did increase groundwater levels.

Courts in several cases denied claims where insurance was purchased while a flood was in progress or on the day of the flood.[241] One court held that a private insurance company had to pay an insurance claim for damage to a property in a community not in the NFIP.[242] An insurance agent erroneously accepted a check for a flood insurance policy, submitted an application form, and cashed the check before learning that flood insurance was not available.

One court upheld total loss payments for a partially damaged structure because repair would have been impractical. In this case, *Gibson v. Secretary of U.S. Dept. of Housing and Urban Development*,[243] a district court held that landowners were entitled to recover costs for constructing a residence at a new location, despite the physical possibility of repairing the structure at the existing location at a much lower price. Flooding had created a permanent channel around the west side of a house, separating it from the stream bank and increasing the flood risk to the point that repair was impractical.

Courts in other flood insurance cases have dealt with procedural issues such as running of the statute of limitations for filing insurance claims;[244] payment of interest and attorney's fees;[245] whether federal courts have exclusive jurisdiction over the flood insurance program (they do not, but federal law must be applied);[246] and whether the federal government could assume issuance of policies from the National Flood Insurers Association (it could).[247]

Avoiding Legal Problems

During the 1980s state and local governments will be able to regulate floodplain areas with greater confidence because of the last decade's favorable court decisions on the taking issue, the sufficiency of floodplain enabling statutes, regulatory objectives, and maps. They can also adopt broader resource management programs with flood-hazard reduction components due to the widespread support for wetland, coastal zone, and other environmental regula-

tions during the decade. Despite greater confidence, communities and states should carefully prepare and implement regulations to avoid legal problems. Where there are questions concerning the validity of adoption procedures (e.g., for resolutions) regulations should be readopted.

States and local governments should design programs to avoid inverse condemnation ("taking") problems. One way of doing this is to focus regulatory goals and standards upon the "nuisance" impacts of floodplain activities such as cumulative increases in flooding, pollution, or other damages to adjacent, upstream, or downstream lands. Courts have been sympathetic to regulations designed to prevent any increased damage to other lands, including not only traditional floodways but also zero-rise floodway restrictions, dune protection regulations, flood storage and stormwater detention regulations, strict control of chemical and gasoline storage and other hazardous and nuisance uses in the floodplain. The difficulties posed by the taking issue can also be diminished by applying regulations consistently to similarly situated properties and by distinguishing between the application of regulations (controlling private use) and eminent domain powers (some measure of public use).

For less seriously flooded areas, regulations can permit low-density, flood-protected structural development or open spaces with economic return such as golf courses, agriculture, forestry, and recreation. The impacts of regulation can be reduced through cluster subdivision provisions, density bonus provisions, and real estate tax incentives. Special permit procedures can provide room for negotiation between landowners and the community or the state.

Comprehensive community planning and regulations and even-handed administration of regulations will also help to meet taking challenges because courts carefully examine the overall rationality and fairness of regulations in deciding whether a taking has occurred.

Governments should provide a sound factual base (maps and other data) for regulations and for the issuance and denial of permits since courts now examine the data base with increasing care. Floodplain maps should be upgraded as watershed conditions change, new flood data becomes available, or development pressures occur. Nevertheless, relatively small-scale and inaccurate maps may suffice where administrative procedures are available to upgrade data on a case-by-case basis as development permits are submitted.

It is also important that the raw data used to prepare maps be preserved for future support of regulations in court. Communities and states should retrieve such information from flood insurance study contractors before the data are lost. Contractors are required to keep it no longer that five years. It is also important that states and communities use experts in hydrology, water resources engineering, and other water-related subjects in fact finding to form the basis for issuance or denial of permits.

Governments should, to the extent possible, provide similar degrees of regulation for similarly situated flood-prone properties since courts are increasingly concerned with the fairness and equity of regulations. In general, regulatory agencies should define floodway lines to provide conveyance on both sides

of a stream. However, mathematical precision is not necessary for setting boundaries. Uniform flood protection elevations should be applied to similarly flooded properties. Only when there are sound reasons should distinctions be made between similarly situated properties.

Regulations should be consistent with broader community and regional planning goals and guidelines. Courts more easily justify the rationale and equity of regulations that are based on soundly conceived short-term and long-term comprehensive data-gathering, planning, and regulatory programs. Comprehensive data-gathering may include community-wide or regional resource inventories. Comprehensive planning may include that done for floodplain management, disaster mitigation, drainage, and land use management.

Governments should review floodplain permits and subdivision plans with care to avoid potential claims of liability which may arise if development increases flood heights. To avoid such liability, agencies may require that landowners whose activities increase flood heights on other lands purchase easements from other affected landowners. Governments should also define floodway boundaries to avoid substantial flood height increases. They should describe flood maps as approximate and warn that larger flood events may occur. Governments should also construct and operate drainage works, dikes, dams, and other flood control measures with increasing care in light of the emerging doctrines of municipal liability. In short, governments should avoid any action which may increase private flood damages.

Footnotes

1. See discussion at p. 138.
2. 272 U.S. 365 (1926).
3. 277 U.S. 183 (1928).
4. See Water Resources Council *et al.* (1970), Appendix A, p. 467.
5. *Id.* at 24. See also J.A. Kusler Associates (1975).
6. See Water Resources Council *et al.* (1970) at 59.
7. See J.A. Kusler Associates (1975) at 18.
8. See Water Resources Council *et al.* (1970) at 42.
9. *Id.* at 297.
10. *Id.* at 301, 314.
11. *Id.* at 392.
12. *Id.* at 326, 330, 338.
13. *Id.* at 326, 335.
14. *Id.* at 326.
15. *Id.* at 356, 364.
16. *Id.* at 340.
17. *Id.* at 340, 354.
18. *Id.* at 389.
19. *Id.* at 305, 392.
20. *Id.* at 302.
21. 283 N.W.2d 538 (Minn. 1979).
22. 276 N.W.2d 377 (Iowa 1979).
23. 395 N.E.2d 880 (Mass. App. Ct. 1979).
24. 387 N.E.2d 455 (Ind. App. 1979).

25. 88 Wash.2d 726, 565 P.2d 1162 (1977).
26. 173 N.J. Super. 311, 414 A.2d 280 (1980).
27. 363 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973).
28. 57 A.D.2d 51, 394 N.Y.S.2d 913 (1977).
29. Mass. App. Ct. Adv. Sh. (1980) 637.
30. 24 C.A.3d 311, *101 Cal. Rptr.* 93 (1972).
31. 116 N.J. Super. 148, 281 A.2d 377 (1971).
32. 90 Misc.2d 360, 394 N.Y.S.2d 517 (1977).
33. 126 N.J. Super. 200, 313 A.2d 624 (1973).
34. 247 N.W.2d 684 (S.D. 1976).
35. 430 F.2d 199 (5th Cir. 1970).
36. *E.g.*, P.F.Z. Properties, Inc. v. Train, 393 F.Supp. 1370 (D.D.C. 1975).
37. Avoyelles Sportsmen's League v. Alexander, 473 F.Supp. 525 (W.D. La. 1979).
38. United States v. Byrd, 609 F.2d 1204 (7th Cir. 1979); Minnehaha Creek Watershed District v. Hoffman, 597 F.2d 617 (8th Cir. 1979).
39. 266 Md. 358, 293 A.2d 241 (1972), *cert. denied*, 409 U.S. 1040 (1972).
40. 116 R.I. 54, 352 A.2d 661 (1976).
41. 56 Wis.2d 7, 201 N.W.2d 761 (1972).
42. 115 N.H. 124, 336 A.2d 239 (1975).
43. 399 So.2d 1374 (Fla. 1981).
44. 57 A.D.2d 51, 394 N.Y.S.2d 913 (1977).
45. 243 Ga. 577, 255 S.E.2d 63 (1979), *cert. denied*, 440 U.S. 936 (1979).
46. *E.g.*, Cinelli v. Whitfield Transportation, Inc., 83 N.M. 205, 490 P.2d 463 (1971); Hamlin v. Matazzaro, 120 N.J. Super. 164, 293 A.2d 450 (1972).
47. 108 Ill.App.2d 230, 247 N.E.2d 47 (1969).
48. *Id.*, 247 N.E.2d at 51.
49. 120 N.J. Super. 164, 293 A.2d 450 (1972).
50. 495 S.W.2d 643 (Mo. 1973).
51. 40 A.D.2d 1005, 338 N.Y.S.2d 778 (1972).
52. See cases cited *in notes* 213-220 *infra*.
53. 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973).
54. *Id.*, 284 N.E.2d at 876.
55. *Id.*, 284 N.E.2d at 876.
56. Moreland Development Co., Inc. v. City of Tulsa, 596 P.2d 1255 (Okla. 1979).
57. Famularo v. Board of County Commissioners of Adams County, 505 P.2d 958 (Colo. 1973).
58. Maple Leaf Investors Inc. v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
59. Lindquist v. Omaha Realty, Inc., 247 N.W.2d 684 (S.D. 1976).
60. 495 S.W.2d 643 (Mo. 1973).
61. 283 N.W.2d 538 (Minn. 1979).
62. 283 N.W.2d 918 (Minn. 1979).
63. 120 N.J. Super. 164, 293 A.2d 450 (1972).
64. Jefferson County v. Johnson, 333 So.2d 143 (Ala. 1976).
65. 596 P.2d 1255 (Okla. 1979).
66. 270 Md. 652, 313 A.2d 820 (1974).
67. 283 N.W.2d 918 (Minn. 1979).
68. 126 N.J. Super. 200, 313 A.2d 624 (1973).
69. 247 N.W.2d 684 (S.D. 1976).
70. *Id.*, 247 N.W.2d at 686.
71. 563 S.W.2d 239 (Tex. 1978).
72. Frisco Land and Mining Co. v. State, 74 Cal. App.3d 736, 141 Cal. Rptr. 820 (1977).
73. Adams v. North Carolina Dept. of Natural and Economic Resources, 295 N.C. 683, 249 S.E.2d 402 (1978).
74. New York City Housing Authority v. Commissioner of Environmental Conservation Department, 82 Misc.2d 89, 372 N.Y.S.2d 146 (1975).
75. Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).

76. Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
77. Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979).
78. Usdin v. State Department of Environmental Protection, 173 N.J. Super. 311, 414 A.2d 280 (1980).
79. 270 Md. 652, 313 A.2d 820 (1974).
80. 92 Wash.2d 894, 602 P.2d 1172 (1979).
81. 240 Ga. 177, 240 S.E.2d 241 (1977).
82. Scott v. State ex. rel. State Highway Comm., 23 Ore. App. 99, 541 P.2d 516 (1975).
83. County of Pine v. State Department of Natural Resources, 280 N.W.2d 625 (Minn. 1979).
84. Frisco Land and Mining Co. v. State, 74 Cal. App.3d 736, 141 Cal. Rptr. 820 (1977); Brown v. Frement, 75 Cal. App.3d 141, 142 Cal. Rptr. 46 (1977).
85. Toms River Affiliates v. Department of Environmental Protection, 140 N.J. Super. 135, 355 A.2d 679 (1976).
86. Adams v. North Carolina Department of Natural and Economic Resources, 295 N.C. 683, 249 S.E.2d 402 (1978).
87. Horizon Adirondack Corp. v. State, 88 Misc.2d 619, 388 N.Y.S.2d 235 (1976).
88. Town of Monroe v. Carey, 96 Misc.2d 238, 412 N.Y.S.2d 939 (1977).
89. Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972).
90. Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979).
91. Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).
92. Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
93. Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979).
94. Subaru of New England, Inc. v. Board of Appeals of Canton, 395 N.E.2d 880 (Mass. App. Ct., 1979).
95. American National Bank and Trust Company of Chicago v. Village of Winfield, 1 Ill. App.3d 376, 274 N.E.2d 144 (1971).
96. Brown v. City of Joliet, 108 Ill. App.2d 230, 247 N.E.2d 47 (1969).
97. Metropolitan St. Louis Sewer District v. Zykan, 495 S.W.2d 643 (Mo. 1973).
98. Hamlin v. Matazzaro, 120 N.J. Super. 164, 293 A.2d 450 (1972).
99. *Id.*
100. 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973).
101. *Id.*, 284 N.E.2d at 896.
102. Dur-Bar Realty Co. v. City of Utica, 57 A.D.2d 51, 394 N.Y.S.2d 913, 918 (1977).
103. Turnpike Realty Co. v. Town of Dedham, 362 Mass. 221, 284 N.E.2d 891, 896 (1972), *cert. denied*, 409 U.S. 1108 (1973).
104. Dur-Bar Realty Co. v. City of Utica, 57 A.D.2d 51, 394 N.Y.S.2d 913, 918 (1977).
105. Beckendorff v. Harris-Galveston Coastal Subsidence District, 558 S.W.2d 75 (Tex. 1977).
106. *Id.*, 558 S.W.2d at 81.
107. Sands Point Harbor, Inc. v. Sullivan, 136 N.J.Super. 436, 346 A.2d 612 (1975); Potomac Sand and Gravel Co. v. Governor of Maryland, 266 Md. 358, 293 A.2d 241 (1972), *cert. denied*, 409 U.S. 1090; J.M. Mills, Inc. v. Murphy, 116 R.I. 54, 352 A.2d 661 (1976).
108. In Re Sports Complex in Hackensack Meadowlands, 62 N.J. 248, 300 A.2d 337 (1973).
109. Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
110. Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979).
111. Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).
112. A.H. Smith Sand and Gravel Co. v. Department of Natural Resources, 270 Md. 652, 313 A.2d 820 (1974).
113. State v. A. Capuano Bros., Inc., 384 A.2d 610 (R.I. 1978).
114. 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972).
115. 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973).
116. 55 A.D.2d 700, 388 N.Y.S.2d 952, 953 (1976).
117. *Id.*, 388 N.Y.S.2d at 954.
118. Sturdy Homes, Inc. v. Tp. of Redford, 30 Mich. App. 53, 186 N.W.2d 43 (1971).
119. Iowa Natural Resources Council v. Van Zee, 261 Iowa 1287, 158 N.W.2d 111 (1968).
120. 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973).

121. *Id.*, 284 N.E.2d at 901.
122. Just v. Marinette County, 56 Wis.2d 7, 201 N.W.2d 761 (1972).
123. 473 F.Supp. 52 (N.D. Miss. 1979).
124. 427 F.Supp. 26 (D. Mass. 1976).
125. 276 N.W.2d 377 (Iowa 1979).
126. 283 N.W.2d 538 (Minn. 1979).
127. 395 N.E.2d 880 (Mass. App. Ct. 1979).
128. Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).
129. 243 Ga. 577, 255 S.E.2d 63 (1979), *cert. denied*, 440 U.S. 936 (1979).
130. Subaru of New England, Inc. v. Board of Appeals, 395 N.E.2d 880 (Mass. App. Ct. 1979).
131. 563 S.W.2d 239 (Tex. 1978).
132. *Id.*, 558 S.W.2d 75, at 76 (Tex. Civ. App. 1977).
133. MacGibbon v. Board of Appeals of Duxbury, 340 N.E.2d 487 (Mass. 1976).
134. Pope v. City of Atlanta, 243 Ga. 577, 255 S.E.2d 63 (1979), *cert. denied*, 440 U.S. 936 (1979).
135. Oakwood at Madison, Inc. v. Township of Madison, 117 N.J. Super. 11, 283 A.2d 353 (1971).
136. 270 Md. 652, 313 A.2d 820 (1974).
137. Roberts v. Secretary, Department of Housing and Urban Development, 473 F.Supp. 52 (N.D. Miss. 1979).
138. Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).
139. *Id.*, 276 N.W.2d at 389.
140. 242 Ga. 331, 249 S.E.2d 16 (1978).
141. See, *e.g.*, Brown v. City of Joliet, 108 Ill. App.2d 230, 247 N.E.2d 47 (1969); Turnpike Realty Co. v. Town of Dedham, 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973); A.H. Smith Sand and Gravel Co. v. Dept. of Water Resources, 270 Md. 652, 313 A.2d 820 (Md. App. 1974); Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979).
142. Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).
143. *Id.*, 276 N.W.2d at 383.
144. *Id.*, 276 N.W.2d at 388.
145. *Id.*, 276 N.W.2d at 384.
146. See cases cited in notes 151-166 *infra*.
147. *E.g.*, Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972); Zisk v. City of Roseville, 127 Cal. Rptr. 896, 56 Cal. App.3d 41 (1976).
148. *E.g.*, Turnpike Realty Co., Inc. v. Town of Dedham, 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973); Subaru of New England, Inc. v. Board of Appeals of Canton, 395 N.E.2d 880 (Mass. App. Ct. 1979).
149. *E.g.*, MacGibbon v. Board of Appeals, 340 N.E.2d 487 (Mass. 1976).
150. A.H. Smith Sand and Gravel Co. v. Dept. of Water Resources, 270 Md. 652, 313 A.2d 820, 828 (1974).
151. See, *e.g.*, cases cited in notes 21-28 *supra*.
152. Pope v. City of Atlanta, 242 Ga. 331, 249 S.E.2d 16 (1978).
153. *Id.*, 249 S.E.2d at 18.
154. Just v. Marinette County, 56 Wis.2d 7, 201 N.W.2d 761 (1972).
155. Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
156. Turnpike Realty Co. v. Town of Dedham, 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973).
157. 57 A.D.2d 51, 394 N.Y.S.2d 913 (1977).
158. Wolfram v. Abbey, 55 A.D.2d 700, 388 N.Y.S.2d 952 (1976).
159. *Id.*, 388 N.Y.S.2d at 953.
160. 340 N.E.2d 487 (Mass. 1976).
161. Pope v. City of Atlanta, 243 Ga. 577, 255 S.E.2d 63 (1979), *cert. denied*, 440 U.S. 936, (1979). The court also held that cumulative impact was one of several considerations in evaluating a permit.

162. 406 A.2d 577 (Pa. Commw. 1979).
163. *Id.*, 406 A.2d at 578.
164. *Id.*, 406 A.2d at 578.
165. 41 N.Y.2d 438, 361 N.E.2d 1028, 393 N.Y.S.2d 379 (1977).
166. *Id.*, 361 N.E.2d at 1033.
167. Scheff v. Tp. of Maple Shade, 149 N.J. Super. 448, 374 A.2d 43, (A.D. 1977).
168. 553 S.W.2d 721 (Mo. 1977).
169. See discussion accompanying notes 221, 222.
170. 98 S.Ct. 2646 (1978).
171. *Id.*, 98 S.ct. at 2659.
172. 100 S.Ct. 2138 (1980), *aff'g* 24 Cal.3d 266, 598 P.2d 25 (1979).
173. *Id.*, see 100 S.Ct. at 2142 where this language is cited.
174. *Id.*
175. 101 S.Ct. 1287 (1981).
176. 101 S.Ct. at 1294.
177. 101 S.Ct. at 1307.
178. See discussion in Kusler (1972).
179. *Id.*, see also note 221 *infra.*
180. *E.g.*, Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979); Moskow v. Commissioner of the Dept. of Environmental Management, 427 N.E.2d 750 (Mass. 1981).
181. *E.g.*, Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977); Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979); Kraiser v. Zoning Hearing Bd. of Horsham Tp., 406 A.2d 577 (Pa. Commw. 1979); Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979); Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972).
182. *E.g.*, Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972); Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979); Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979).
183. Lorio v. City of Sea Isle, 88 N.J. Super. 506, 212 A.2d 802 (1965). Construction of a sand dune on private property is a taking.
184. *E.g.*, Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979); Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
185. *E.g.*, Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977); Pope v. City of Atlanta, 240 Ga. 177, 240 S.E.2d 241 (1977).
186. Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977).
187. *Id.*; see also Foreman v. State Department of Natural Resources, 387 N.E.2d 455 (Ind. App. 1979).
188. *E.g.*, Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538, (Minn. 1979); Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr 93 (1972); Subaru of New England, Inc. v. Board of Appeals of Canton, 395 N.E.2d 880 (Mass. App. Ct. 1979).
189. See notes 132, 134, *supra;* Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979).
190. Moskow v. Commissioner of the Department of Environmental Management, 427 N.E.2d 750 (Mass. 1981).
191. *Id.*, 427 N.E.2d at 754.
192. *E.g.*, Maple Leaf Investors v. State Department of Ecology, 88 Wash.2d 726, 565 P.2d 1162 (1977); Young Plumbing and Heating Co. v. Iowa Natural Resources Council, 276 N.W.2d 377 (Iowa 1979).
193. *E.g.*, Spiegle v. Borough of Beach Haven, 116 N.J. Super. 148, 281 A.2d 377 (1971); County of Ramsey v. Stevens, 283 N.W.2d 918 (Minn. 1979).
194. *E.g.*, Turnpike Realty Co. v. Town of Dedham, 362 Mass. 221, 284 N.E.2d 891 (1972), *cert. denied*, 409 U.S. 1108 (1973); Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972). See also cases cited in notes 21-31 *supra.*
195. See cases cited in note 180 *supra.*
196. *E.g.*, Spiegle v. Borough of Beach Haven, 116 N.J. Super. 148, 281 A.2d 377 (1971); Turner v. County of Del Norte, 24 C.A.3d 311, 101 Cal. Rptr. 93 (1972); Foreman v. State Department of Natural Resources 387 N.E.2d 455 (Ind. App. 1979).

197. Just v. Marinette County, 56 Wis.2d 7, 201 N.W.2d 761 (1972).
198. See cases cited in notes 156, 157, *supra.*
199. See Water Resources Council *et al.* (1972).
200. 657 F.2d 1184 (Ct. Cl. 1981).
201. 56 Wis.2d 7, 201 N.W.2d 761 (1972).
202. *Id.*, 201 N.W.2d at 768.
203. 266 Md. 358, 293 A.2d 241 (1972), *cert. denied,* 409 U.S. 1040 (1972).
204. 136 N.J. Super. 436, 346 A.2d 612 (Super. Ct. App. Div. 1975).
205. County of Pine v. State, Department of Natural Resources, 280 N.W.2d 625 (Minn. 1979).
206. Scott v. State ex. rel. State Highway Comm., 23 Ore. App. 99, 541 P.2d 516 (1975).
207. State v. Superior Court of Orange County, 12 Cal.3d 237, 524 P.2d 1281, 115 Cal. Rptr. 497 (1974).
208. Toms River Affiliates v. Dept. of Environmental Protection, 140 N.J. Super., 355 A.2d 679 (1976).
209. Adams v. North Carolina Dept. of Natural and Economic Resources, 295 N.C. 683, 249 S.E.2d 402 (1978).
210. *E.g.*, Gisler v. County of Madera, 38 Cal. App.3d 303, 112 Cal. Rptr. 919 (1974).
211. Just v. Marinette County, 56 Wis.2d 7, 201 N.W.2d 761 (1972).
212. *E.g.*, State Dept. of Ecology v. Pacesetter Const. Co., 89 Wash.2d 203, 571 P.2d 196 (1977).
213. 283 N.W.2d 918 (Minn. 1979).
214. *E.g.*, Long v. City of Highland Park, 329 Mich. 146, 45 N.W.2d 10 (1950); Kissinger v. City of Los Angeles, 161 Cal. App.2d 454, 327 P.2d 10 (1958).
215. 24 Cal. App.3d 311, 101 Cal. Rptr. 93 (1972).
216. 387 N.E.2d 455 (Ind. App. 1979).
217. 127 Cal. Rptr. 896, 56 Cal. App.3d 41 (1976).
218. Gaebel v. Thornbury Township, Delaware County, 8 Pa. Commw. Ct. 379, 303 A.2d 57 (1973).
219. Krahl v. Nine Mile Creek Watershed District, 283 N.W.2d 538 (Minn. 1979).
220. Kessler v. Town of Shelter Island Planning Board, 40 A.D.2d 1005, 338 N.Y.S.2d 778 (1972).
221. 30 Mich. App. 53, 186 N.W.2d 43 (1971).
222. 1 Ill. App.3d 376, 274 N.E.2d 144 (1971).
223. Lemp v. Town Board of Town of Islip, 90 Misc.2d 360, 394 N.Y.S.2d 517 (1977).
224. United States v. Sponenbarger, 308 U.S. 256, (1939). B Amusement Company v. United States, 180 F.Supp. 386, (Ct.Cl. 1960).
225. See generally Oahe Conservancy Sub-District v. Alexander, 493 F.Supp. 1294 (D. South Dakota 1980).
226. Barnes v. United States, 538 F.2d 865 (Ct.Cl. 1976).
227. 48 Ohio St.2d 334, 358 N.E.2d 598 (1976). See also Myotte v. Village of Mayfield, 54 Ohio App.2d 97, 375 N.E.2d 816 (1977). Court held that a municipality which issued a building permit for an industrial complex and partially improved a drainage system, but not an appellant's land, was liable for increased run-off.
228. *E.g.*, Myotte v. Village of Mayfield, 54 Ohio App.2d 97, 375 N.E.2d 816 (1977); Sheffet v. County of Los Angeles, 3 Cal. App.3d 720, 84 Cal. Rptr. 11 (1970).
229. 24 Cal. App.3d 311, 101 Cal. Rptr. 93 (1972).
230. 283 N.W.2d 918 (Minn. 1979).
231. 8 Pa. Commw. Ct. 379, 303 A.2d 57 (1973).
232. 453 F.Supp. 1025 (D.D.C. 1978), *aff'd* 598 F.2d 311 (D.C. Cir. 1979), *cert. denied,* 100 S.Ct. 267 (1979).
233. 520 F.2d 11 (1975) *on remand,* 420 F.Supp. 221 (M.D. Pa. 1976).
234. 473 F.Supp. 52 (N.D. Miss. 1979).
235. 427 F.Supp. 26 (D. Mass. 1976).
236. Jeremy & Sons, Inc. v. Commercial Union Assurance Companies, 398 F.Supp. 374 (N.D. Ohio 1975).
237. Segal v. Great American Insurance Co., 390 F.Supp. 1074 (E.D.N.Y. 1974).
238. Mason v. National Flood Insurers Association, 361 F.Supp. 939 (D. Hawaii 1973).
239. Jackson v. National Flood Insurers Association, 398 F.Supp. 1383 (S.D. Texas 1974).

240. West v. Harris, 573 F.2d 873 (5th Cir. 1978), *cert. denied*, 440 U.S. 946 (1979); Zabel v. Tabb, 430 F.2d 199 (5th Cir. 1970), *cert. denied*, 401 U.S. 910 (1971).
241. Presley v. National Flood Insurers Association, 399 F.Supp. 1242 (E.D. Mo. 1975); Summers v. Harris, 573 F.2d 869 (5th Cir. 1978).
242. Horeftis v. National Flood Insurers Association, 437 F.Supp. 794 (E.D. Mich. 1977).
243. 479 F.Supp. 3 (M.D. Penn. 1978).
244. Nunnery v. Insurance Companies, Members of National Flood Insurers Association, 414 F.Supp. 973 (N.D. Miss. 1976); Horeftis v. National Flood Insurers Association, 437 F.Supp. 794 (E.D. Mich. 1977).
245. Davis v. Aetna Casualty and Surety Co., 329 So.2d 868, (Ct. App. La. 1976); Bains v. Hartford Fire Insurance Co., 440 F.Supp. 15 (N.D. Ga. 1977).
246. Davis v. Aetna Casualty and Surety Company, 329 So.2d 868, (Ct. App. La. 1976); Bains v. Hartford Fire Insurance Co., 440 F.Supp. 15 (N.D. Ga. 1977); Mason v. National Flood Insurers Association, 431 F.Supp. 1021 (N.D. Okla. 1977); Burrell v. Turner Corp., 431 F.Supp. 1018 (N.D. Okla. 1977); Drewett v. Aetna Casualty and Surety Co., 539 F.2d 496 (5th Cir. 1976).
247. National Flood Insurers Association v. Harris, 444 F.Supp. 969 (D.D.C. 1977).

CHAPTER VIII

STRATEGIES FOR THE 1980s

Chapters I through VII detailed progress and problems with floodplain management in the 1970s. This chapter deals with strategies for the 1980s to improve the effectiveness of regulations in combination with other management techniques not only to reduce flood losses but also to achieve broad economic and social goals. The first section describes overall strategies, including measures to reduce costs. The next section covers recommendations for specific local, state, and federal actions. The final section discusses subjects that need further research.

Overall Strategies

In the 1970s, federal, state, and local governments made progress in developing an overall policy to reduce future flood losses by requiring that new development and redevelopment be protected from flooding and applying hazard reduction measures to existing uses. Judicial support for these floodplain regulations was overwhelming. Even so, serious gaps and deficiencies remain in mapping, technical assistance, and regulations. Program coordination is incomplete and much work to implement policies remains.

If the thousands of state and local programs already under way are to be implemented, federal philosophy must shift during the 1980s. To date, FEMA has primarily encouraged local adoption of regulations by providing insurance incentives and generalized maps, standards, guidelines, and information. Now, technical assistance, more specific flood studies, wider application of federal expertise, and more flexibility in standards and criteria are needed to support state and local implementation of site-specific aspects of floodplain management. To do this, federal technical assistance, training, education, mapping, and standard-setting should be geared to the differing needs of each area but within a continued framework of overall standards (*e.g.*, the 100-year flood standard). For example, metropolitan flood hazard regulations should include provisions for stormwater management. As far as possible, federal support should encourage rather than discourage a tailoring of programs.

All levels of government should focus on ten types of action.

1. Improving flood studies not only to reflect actual hazards (wave heights, erosion, future watershed conditions) but also to delineate topographic contours, existing structures, roads and other features;
2. Upgrading interim regulations and resolutions to avoid legal problems, reduce delays in permit processing, and provide certainty to landowners;
3. Improving the administration, monitoring, and enforcement of floodplain regulations by increasing state and local expertise in planning, assessment of hazards and natural values, regulation, acquisition, relocation, flood warning systems, flood control works and flood insurance;
4. Developing predisaster and postdisaster plans to guide public investment and reduce losses to existing private and public uses;
5. Combining regulations and nonregulatory measures to reduce the damage potential of existing uses and to serve multipurpose community goals;
6. Guiding public works projects and public investment in the floodplain to avoid floodways and high hazard areas and to incorporate floodproofing measures;
7. Educating public officials, floodplain occupants, bankers, local governmental officials and architects in the details of flood loss reduction measures;
8. Coordinating or integrating floodplain plans with broader community and regional planning to serve multipurpose goals;
9. Revising federal, state, and local subsidies for flood insurance, disaster assistance, and floodplain regulations in order to provide incentives to floodplain occupants and local governments to develop their own self-help techniques for reducing flood losses;
10. Testing, documenting, and publicizing the long-term effectiveness of alternative flood loss reduction methods.

Reduced federal, state, and local spending in the 1980s may severely strain personnel, resources, and the implementation of flood damage reduction measures. High capital outlays and maintenance costs will make structural measures particularly difficult to implement. Funds to implement nonstructural measures may also be reduced. However, if governmental response to flood disasters over the last 50 years is any guide, arguments that regulations should be reduced to save government funds and that floodplain occupants be permitted to bear flood losses as they see fit are unrealistic. Once a flood occurs, pubic opinion or concern for flood victims forces Congress and state legislatures to appropriate monies for disaster relief, rebuilding, and flood control measures. An "ounce of prevention" is needed.

The combination of nonstructural floodplain measures along with regulations supports the cost-effective objectives that those who occupy the floodplain

should be responsible for the results of their own actions.[1] This type of management can also support cost-effective, multipurpose community goals such as less expensive municipal services (roads, sewers), optimum use of natural resources (water supply, agricultural land, timber, fish, and wildlife), renewal of blighted areas, and protection of the tax base, which is usually lowered when flood damage occurs.

Even though proponents of free market decision making usually fail to address the principal problem of uncontrolled floodplain activities—their long-term external costs—regulations will continue to be challenged during the next decade on philosophical grounds and as restraints to private and local government decision making. The alternative—piece-meal dismantling of regulations—would permit continued landowner irresponsibility. The floodplain landowner has little incentive to consider the external costs of increased flood heights and velocities, or the damages to other property caused by fill, dams, or buildings. Instead of relaxing regulations, planners and managers should focus on improving the quality of regulations, thereby reducing landowners' objections. Acquisition can also be used to minimize problems and reduce ultimate costs.

Floodplain regulations can be simplified and streamlined. More specific floodplain standards offer landowners more certainty about their use of the land. If states and localities adopt joint procedures for regulating floodplains and wetlands they can reduce the total time required for project review. Regulatory standards can be better tailored to special problems and needs and tax incentives can be coordinated to support regulations. Regulations can be incorporated into broader packages of floodplain management techniques to improve their quality and effectiveness.

Several strategies are available to improve floodplain management in spite of tight budgets.

- Program priorities should be carefully established. All levels of government should focus their mapping, planning, regulations, education, and technical assistance on areas subject to the most severe flood hazards and development pressures. Good examples are barrier islands and inland areas subject to flash floods.

- Funds should be reallocated to floodplain management techniques that have the greatest long-term cost effectiveness. For example, the federal grants to improve state floodplain management capability (now at a total level of $3 million) may be a better federal investment that the construction of a single small dam. In the long run, public acquisition of damage-prone properties may cost federal taxpayers less than repeated payment of flood insurance claims.

- Multipurpose programs should be encouraged. For grants in aid, technical assistance, and mapping, preference should be given to states and localities with multiobjective floodplain planning and management programs. This

will not only reduce flood losses but also support urban renewal, open space protection, and other social and environmental programs.

- Those who benefit from flood loss reduction measures should be made to bear a larger portion of the costs of such measures. Consistent federal policies are needed to require state, local, and private cost-sharing in flood control works, disaster assistance, acquisition, and other hazard reduction measures. This will reduce federal outlays and encourage states and localities to assume their share of the responsibilities.
- State and local floodplain management roles should be enhanced. State and local training and education, monitoring, permit processing, and acquisition are often more cost-effective than comparable federal programs because their staffs are closer to the problems, their pay scales are generally lower, duplication of work is reduced, and the personnel can be shared more easily with ongoing programs.
- Executive orders and state and local guidelines for public uses should be enforced. The Floodplain Management Executive Order and similar state and local guidelines for public uses that require either avoidance of flood hazards or flood protection should be carefully enforced. Their implementation can not only reduce future losses to the uses but also discourage private development which is often attracted by public services in the floodplain.
- The Disaster Assistance Act of 1974 requirements that hazard mitigation measures be adopted as a condition to federal disaster assistance should be consistently and vigorously enforced to reduce continued losses in frequently flooded areas.
- Flood loss reduction measures with long-term cost effectiveness and built-in safety factors should be emphasized. It is often more cost-effective to acquire and relocate structures than to support repeated flood losses at public and private expense. Elevation provides a greater built-in safety factor than levees and channeling. Acquisition or regulation to maintain open floodplains or floodways to protect their flood storage and natural conveyance capacities will often cost less than construction of flood control works.
- More flexible federal mapping criteria should be adopted. Managers should compare the costs of developing accurate and detailed area-wide flood studies with those for conducting case-by-case analyses of individual permits.
- Flood insurance rates should reflect the total risk. This will increase revenues for the flood insurance program and remove the present incentive to develop in areas where it is economically unjustified to do so.
- Government incentives for private self-help should be increased. Flood insurance rates and income tax or other economic incentives should be

revised to motivate private floodplain occupants to assume responsibility for reducing flood damage. Instruction should be provided to private landowners (residential, commercial, industrial) on how to establish flood warning systems, install floodproofing, and develop other loss-reducing measures. These measures can simultaneously support other goals such as energy efficiency. The public can be educated through brochures, workshops, or one-on-one consultations. Bankers, lawyers, architects, engineers, and others who advise landowners or finance, design, or build structures in the floodplain should be educated on the nature of flood hazards and on the economic value of flood protection measures.

- To facilitate evaluation of flood loss reduction measures on a national basis, a quantified national goal of holding flood losses to no more than a fixed average figure per year or reducing losses (*e.g.*, $2.5 billion per year through 1990) might be adopted. The effectiveness of regulations and other public and private flood loss reduction programs could be measured against such a quantified standard. This would facilitate the setting and balancing of federal budgets.

Local, State, and Federal Roles

The federal, state, and local partnership for floodplain management set forth in **A Unified National Program for Flood Plain Management** was tested during the 1970s. The partnership reflects a workable hierarchy of efforts that should continue to be implemented in the 1980s. State and local regulation, acquisition, and other floodplain management measures should be the basic elements of a unified program. The federal government should set standards, establish incentives, and provide technical assistance to support state and local programs. Implementation of the working partnership will require that the federal government understand and be responsive to state and local needs; and that states and local governments, in turn, accept greater responsibility for floodplain management.

LOCAL PROGRAMS

With state and federal help, the 17,000 local floodplain management programs that have already been initiated should be fully implemented. Implementation of local floodplain management, tailored to local problems and needs, is the key to cost-effective flood loss reduction. Local governments are in the best position to implement comprehensive floodplain management: they are closest to the problems, and have broad powers to regulate, acquire, zone, and tax property. In addition, they are routinely involved in comprehensive land use planning and day-to-day management. Moreover, they have the greatest incentive for packaging and coordinating programs since flooding most seriously affects their residents, jobs, and tax base.

For some communities, implementation will be relatively straight-forward—adoption of zoning and subdivision regulations consistent with maps provided by FEMA, NOAA, TVA, SCS, the Corps, USGS, or the states. Others need maps and regulations tailored to local conditions and combinations of regulatory and nonregulatory approaches.

Specific recommendations for local governments are:

Local governments should carefully formulate management goals for public and private use of floodplains. These goals can then be translated into site-specific plans and implementation measures. In setting goals, community leaders should view floodplain management as an opportunity to achieve a community's economic, social, and environmental objectives, not simply as a means to reduce flood losses. Through relocation or floodproofing, the community can correct past land use mistakes. In formulating goals, the community should also evaluate the severity of flood problems; the natural floodplain capacities and the cost of replacing those capacities at upland sites if the land is developed; the availability of other sites in the community for development; the costs of public services; and state and local standards.

Local governments should form special work groups or obtain the help of statutory bodies such as conservation commissions to develop policies and advise them on floodplain problems. These groups can ensure broad-based community involvement in policy and plan formulation. Local planners and engineers and state floodplain management personnel can often provide expert assistance. Private consultants and federal agencies such as the Corps, FEMA, TVA, and SCS can also provide guidance.

Some communities need to prepare more detailed studies of flooding or natural resources to assist policy formulation and planning and to provide the basis for later implementation. Communities generally need more detailed studies for areas that are under intense development pressures or that are candidates for redevelopment. Such areas usually require maps at scales of 1"=100' to 1"=400'. For urbanizing and urban areas, maps should show topographic contours and existing uses, as well as flood, floodway, and wetland boundaries.

Communities should integrate or carefully coordinate floodplain management with management of wetlands, wild and scenic rivers, prime agricultural lands, and mineral resources. This may be accomplished in part through maps showing floodplains and broader resource areas (e.g., Sanibel, Florida). Resource protection standards may be incorporated into floodplain regulations and, vice versa, floodplain standards may be incorporated into resource protection regulations. Acquisition and tax incentives can be combined with regulations to achieve multipurpose goals.

Communities should adopt floodplain regulatory standards that are appropriate to their multipurpose needs rather than rely on minimum NFIP and state standards. For example, if a community is guiding all new develop-

ment to upland sites, it can present losses not only to the users themselves but also to public facilities that serve them. This strategy will avoid the potential residual problems of floodplain development that will lead to future flood losses (e.g., deterioration of pilings or of structural floodproofing). Development may be guided to upland sites through zoning and other regulations, but also by educating the public, marking hazard areas, and providing density bonuses and real estate tax incentives. Guiding all new development to upland sites is often feasible in areas where there is little or no development in the floodplain or where the floodplain is narrow.

Communities should emphasize flood adjustment measures with built-in safety factors such as elevation on fill instead of on wood pilings. Regulations should be specifically tailored to the hazard at the given location, including combined storm surge, wave, and erosion problems in coastal areas; high velocity flows in mountain areas; and fluctuating water levels near lakes. To avoid increased flood damages to existing floodplain development and to lands presently beyond floodplain boundaries, communities should implement strict floodway and flood storage regulations.

Communities in the emergency program of the NFIP should upgrade the "resolutions" they adopted to join the regular program. More permanent regulations requiring case-by-case analysis of flood hazards may be appropriate if there are no maps to show 100-year flood elevations, floodways, or coastal velocity zones. Communities in the regular program should upgrade their regulations as needed. This is particularly important for coastal and barrier island communities that have not evaluated wave heights and erosion problems and for inland communities that have high velocity flows and long-term fluctuations in water levels.

Local governments within metropolitan areas should cooperate to integrate their stormwater management and floodplain regulations to provide regional hazard reduction and reduce the effects of urbanization on flood flows.

Communities should improve their own monitoring of development and enforcement of regulations by performing field checks before and after construction. They should inventory nonconforming uses. Citizens and members of interest groups should be encouraged to report violations.

Local governments should educate and train floodplain landowners and other decision makers in flood loss avoidance and reduction. Education techniques can include distribution of flood maps and brochures; marking flood hazard areas; workshops; television, radio, and newspaper ads; and one-on-one discussions. Communities can distribute floodplain management information to individual property owners with tax information (as in Avalon, New Jersey).

Local governments should carefully tailor nonconforming use regulations to local flood conditions and the impact of existing uses upon such conditions. Either before or after a flood, communities should survey existing

damage-prone uses to determine the types and degree of nonconformity and the floodproofing and relocation potential. This information can form the basis for more specific regulation and short- and long-term plans for urban renewal, floodplain management, and postdisaster response.

Based on such surveys, communities can tighten "substantial improvement" criteria in their building codes, zoning, or other regulations to control repair or rebuilding in excess of 30% or 40% of preflood values for fill and structures in floodways. Amortization provisions with short- or long-term repair or termination dates can also be adopted.

Public education programs and workshops could also encourage voluntary floodproofing and relocation. Such programs may be particularly effective for industrial and commercial uses.

With this information, communities can also prepare flood warning systems and flood evacuation and emergency preparedness plans. Corrective measures such as ring dikes, levees, or channel modifications may also be applied.

After a flood, local governments can often adopt temporary moratoria on rebuilding until flood mitigation plans and policies are completed (as in Rapid City, South Dakota). Flood insurance payments, disaster grants and loans, and other financial measures can be combined with regulations to encourage or require relocation or floodproofing (as in Lake Elsinore, California). Relocation can often serve multipurpose objectives, including stormwater management, urban renewal, and energy conservation (as in Soldiers Grove, Wisconsin).[2]

STATE ROLES

State legislatures and agencies should also strengthen the state role in floodplain management, especially along the coasts and in inland rural areas that lack maps and have little or no local floodplain management expertise. Even though some states need improved programs, it is unclear whether they wish to or will assume added responsibility for floodplain management without federal support, including technical assistance, mapping, and grants in aid.

Specific strategies are:

Legislatures should adopt new legislation or amend existing regulatory powers to clarify those powers and authorize nonregulatory measures such as acquisition (e.g., as in Arizona) to supplement regulations. Although direct state regulation may be generally appropriate for floodway and coastal high hazard areas, state standard-setting for local regulation is often most appropriate for flood fringe areas. State standard-setting for local regulations builds on both state and local capabilities. The state can assist localities by coordinating state, local, and federal programs; providing maps; assisting with evaluation of individual permits; assisting with the design of flood control projects; advising on local monitoring and enforcement of regulations; and training and educating local officials, landowners, and lenders.

States should develop their own standards and guidelines rather than rely on minimum NFIP standards where needed to meet multipurpose land and water management goals. These include standards for mapping; nonconforming uses; floodproofing; and special flood problems such as high velocity flow areas, floodways, lakeshores, alluvial fans, and erosion areas.

States should either develop more detailed maps or initiate cooperative state, local, and federal mapping on a watershed basis if federal maps are inadequate. Maps should show existing uses, topographic contours, wetlands, and other pertinent resources. To facilitate or carry out mapping, states may act as study contractors to FEMA (*e.g.*, as in Maryland and New Jersey), undertake their own independent mapping (*e.g.*, as in California), or financially and technically assist local governments in mapping (*e.g.*, as in Wisconsin).

States should strengthen their clearinghouse and coordination function for local, state, and federal activities that affect floodplains. These activities include public works projects, permits, subdivision proposals, local ordinances, grants in aid, and disaster assistance payments. Such functions can be performed pursuant to state A-95 review procedures, environmental impact review procedures, floodplain management acts and executive orders, permitting and subdivision review powers, disaster preparedness and response, and civil defense powers. States should also help federal agencies and localities "package" grants in aid, technical assistance, and other measures (*e.g.*, flood control works) to facilitate multipurpose floodplain management.

States should apply or encourage communities to apply innovative combinations of nonregulatory as well as regulatory techniques. They can do this through guidebooks, workshops, grants in aid, and education.

States should carry out additional public education and technical assistance. Such activities may include preparing and distributing model ordinances and brochures on flood preparedness and response and floodplain management; conducting workshops and training sessions for local officials, lawyers, architects, planners, lenders, engineers, and landowners; marking flood hazard areas; distributing maps; and conducting one-on-one meetings with developers, local government officials, and the public.[3]

FEDERAL ROLES

Although state and local initiative and responsibility are essential to sound floodplain management in the 1980s, many local governments lack the expertise, funds, and size (*i.e.*, they often encompass only part of the watershed) to carry out programs without help. Insufficient personnel and funds also constrain state programs. States and communities will need continued federal technical, mapping, and other assistance. However, federal monies should be spent only where states and communities are willing to make positive efforts to reduce flood problems. The test for federal programs should be, "How can

the federal government reduce its own losses and best help floodplain occupants, local governments, and states help themselves?'' To this end, FEMA, OMB, and other federal agencies should vigorously enforce the Floodplain Management Executive Order and the Coastal Barrier Resources Act to reduce public investment that is proposed for flood-prone areas and to set hazard mitigation examples for states and local governments. As discussed above, the federal government should respond to state and local needs with greater specificity in mapping, standard-setting, technical assistance, and training and education. Other strategies are:

Congress, OMB, FEMA, and other agencies should help states to enhance their floodplain management capability. To achieve this, Congress and OMB should continue FEMA grants in aid (State Assistance Program) to states that are willing to build their floodplain management programs and assume some of the responsibilities currently carried out by federal agencies, e.g., monitoring community compliance with the NFIP. Congress and federal agencies should also involve states more fully in establishing federal policies for water resources projects, flood insurance rates, disaster assistance, and other flood-related measures.

Federal agencies should encourage states and communities to adopt innovative, multipurpose floodplain management programs for pre- and postflood situations[4] by

- Stressing the minimal nature of federal standards and maps;
- Providing increasingly specific technical assistance and standards, including upgraded flood studies;
- Developing ''how-to'' manuals and guidebooks with examples of innovation and distributing them to local governments;
- Funding floodplain acquisition, flood warning systems, and other measures to upplement regulations;
- Streamlining ways to ''package'' federal grants for multipurpose projects such as community development block grants and open space funds, with special bonuses to communities proposing multipurpose projects;
- Coordinating federal programs and policies with state and local programs for flood insurance, land acquisition, disaster assistance, wetland protection, and public land management. Coordination can be improved through postdisaster assessment teams (now required), interagency review of projects pursuant to Executive Order 11988 procedures, joint processing of permits, joint research projects, and dissemination of research and program status information.

Congress, OMB, and FEMA should revise subsidy and cost-sharing policies to provide incentives for state, local, and private self-help by

- Revising subsidized NFIP rates to reflect the actual costs of floodplain occupancy;

- Clarifying and enforcing conditions for disaster assistance in order to require improved predisaster planning and adoption of mitigation measures after a disaster;
- Modifying federal criteria for water resources projects to balance structural with nonstructural floodplain management. This should be done by disallowing land enhancement benefits for new development behind flood control works where alternative sites are available;
- Requiring consistent state and local cost-sharing in flood control measures, disaster assistance, and flood insurance. This would remove the present bias toward flood control works and encourage balanced state and local floodplain management;
- Monitoring state and local regulations and other hazard reduction measures to ensure that the federal investment in flood insurance, disaster assistance, flood control works, and other measures achieves desired results.

FEMA, the Corps, USGS, SCS, and NOAA should upgrade federal or joint federal, state, and local flood studies and maps to facilitate land use management.[5] The agencies should develop the studies in cooperation with the states and localities for selected priority areas. Although arguments for uniformity in federal studies were once used to justify the present system of nationwide mapping, those arguments lose force as specific and unique implementation needs arise. Costs might be shared for studies reflecting state and local needs such as alternative floodway definitions.

Upgrading of studies should involve:

- Improved criteria for defining the 100-year flood elevation, floodway, and coastal high hazard areas. The criteria should include wave heights, wave runup and erosion for coastal areas, and flood velocities for inland high-velocity flow areas. New regional hydrologic information that includes changing flood conditions is needed for large urban and metropolitan areas. Maps should also show data on erosion areas, wetlands and existing uses. More detailed flood studies that include smaller contour intervals and larger map scales are needed. However, a partial trade-off between flood study and map scale versus accuracy and technical assistance may be appropriate where state, local, or private expertise is available to evaluate floodplain projects on a case-by-case basis. Developing urban areas need map scales of 1"=200' to 1"=400' with one- to four-foot contour intervals. This information should be placed on an orthophoto or topographic base.
- Improved storage of flood data. FEMA should make an immediate and concerted effort to retrieve information gathered for its studies since study contractors may discard the data after five years. The raw data used in the preparation of existing floodplain maps must not be lost: it may be needed to evaluate individual permits, upgrade maps, or de-

fend floodplain regulations in court. Either the states or the federal government should be the repository for this information.

- Improved dissemination and interpretation of data. Dissemination should be streamlined and increased rather than decreased. The long-term cost effectiveness of the $900 million already spent on federal mapping will largely depend on the dissemination and interpretation of the data to potential users, including local government, lenders, insurance agents, and developers.

FEMA, OMB, the Corps, SCS, NOAA, and other agencies should continue to improve measures to prevent and respond to flood disasters and to reduce the loss potential of existing uses. Agencies should first identify communities with potential for catastrophic loss of life or property from inland flash flooding, hurricane storm surge and wave action, tsunamis, or other sudden flooding. This identification could be based on existing FEMA flood insurance claims, and disaster assistance information, and National Weather Service data showing areas of high-intensity rainfall. Agencies could then focus mapping, technical assistance, predisaster planning, flood warning systems, and acquisition on these areas. Preflood floodproofing and relocation could be encouraged through education and insurance incentives. After a disaster, federal teams should prepare hazard mitigation plans (as now required by an OMB directive of July 1980) with state and local assistance. These plans could be implemented through a combination of monies from Community Development Block Grants, FEMA constructive total loss insurance payments, disaster assistance grants and loans, open space funds, and state and local bonds or general revenues.

FEMA, SCS, NOAA, and other agencies should revise and expand education on the severity of flood hazards and the "nuts and bolts" of hazard reduction techniques. To be effective, education must reach the decision makers. Federal agencies could begin by training their own staffs in Washington, D.C. and at federal regional centers in the specifics of regulation, acquisition, floodproofing, flood warning systems, postdisaster response, implementation of the executive orders, and resource evaluation. FEMA and other agencies could also educate state agency personnel and train engineers, lawyers, and architects. Most training of local officials and landowners should be at the state or local level, but with federal assistance. Agencies could improve landowner awareness by disseminating flood information along with flood insurance policies.

Research

Research to improve the quality and effectiveness of floodplain regulations in the 1980s should focus not only on regulations *per se* but also on broader techniques of floodplain management.[6] Research should not duplicate subjects

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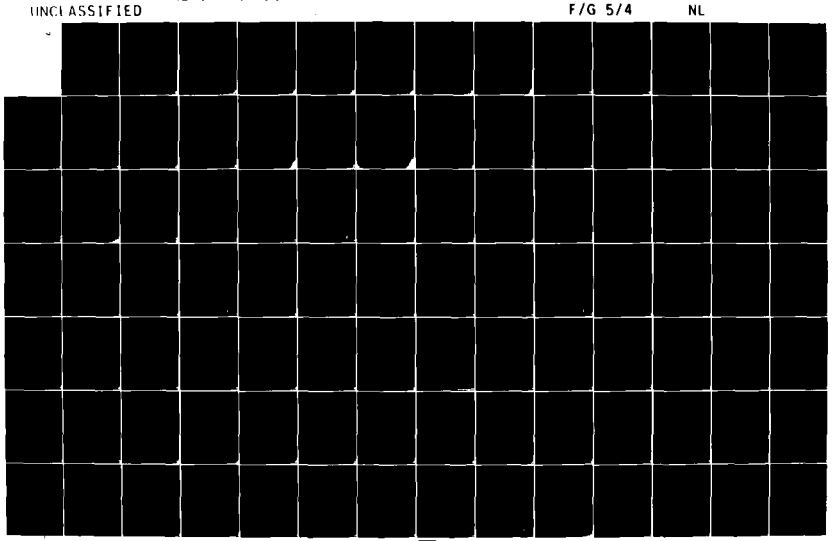

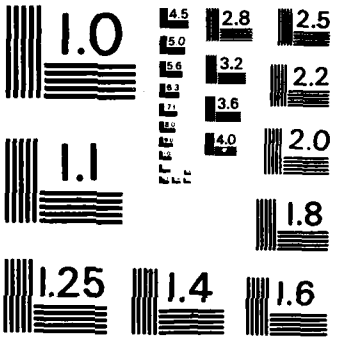

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that have already been given adequate treatment such as general floodplain zoning ordinances.

Results, including those of completed research, should be broadly disseminated by all levels of government. The National Science Foundation (NSF), the Corps, SCS, or other federal agencies should fund or carry out supplemental implementation-oriented floodplain management research, with the following topics as priorities.

ESTABLISHMENT AND IMPLEMENTATION OF A FLOOD DAMAGE MONITORING SYSTEM

FEMA, in cooperation with other agencies, should establish a comprehensive federal/state/local flood damage monitoring and reporting system for public and private flood losses. This system should monitor and report on the types and magnitudes of flood damages and public payments to floodplain occupants by type of use, location, method of protection, and other factors. The monitoring program would provide the basis for readjusting flood insurance rates and determining the effectiveness of various approaches such as elevation on fill and open works, and wet and dry floodproofing.

EVALUATION OF FLOOD LOSS REDUCTION TECHNIQUES

FEMA, the Corps, NSF, or other agencies should investigate the short- and long-term effectiveness of elevation, flood control, and floodproofing under various flooding frequencies, including rare events such as the 500-year flood. Research should include an analysis of "safety factors" (*e.g.*, the ability of various methods to withstand flooding greater than the design flood). This information would help to evaluate how effective floodplain regulations are in reducing flood losses; establish standards for particularly vulnerable or critical facilities; and establish flood insurance rates reflecting actual risk. Elevation of structures on fill should be compared to elevation on open works and also to floodproofing.

EVALUATION OF INCENTIVES AND DISINCENTIVES FOR PRIVATE SELF-HELP

FEMA, OMB, and NSF should carefully examine the incentives and disincentives to private landowners, bankers, and local government officials presented by the flood insurance programs, flood control works, disaster assistance, and regulations. Measures should be identified for encouraging self-help by those contemplating building or rebuilding in the floodplain or by those who are modifying structures to reduce flood damage susceptibility.

IDENTIFICATION OF COMMUNITIES WITH SPECIAL FLOOD PROBLEMS

FEMA, in cooperation with other agencies and the states, should make a nationwide analysis of community flood problems so that FEMA, the Corps,

USGS, SCS, NSF and other federal and state agencies can tailor federal and state mapping, technical assistance, and other loss-reduction efforts to those communities in greatest need. The analysis should survey[7]

- Cities with chronic flood problems such as Johnstown, Pennsylvania; Houston, Texas; Soldiers Grove, Wisconsin; and Mobile, Alabama, which have been flooded as frequently as once in 10, five or even three years. They are either particularly ripe for corrective action or have already initiated active floodplain management programs. The total number of these communities is estimated to range from 150 to 250. These communities are particularly good candidates for detailed mapping, predisaster planning, training and education, technical assistance, floodplain acquisition, and floodplain monitoring.

- Cities like Jackson, Mississippi; Rochester, Minnesota; and Gulf Shores, Alabama, which had recent severe floods and are faced with flood losses that had been vaguely anticipated in the past but are now presented in stark dimensions. After a disaster there is often a period of at least a few days and at most a couple of years, when the public will support drastic readjustments in floodplain use. The communities in this category change annually. The number of communities suffering a disaster may average 30-100 over several years, but may exceed 500 in a year of major rains combined with rapid spring snowmelt or a major hurricane. These communities are candidates for postdisaster assessments and planning, mapping, technical assistance, floodproofing, and relocation.

- Communities with a high potential for disaster. These include areas like Boulder, Colorado, where planning and civic groups are aware of the prospect of a major disaster but have not experienced one recently. Other areas with continuous potential for disaster include many barrier islands and flash flood regions. The estimated number of these communities is 500 to 1,000. Communities anticipating disaster are prime candidates for predisaster planning, technical assistance, training and education, detailed mapping, flood warning systems, and evacuation plans.

- Partially protected areas. Many communities are partially protected by dikes, levees, and dams, so residents in certain areas assume they are protected from floods of designated magnitude and frequency. Few of these communities have complete protection. Levees and channel improvements can fail. Detention reservoir flows can exceed the projected design flow. Development outside of protected areas may also occur. Inadequate drainage may also cause flood damages within the protected areas. If flooding exceeds design standards, losses may be catastrophic, as in Jackson, Mississippi. Some of these communities are candidates for training and education, predisaster planning, and development of monitoring projects.

- Special flood problems. An estimated 2,000 to 3,000 communities are subject to special flood problems not adequately addressed by NFIP regulations and other standards. These include areas subject to erosion, fluctuating groundwater levels, supercritical inland flows, subsidence, mud flows, and alluvial fan flooding.

DEVELOPMENT OF MANUALS AND ORDINANCES FOR SPECIFIC FLOOD PROBLEMS

FEMA, NOAA, other agencies and states should prepare floodplain manuals and ordinances that deal with special flood problems. A separate manual and model ordinance should be developed for each of the following:

- Inland supercritical flow areas common in the mountain states of the East and West. Manuals should address study techniques, delineation of areas, and protection standards.
- Barrier islands and beach areas. An ordinance or manual should address combined storm surge, wave height and runup, and erosion problems. The manual should explain the natural forces at work, options for dealing with them, and the strengths and weakness of each option.
- Flooding behind dikes and levees and below dams, where perhaps one-third of the nations's floodplain structures are located. A description of short- and long-term risks and techniques for dealing with them is needed. The manual should address ponding, evacuation, and perception of risk.
- Alluvial fans and mudslide areas. A discussion of the problems, data gathering needs, sources of data, and regulatory and nonregulatory methods is needed.
- Fluctuating lake levels due to runoff and changes in groundwater levels. The manual should cover prediction of fluctuations and adjustments to problems, including long-term remedies such as relocation.
- Combined wetland protection and floodplain management needs. Assessment of floodplain and wetland natural values, regulations, standards, and options for integrating or coordinating standards should be addressed.

DEVELOPMENT OF IMPROVED MAPPING TECHNIQUES

Improved map criteria and cost-effective techniques for generating map data and preparing maps should be developed. Techniques should also be developed for forecasting future runoff in urbanizing watersheds so that flood studies will not become quickly outdated and so that landowners and governments can rely on the long-term accuracy of published elevations. Techniques should also be improved for accurately forecasting coastal erosion recession rates and for establishing setback lines.

In summary, the progress of the 1970s in reducing future flood losses through nonstructural approaches with regulations as one component must be continued in the 1980s with emphasis on increased specificity and creativity at all levels of governments.

Footnotes

1. Task Force on Federal Flood Control Policy (1966).
2. See Appendix III to this report for more detailed recommendations.
3. See Appendix I to this report for more detailed recommendations.
4. *Id.*
5. Approaches to improve FEMA map criteria and techniques are the subjects of several studies including one by Anderson-Nichols, Inc. for FEMA entitled, "Promising Methods and Procedures for Performing Riverine Flood Insurance Restudies," and one by the National Academy of Sciences now in press.
6. For additional discussion of research needs see National Science Foundation (1980); National Wetlands Technical Council (1979); and White *et al.* (1975).
7. See White (1979).

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APPENDIX I

Strengthening State Floodplain Management: Recommendations and Profiles

The following materials were extracted from a report prepared by Patricia Bloomgren and the Association of State Flood Plain Managers and published separately by the Natural Hazards Research and Applications Information Center in 1982. Much of the text of that report has been integrated into this final version of **Regulation of Flood Hazard Areas to Reduce Flood Losses, Volume 3.** Selected recommendations and state profiles are duplicated below.

Recommendations

Experience of the last decade indicates that certain elements are found in the more effective state programs. (Note that not all programs contain all elements.) The following are key elements:

1. *A lead agency.* A floodplain coordinating agency, or division within an agency, is necessary. Its personnel should have expertise in floodplain management, not just water resources management or civil defense. At a minimum, the lead agency should have authority to coordinate activities, provide technical assistance and education and establish standards.

2. *Adequate funding.* The lead agency must have funding sufficient to provide expert, interdisciplinary staff and mapping; technical assistance; public education; monitoring and enforcement; and nonregulatory supplementary measures such as land acquisition.

3. *Expert staff.* A staff that has specific training in floodplain regulation should be provided. Mapping, acquisition, floodproofing and other related expertise is desirable.

4. *Regulation of private uses.* A state agency needs statutory authority either to regulate directly private floodplain uses or to ensure local adoption and administration of floodplain regulations. Not all states have this authority.

5. *Supplementary floodplain management measures.* Statutory authorization may also provide for nonregulatory floodplain management techniques such as marking flood hazard areas, operating flood warning systems, development of flood hazard mitigation plans, and acquisition of selected flood-prone areas either before or after a disaster.

6. *Rules.* After a statute has been adopted, the administering agency adopts rules or regulations to supplement statutory provisions dealing with map standards, floodproofing, nonconforming uses, exemptions, project review, flood control works and other related areas.

7. *Mapping and data gathering.* The state either maps floodplains or assists with federal or local mapping. The state also coordinates the collection of natural resource data that is related to floodplains—hazard mapping, topographic mapping, wetland mapping, coastal zone mapping,

soils mapping and other data-gathering efforts. The state should either serve as the repository for flood insurance data and other information or is in close contact with such a repository.

8. *Technical assistance.* The state should provide continuing technical assistance to communities, other state agencies and private landowners, often in cooperation with federal and regional planning agencies. Areas for technical assistance may include map interpretation, flood hazard mitigation planning, flood insurance, acquisition and project review.

9. *Education.* The state needs to provide continuing educational support for local officials, landowners, state employees, lenders, lawyers and others dealing with floodplain activities. Such educational efforts may be carried out in cooperation with federal agencies, regional planning agencies, universities, and others.

10. *Planning before and after floods.* It is desirable for the state to carry out flood hazard mitigation planning in cooperation with communities, federal agencies and state emergency services personnel.

FEDERAL ROLE

The federal government could encourage the development of key elements in state and local programs through several initiatives:

1. Congress and federal agencies should place nonstructural measures on an equal financial and administrative footing with structural measures by providing explicit direction to the field staff.

2. Congress and federal agencies should require that nonstructural measures be adopted as a condition for funding structural measures.

3. Federal agencies should increase the intermediary role played by the states to help implement federal, state and local floodplain management within watersheds.

4. Congress and the Federal Emergency Management Agency (FEMA) should continue financial support to states to enhance floodplain management capability. Additional financial support should also be considered to supplement state monitoring, planning and other capabilities, particularly when it is cost-effective for states to help carry out federal programs such as the National Flood Insurance Program.

5. Federal agencies should make better use of state agencies with expertise in pre-flood planning, site review and post-flood hazard mitigation.

6. FEMA, the U.S. Army Corps of Engineers and other federal agencies should stress the limited nature of federal regulations such as the NFIP minimum elevation and encroachment standards. They should promote more stringent state and local floodway delineation, flood protection, and other standards.

7. The Office of Management and Budget (OMB), the Water Resources Council (WRC), and other federal agencies should improve federal consistency and coordination in flood control, insurance, disaster assistance, wetland protection. Federal, state and local floodplain management programs should likewise be made more compatible.

8. Federal agencies (particularly FEMA) should improve federal floodplain mapping, map dissemination and data storage programs, especially in urban and coastal areas. Larger scale and more accurate maps should be developed in cooperation with states and localities. These maps should be on an orthophoto or topographic base. For rural areas and some urban areas, a tradeoff between map scale and accuracy and technical assistance may be possible. Wave heights are needed for coastal maps. Floodway delineations should be improved for some riverine areas. Serious legal and administrative problems as well as substantial loss of federal investment will result if

the raw data developed for FEMA flood insurance studies is not retrieved from study contractors who will soon, in many areas, have no further contractual duty to store it.

9. In cooperation with the states, federal agencies should increase technical assistance in floodplain management techniques, such as mapping, map interpretation and flood warning systems.

10. FEMA, WRC, OMB, the Corps, the Environmental Protection Agency, the Office of Coastal Zone Management, the Fish and Wildlife Service, the Soil Conservation Service, the Small Business Administration and other agencies should vigorously enforce the Executive Orders on Wetland Protection and Floodplain Management.

11. Federal agencies should enhance their staff training and education in flood hazard mitigation. State and local officials also need more training. Federal agencies can best provide training on federal programs and issues of national concern. States can best provide more specific training on state legislation and specific floodplain management applications.

12. FEMA, the National Oceanic and Atmospheric Administration and other federal agencies should encourage and undertake additional cooperative federal, state and local floodplain management planning both before and after floods.

13. The National Science Foundation, FEMA, the Corps and other agencies should research mapping, monitoring of floodplain development, floodproofing, and social factors of floodplain occupation and use. Research should be conducted in cooperation with states and localities and research results should be disseminated widely.

State Program Profiles

ALABAMA

1. **Number of Communities Subject to Flooding**

Number in NFIP	268
Hazard area identified, but not in NFIP	107
	375

2. **Local Enabling Authority**
Municipalities have general broad authority to regulate land subdivision, administer zoning regulations, and enforce building codes. Counties have general authority to regulate land subdivision, administer zoning regulations, and enforce building codes in flood-prone areas.

3. **Existing State Floodplain Management**
State departments operate under an executive order from the Governor to implement flood hazard control regulations included in the order.

The Office of State Planning and Federal Programs, as coordinator of the NFIP, provides technical assistance to local communities in upgrading regulations aimed at flood hazard control and floodplain management.

4. **State Floodplain Management Activities**
The Office of State Planning and Federal Programs (OSPFP) coordinates water resource planning and flood studies with economic and resource development programs throughout the state. As part of this effort, OSPFP provides technical assistance to local communities in reducing and mitigating flood hazards and coordinates the National Flood Insurance Program.

Under Executive Order No. 11, OSPFP is charged with advising and assisting all state departments in developing appropriate instructions to their respective divisions for implementing

floodplain management regulations included in the order. The State Building Commission is responsible for enforcing these regulations as they pertain to construction involving state funds or property.

5. **Problems**
   There are no significant problems in implementing the state floodplain management activities scheduled for this calendar year. The usual budgetary problems will likely be intensified by federal cut-backs during the next fiscal year. Also, state matching dollars will probably be in short supply.

   A minor problem that could require additional legislation is that some state agencies are not covered directly by the Governor's executive order to implement floodplain management regulations. However, any new building requiring state funds is covered indirectly through the review of the State Building Commission.

For further information, contact:

Resource Development Division
Office of State Planning and
Federal Programs
135 South Union Street
Montgomery, Alabama 36130-5601

ALASKA

1. **Number of Communities Subject To Flooding**
   21 communities are participants in the National Flood Insurance Program.

   Approximately 45 additional communities are subject to very high, high or high average flooding or flood-related erosion but lack the regulatory (planning and zoning) authority and capability to participate in the NFIP.

2. **Local Enabling Authority**
   Alaska Statutes Title 29 is the enabling authority applicable to all municipalities and boroughs. Title 29 includes planning and zoning powers, and powers to provide for watercourse and flood control facilities.

3. **Existing State Floodplain Management**
   Governor's Administrative Order #46 requires state agencies to comply with NFIP regulations including actions relating to all capital improvement programs, grant or loan programs, land or property disposals, programs which affect land use planning and permit programs.

   The Department of Community and Regional Affairs (DCRA) is the NFIP coordinating agency and has been actively promoting enforcement of A046 and other state floodplain management activities through the State Assistance Program since 1980.

4. **State Floodplain Management Activities**
   Providing technical assistance to communities participating in the NFIP, ordinance preparation and enforcement, and establishment of comprehensive local floodplain management programs. Technical assistance to communities not identified for NFIP participation assessing flood and erosion hazards, proposing alternative solutions, problem identification, etc. Flood data repository and distribution of information. Assistance to lenders, insurance agents, developers and citizens regarding flood hazards and NFIP determinations.

   Coordination of floodplain mapping projects.

5. **Problems**
   Funding for completion of conversion mapping for remaining Emergency Program communities; no standards or mapping for special hazards such as erosion and ice-jam flooding.

   Assuring state consistency and adherence to flood hazard standards in large areas of the state with no mapped data or elevation data. Lack of state enabling authority.

6. **Innovation**
   The Municipality of Anchorage has purchased floodplains to use as greenbelts. Dillingham has purchased highly erosion-prone river bluff property.

   Several communities have evaluated the feasibility of relocation; the community of Port Heiden has begun relocating to avoid erosion; several communities have added erosion setback requirements to floodplain ordinances.

   Rivers are sanded from the air prior to spring breakup to mitigate ice jam flooding at known jam point.

7. **Selected State Floodplain Management Publications**

   Floodplain Management for Alaskan Communities, Planning Guidebook Series.

   Flood Data Bibliography For Alaska.

   Understanding and Evaluating Erosion Problems, by Woodward-Clyde Consultants.

   Model ordinance for *Regular Program Phase of the NFIP.*

For further information contact:

Department of Community and Regional Affairs
Division of Community Planning
225 Cordova Street, Bldg. B
Anchorage, Alaska 99501
(907) 264-2206

ARIZONA

1. **Number of Communities Subject to Flooding**
   83.

2. **Local Enabling Authority**
   Cities, towns and counties have broad enabling authority with specific flood language and a special enabling act requiring floodplain regulations.

3. **Existing State Floodplain Management**
   There is no direct state regulation of floodplains, but local units of government are mandated to adopt floodplain regulations consistent with state minimum standards.

   The Arizona Department of Water Resources is the state coordinating agency. One part-time person and an approximate budget of $35,000 are authorized.

4. **State Floodplain Management Activities**
   The staff prepares model ordinances, trains local officials, reviews and approves technical data, distributes information, supports insurance activities, and monitors community administration. Priorities are the model ordinance, training and monitoring.

5. **Problems**
   Problems include inadequate staff, funding and enabling legislation.

6. **Innovations**
   Several major relocations have been undertaken and others are planned. An exchange of flood-free state-owned land for floodplain property has facilitated these relocation projects.

For further information, contact:

State Coordinator
National Flood Insurance Program
Arizona Department of Water Resources
99 E. Virginia
Phoenix, Arizona 85004

ARKANSAS

1. **Number of Communities Subject to Flooding**
   415.
2. **Local Enabling Authority**
   Local units of government are authorized to adopt zoning, subdivision regulations and building codes for flood insurance purposes.
3. **Existing State Floodplain Management**
   None.
4. **State Floodplain Management Activities**
   One staff member is assigned full-time to floodplain management activities; four additional staff members contribute a small amount of time in addition to their other duties. The staff prepares model ordinances for local units of government, supports ordinance adoption, administration and enforcement, supports flood insurance activities and distributes program materials. Ordinance adoption is a priority. The staff also provides general and technical assistance to local communities.
5. **Problems**
   The major problem has been inadequate funds.

For further information, contact:

State Coordinator
National Flood Insurance Program
Division of Soil & Water Resources
State Department of Commerce
1818 West Capitol — Building "A"
Little Rock, Arkansas 72202

CALIFORNIA

1. **Number of Communities Subject to Flooding**
   439.
2. **Local Enabling Authority**
   Cities and counties have broad, general enabling authority.
3. **Existing State Floodplain Management**
   The state will participate in federal flood control projects on a cost sharing basis provided local floodplain regulations are adopted (Cobey-Alquist Flood Plain Management Act). A

State Executive Order for Flood Plain Management requires the various state agencies to evaluate the flood hazard for construction and acquisition of state owned and supervised properties, and to conform to the standards of the National Flood Insurance Program. The Department of Water Resources is the state coordinating agency. Two full-time staff persons and four part-time district personnel with a budget of $400,000 are authorized.

4. **State Floodplain Management Activities**
   The program activities are carried out in four locations throughout the state, and include: conducting community interviews to monitor compliance with the local floodplain management ordinances; furthering floodplain management objectives through work with the general plan, pre- and post-flood hazard mitigation plans, public awareness presentations and the Executive Order for Flood Plain Management; conducting workshops to provide education and technical assistance to the public and private sectors; and evaluating the flood hazard in environmental documents and responding to public inquiries.

5. **Problems**
   The major problem has been local government resistance to any restriction on land use. This has hindered the development of state regulations.

6. **Innovations**
   Certificates of commendation were awarded to projects in which the sponsors made wise use of floodplain areas. Letters were written to commend communities that took action to support floodplain management practices.

7. **Selected State Floodplain Management Publications**

   State of California. Bulletin 199. *California Flood Management: An Evaluation of Flood Damage Prevention Programs*, September 1980.

   State of California, Department of Water Resources, "Flood Control Operations in Northern California."

   _____. "Flood Damage Prevention."

   State of California, Office of Planning and Research, "General Plan Guidelines."

   State of California, Department of Water Resources, in cooperation with the National Oceanographic and Atmospheric Administration, National Weather Service, "Flood Forecasting in California." December 1974.

   State of California, Department of Water Resources, *Information on Regulations for the Administration of the Cobey-Alquist Flood Plain Management Act*, February 1974.

For further information, contact:

State Coordinator
Flood Plain Management Program
Department of Water Resources
P.O. Box 388
Sacramento, California 95802

COLORADO

1. **Number of Communities Subject to Flooding**
   275 (212 cities and towns and all 63 counties).

2. **Local Enabling Authority**

Counties and municipalities have authority to plan and regulate land uses by adopting zoning and subdivision regulations. Creation of a planning commission and adoption of subdivision regulations has been required for counties since 1972, but is optional for municipalities. Home rule cities may derive additional authority from their charters.

3. **Existing State Floodplain Management**

The Colorado Water Conservation Board (CWCB) has developed several programs directed towards the identification of floodplains and the provision of technical services to other state agencies and to local units of governments. The Colorado Land Use Commission can intervene to resolve a "matter of state interest," such as local floodplain issue, using its "Temporary Emergency Powers."

4. **State Floodplain Management Activities**

The CWCB has prepared a flood hazard mitigation plan, floodplain reports, flood control and drainage plans, flood documentary reports, technical manuals and review criteria so that reasonably uniform standards can be applied to the identification and designation of all floodplains within the state. The CWCB can provide floodplain management services to local governments including flood hazard reviews, coordination with the NFIP, development of local ordinances, assistance in establishing flood warning systems, and training of local officials.

5. **Problems**

Problems have largely concerned inadequate coordination and communication by representatives of the federal government, where the federal agencies deal directly with the local units and do not properly involve the state. Inadequate enabling authority and a decline in funding by the legislature are also problems.

6. **Innovations**

The CWCB has prepared a flood hazard mitigation plan which is statewide in scope.

Many hydrologic studies in Colorado separate rain and snowmelt flood peaks to define flood conditions unique to the Rocky Mountain region.

The CWCB model floodplain regulation distinguishes between two options for managing the floodplain—the hazard area concept and the floodway concept.

A refined method for mapping flood boundaries has improved consistency between flood profiles and flooded areas shown in floodplain information reports.

Approximate methods to map the catastrophic floodplain, such as from a dam failure, are being formulated by the CWCB for use by local emergency preparedness officials.

The Urban Drainage and Flood Control District manages multi-governmental flood problems in the Denver metro area.

7. **Selected State Floodplain Management Publications**

Colorado Water Conservation Board, *Floodplain Information in Colorado Index Map*, April 1, 1981.

_____. *Model Floodplain Regulations for Local Governments in Colorado*, June 3, 1982.

_____. Brochure on "Managing Floodplains in Colorado," 1982.

_____. *Flood Hazard Mitigation Plan for Colorado*, January, 1983.

_____. *Floodplain Management Manual for Local Governments*, (in preparation).

For further information, contact:

State Coordinator
National Flood Insurance Program
Colorado Water Conservation Board
Room 823, State Centennial Building
1313 Sherman Street
Denver, Colorado 80203

CONNECTICUT

1. **Number of Communities Subject to Flooding:**
   Statewide; all 169 communities.

2. **Local Enabling Authority**
   General zoning and subdivision authority with specific flood language is delegated to cities, towns and boroughs. State statutes also allow the establishment of local flood and erosion control boards which have the power to enter into agreement to cost-share with the state for flood control works of improvement. The recently revised State Building Code includes several flood plain management standards which are enforced by the local building inspector. Any deviations from these standards must be approved by the State Department of Environmental Protection (DEP).

   The Coastal Area Management Act requires all coastal communities to undertake site plan reviews for all projects within the coastal area to ensure consistency with coastal resource and use policies.

3. **Existing State Flood Plain Management**
   The state has several programs regulating or impacting flood plain activities. The state is authorized to establish stream encroachment lines for waterways or flood-prone areas considered for any flood alleviation measures. State permits are required for any structures or obstructions within the lines. Approximately 165 river miles are regulated at this time.

   The State Inland Wetlands and Watercourse Act regulates inland wetland by soil type or watercourse type. Permits are required for any wetland alteration. The state has presently delegated the inland wetland powers to 153 communities with a provision to oversee if a community fails to regulate. The state DEP regulates all state activities in inland wetlands.

   The Preservation of Tidal Wetlands Act requires a state permit for any activity within a navigable waterway.

   Both the wetland acts and the Structures and Dredging Act require due consideration be given to the impacts on and from floods and flooding.

   The State Executive Order requires that all state agencies conform to the minimum standards of the NFIP. Additionally, for state highway projects over or adjacent to streams and waterways, state statutes mandate limitations on flood plain impact.

   The Connecticut Environmental Policy Act requires that all state projects undergo a mandatory site review process which includes assessing flood hazards.

   The Coastal Area Management Act provides for oversight of local coastal site plan reviews to ensure consistency with 50 statutorily mandated coastal resource and use policies.

   The State Dam Safety Program is responsible for ensuring the safety of the 3200 dams within Connecticut.

4. **State Flood Plain Management Activities**
   Non-regulatory activities include: participation in the FEMA-SAP, providing general and technical assistance to local communities on flood plain management matters and developments,

operating a clearinghouse for flood plain and NFIP information, periodic workshops and other education efforts, the State Long-Range Water Resources Management Plan, cooperation with the Corps of Engineers and Soil Conservation Service on flood prevention studies, and Civil Preparedness efforts to update the state and local civil preparedness flood emergency plans.

The DEP flood management policy serves as a guide to encourage non-structural flood prevention alternatives whenever applicable.

5. **Problems**
   A comprehensive review of flood management activities is presently underway which will identify program and policy needs in the future.

   No statutory authority for regulation of all state activities in flood zones.

   Long-range capability to maintain and expand staffing levels due to state budget problems and redirection and/or reduction of federal efforts.

For further information contact:

Department of Environmental Protection
Water Resources Unit
Rm. 207 State Office Building
165 Capitol Avenue
Hartford, Connecticut 06106

DELAWARE

1. **Number of Communities Subject to Flooding**
   42.
2. **Local Enabling Authority**
   Cities, towns and certain counties have broad zoning enabling authority. Some include specific flood language.
3. **Existing State Floodplain Management**
   There is no specific state floodplain management program although state laws regulate beaches, wetlands and coastal areas. The Office of Management, Budget and Planning is the state coordinating office; one staff person is assigned on a part-time basis.
4. **State Floodplain Management Activities**
   Principal activities are distribution of information, monitoring local administration, and general assistance.
5. **Problems**
   Problems are inadequate enabling authority, and problems with state/federal coordination.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Natural Resources and
Environmental Control
Division of Soil and Water Conservation
89 Kings Highway
P.O. Box 1401
Dover, Delaware 19901

DISTRICT OF COLUMBIA

1. **Number of Communities Subject to Flooding**
   1.
2. **Local Enabling Authority**
   The District has zoning, subdivision control and other authorities that can be used for floodplain management.
3. **Existing State Floodplain Management**
   The District is presently conducting a study (see #6, below) and planning to adopt an improved management ordinance when the study is completed. No construction will be permitted in floodways. The Department of Environmental Services is the state coordinating agency. A staff of eight part-time workers with a budget of approximately $33,000 is authorized.
4. **State Floodplain Management Activities**
   The staff adopts and administers ordinances; trains local officials; reviews technical data, enforces violations and distributes materials. Review and approval of technical data and ordinance adoption are the priority activities.
5. **Problems**
   Problems include inadequate staff, funds and flood data.
6. **Innovations**
   Fluvial and tidal flooding in the Potomac River Estuary have been hydraulically modelled.
7. **Selected State Floodplain Management Publications**

   Department of Environmental Science. *Handbook, Erosion and Sediment Control.*

   _____. *Flood Emergency Manual.* August 1976.

For further information, contact:

State Coordinator
National Flood Insurance Program
Office of Environmental Planning
and Management
415 12th Street N.W.
Washington, D.C. 20004

FLORIDA

1. **Number of Communities Subject to Flooding**
   395.
2. **Local Enabling Authority**
   Municipalities and counties have broad zoning enabling authority with specific flood language.
3. **Existing State Floodplain Management**
   The Department of Community Affairs (DCA) is the state coordinator of the NFIP and is the state disaster preparedness agency. Currently, the state administers 41 programs which impact floodplains. Fourteen different state agencies administer these programs. These 41 state programs fall into one of five program categories: Property acquisition and management; public improvement; granting of permits and licenses; provision of assistance to local governments; and land use planning and management.

4. **State Floodplain Management Activities**
   The DCA provides technical assistance to communities. The staff has developed a model ordinance and provides assistance in ordinance adoption, administration and enforcement of NFIP regulations and provides a continuing training program for local officials, lenders, insurance agents and builders on floodplain management. The staff is currently developing a statewide, coordinated floodplain management policy.

5. **Problems**
   Problems include inadequate funds and flood data.

6. **Selected State Floodplain Management Publications**

   Florida, Department of Community Affairs, *Floodplain Management in Florida: An Assessment of State, Regional and Local Priorities* (1981), two volumes.

   _____. *A Local Official's Guide to Assessing the Impacts of Development in the Floodplain* (1981).

   _____. *Tools for the Non-Structural Management of the Floodplains* (1981).

   Florida, Department of Community Affairs and University of Florida Center for Governmental Responsibility, *Conference Materials: Local Options for Floodplain and Wetlands Management* (September, 1982).

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Community Affairs
2571 Executive Center Circle, East
Tallahassee, Florida 32301

GEORGIA

1. **Number of Communities Subject to Flooding**
   445.

2. **Local Enabling Authority**
   Cities, incorporated towns and counties have broad zoning authority with specific flood language.

3. **Existing State Floodplain Management**
   There is no state floodplain management program or direct state regulation of floodplains. The Department of Natural Resources, Environmental Protection Division, is the state coordinating agency. Three staff members (one part-time, two full-time) with an average annual budget of $70,000 are authorized.

4. **State Floodplain Management Activities**
   The staff assists in ordinance adoption and administration, monitoring and distribution of information. Priority activities are community assistance and public education.

5. **Problems**
   Problems include inadequate staff and flood data and inaccurate flood hazard boundary maps. Community involvement is lacking due to infrequent flooding.

For further information, contact:

State Coordinator
National Flood Insurance Program
Environmental Protection Division
19 Martin Luther King Jr. Drive
Atlanta, Georgia 30334

HAWAII

1. **Number of Communities Subject to Flooding**
   25.
2. **Local Enabling Authority**
   Hawaii's four counties have enabling authority to adopt zoning, subdivision and building codes. Specific ordinances on regulating developments in floodplains are being finalized for lands zoned urban, rural and agricultural. Counties also issue specific management area permits under the state's coastal zone management program.
3. **Existing State Floodplain Management**
   Although there is no direct state floodplain management program, statewide floodplain regulation is indirectly provided by the State Land Use Zoning Program under the Conservation District Use Application system administered by the Department of Land and Natural Resources (DLNR). The DLNR's Division of Water and Land Development is the state flood control coordinating agency.
4. **State Floodplain Management Activities**
   Major activities include review of state land use boundary change proposals, coordination of flood control projects for structural and nonstructural solutions, review of state grants to counties for flood control projects, collection and analysis of flood flow data in cooperation with the USGS, preparation and dissemination of post-flood reports, maintenance of a statewide flood control plan and technical assistance to counties.
5. **Problems**
   Federal, state, and county agencies involved in floodplain management need to increase coordination and communication. Floodplain mapping and flood routing analysis need to be refined and state and county enforcement and monitoring activities need to be bolstered with additional personnel and financial resources.
6. **Innovations**
   The State Department of Land and Natural Resources is concluding a statewide silt basin study to assess critical erosion and sedimentation areas and to prepare preliminary engineering designs for a demonstration silt basin facility.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Land and Natural Resources
Division of Water and Land Development
P.O. Box 373
Honolulu, Hawaii 96809

ILLINOIS

1. **Number of Communities Subject to Flooding**
   804.

2. **Local Enabling Authority**
   Cities, villages, incorporated towns and counties are granted broad general authority to zone or use building code authority for flood protection.

3. **Existing State Floodplain Management**
   There is a direct state regulation of certain mapped floodplain areas. A permit is required for structures in these floodplains. A separate statutory authority provides state regulation of floodways throughout the state. The Division of Water Resources of the Illinois Department of Transportation is the state coordinating agency. Two people, with a $100,000 budget, coordinate the National Flood Insurance Program and provide local assistance for the program. Additionally, there are seven staff members in the state permit program in Springfield ($700,000 budget). The regional field office in Schaumburg has five people and a budget of $250,000. The Illinois Institute of Natural Resources, State Water Survey, in Champaign has three and one-half staff members and a $100,000 budget for the floodplain data repository. The State Assistance Program funds field advisors in regional planning agencies who provide direct advice and assistance to local officials.

4. **State Floodplain Management Activities**
   The staff is assigned to an array of floodplain management activities. Priority is placed on training local officials and enforcing of violations and post-flood mitigations, both as a state action and as a community assistance measure.

5. **Problems**
   Problems cited include inadequate staff and funds.

6. ***Innovations***
   The hazard mitigation study for Wilmington, Illinois, was particularly comprehensive. Considerable emphasis has been placed on the development of public informational materials, e.g., a manual on regulations, which discusses coordination of state and local permits, and a homeowner's self-help manual.

7. **Selected State Floodplain Management Publications**

   Illinois Department of Transportation, Division of Water Resources. *Information Sheet:*

   1. "Illinois Water Resources—Where to Get Help."
   2. "National Flood Insurance Program—Reading Flood Hazard Boundary Maps."
   3. "National Flood Insurance Program—Revising Flood Insurance Maps."
   4. "National Flood Insurance Program—Floodplain Development Regulations."
   5. "National Flood Insurance Program—Flood Insurance."
   6. "National Flood Insurance Program—Rules for Lenders."
   7. "Floodplain Management Measures."

   _____. *Local Assistance Series:*

   1A. "Floodplain Publications," prepared for the state by U.S. Army Corps of Engineers, Chicago District, Floodplain Management Services. January 1980.
   1B. "Directory of Floodplain Agencies," prepared for the state by U.S. Army Corps of Engineers, Chicago District, Floodplain Management Services. January 1980.
   2A. "Program Summary," March 1982.
   2B. "Local Government Application Procedure," March 1980.
   2C. "Floodplain Regulations," April 1983.
   2D. "NFIP Model Ordinance—Short Version," April 1981.

2F. "NIPC Planning Aid No. 9," February 1978.
3B. "Protect Your Home From Flood Damage," March 1982.
4A. "Stormwater Management," December 1982.
4B. "Stormwater Management—Model Ordinance," December 1982.
5A. "River Stages in Illinois: Flood and Damage Data," March 1980.

JDOT, DWR, *Stream Preservation Handbook*, October 1981.

Report on Wilmington's Floodplain Programs, City of Wilmington, Illinois.

Illinois State Water Survey in cooperation with Illinois Department of Transportation, Division of Water Resources. Floodplain Information Assistance. July 1979.

Illinois State Water Survey. Circular 137. "Floodplain Services Available from the Illinois State Water Survey." 1979.

Illinois Department of Transportation, Division of Water Resources. "Notifying Floodplain Residents: An Assessment of the Literature." July 1980.

_____. "Report on the Executive Order." May 1979.

Resource Coordination Policy Committee, *Our Community and Flooding*, 1981.

"Rules and Regulations, Regulation of Construction within Floodplains Established Pursuant to Section 65f, Chapter 19, Illinois Revised Statutes." July 1979.

For further information, contact:

State Coordinator
National Flood Insurance Program
Illinois Department of Transportation
Division of Water Resources
300 North State Street, Room 1010
Chicago, Illinois 60610

INDIANA

1. **Number of Communities Subject to Flooding**
   400.
2. **Local Enabling Authority**
   Cities, counties and incorporated towns all have general zoning authority with specific flood language. A special act also authorizes floodplain regulations consistent with state standards.
3. **Existing State Floodplain Management**
   The state directly regulates floodways and requires permits for developments within them. The state must also approve local floodplain zoning ordinances.

   The Division of Water of the Department of Natural Resources is the state coordinating agency. Four professional and two clerical staff members have a budget of approximately $100,000.
4. **State Floodplain Management Activities**
   A wide range of activities are undertaken. Priorities include the review and approval of hydrologic and hydraulic studies, approval of local ordinances and assistance to communities in ordinance adoption.
5. **Problems**
   Problems include inadequate staff, funds and data. Local efforts and programs are not fully utilized in the state regulatory program.

6. **Innovations**
   After the 1979 flood disaster in English and Marengo, Indiana, the following hazard mitigation was accomplished: 20 heavily damaged structures were demolished, several businesses were relocated and a HUD Community Development Block Grant was received, which will help improve streets and gutters and rehabilitate the less seriously damaged structures.

7. **Selected State Floodplain Management Publications**
   State of Indiana, "Hazard Mitigation Plan." 1979 Flood Disaster in English and Marengo.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Natural Resources
Division of Water
605 State Office Building
Indianapolis, Indiana 46204

IOWA

1. **Number of Communities Subject to Flooding**
   548.

2. **Local Enabling Authority**
   Cities and counties have broad general authority to zone with specific reference to flooding in the enabling language. Cities and counties also have statutory authority to regulate subdivisions and to adopt building codes. In addition, limited home rule powers have been granted to both cities and counties.

3. **Existing State Floodplain Management**
   There is direct state regulation in most instances. The state must also review and approve local regulations for flood areas before they become effective. The Natural Resources Council* is the state coordinating agency. The Flood Plain Management Division has a staff of 15, two of which are assigned to deal with local governments in floodplain management, including coordination of the NFIP. A budget of $350,000 is allocated.

4. **State Floodplain Management Activities**
   The staff undertakes a wide range of activities, with priority given assisting local communities in ordinance adoption, reviewing flood insurance studies and public education.

5. **Problems**
   Problems include inadequate staff, funds and flood data.

For further information, contact:

State Coordinator
National Flood Insurance Program
Iowa Natural Resources Council
Wallace State Office Building
Des Moines, Iowa 50319

*The Iowa Natural Reasources Council will be merged with the Iowa Department of Environmental Quality as of July 1983, forming a new Department of Water, Air & Waste Management. The existing floodplain management functions will remain intact.

KANSAS

1. **Number of Communities Subject to Flooding**
   446.
2. **Local Enabling Authority**
   Cities and counties have power to zone. A special act provides specific floodplain regulatory powers.
3. **Existing State Floodplain Management**
   Although there is no direct state regulation, the state has developed standards for local regulation and the state must also approve local ordinances. The state coordinating agency is the Division of Water Resources of the State Board of Agriculture. A staff of 1.0 person with a budget of $44,766 is assigned to floodplain zoning. Additional staff are involved in the dam section, which covers other structural approaches such as levees, channel changes, etc.
4. **State Floodplain Management Activities**
   The staff has a wide range of activities but a priority is local coordination, including variance approval and ordinance adoption.
5. **Problems**
   Problems have been inadequacies of both staff and flood data coupled with statutory duplication of concepts without integration.
6. **Innovations**
   The state program has consistently assisted the local community to use NFIP in meeting a flood damage reduction goal in the state water plan.
7. **Selected State Floodplain Management Publications**
   Bell, Fletcher. "Flood Insurance Facts to Help You." Kansas Insurance Department, State Office Building, Topeka, Kansas 66612.

   Eberle, William M. "Alternatives and Actions for the Community, National Flood Insurance Program." Kansas State University, Community Resource Development Cooperative Extension Service.

For further information, contact:

State Coordinator
National Flood Insurance Program
Division of Water Resources
State Board of Agriculture
109 SW 9th Street
Topeka, Kansas 66612-1283

KENTUCKY

1. **Number of Communities Subject to Flooding**
   308.
2. **Local Enabling Authority**
   Cities and counties have broad zoning power with specific flood language in the legislation.
3. **Existing State Floodplain Management**
   The state requires permits to regulate the placement of obstructions in the floodway. The state coordinating agency is the Cabinet of Natural Resources and Environmental Protec-

tion. Two staff persons (budget about $40,000) coordinate the NFIP and five persons work with regulations. Total budget is approximately $280,000.

4. **State Floodplain Management Activities**
   The staff trains local officials, agents and lenders, reviews and approves hydrology and hydraulics of studies, distributes program information and enforces violations. Review and approval of the technical data are priorities as is the administration of the FEMA State Assistance Program grant.

5. **Problems**
   Inadequate staff, funds and flood data are problems. Obtaining legal assistance has also been a problem.

6. **Innovations**
   Commonwealth funds are available to administer community flood damage abatement programs in order to alleviate persistent flood damage problems.

7. **Selected State Floodplain Management Publications**

Kentucky Natural Resources and Environmental Protection Cabinet. *Staff Report.* "The Floods of April." 1977.

_____. *Floodplain Management: Summary of Legislative and Administrative Basis*, 1982.

_____. *Floodplain Management: Legislation and Regulation*, 1981.

_____. *Floodplain Management and Flood Hazard Mitigation Agencies: Kentucky Directory*, 1981.

For further information, contact:

State Coordinator
National Flood Insurance Program
Kentucky Natural Resources and Environmental
Protection Cabinet
Division of Water
18 Reilly Road
Fort Boone Plaza
Frankfort, Kentucky 40601

LOUISIANA

1. **Number of Communities Subject to Flooding**
   259.

2. **Local Enabling Authority**
   Parishes and municipalities are authorized to enact zoning laws, subdivision regulations and building codes in order to satisfy NFIP requirements.

3. **Existing State Floodplain Management**
   There is no state floodplain management program or direct state regulation of floodplains. The Department of Urban and Community Affairs is the state coordinating agency. A staff of three with a budget of $70,000 are assigned to the program.

4. **State Floodplain Management Activities**
   Staff activities cover a range of areas, including community training, enforcement of violations, and distribution of materials. A priority is the adoption of strong ordinances.

5. **Problems**
   In addition to inadequate staff, funds, data and enabling legislation, the general public believes that the solution to every flood is another levee.

6. **Innovations**
   A proposed action that deserves attention is the plan to develop curriculum materials in floodplain management.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Urban and Community Affairs
5790 Florida Boulevard
Baton Rouge, Louisiana 70806

MAINE

1. **Number of Communities Subject to Flooding**
   896.

2. **Local Enabling Authority**
   Cities and towns are broadly authorized to adopt zoning regulations; the state regulates unorganized territories. There is no comprehensive floodplain regulation.

3. **Existing State Floodplain Management**
   There is no formal floodplain management program but the state regulates certain floodplains through the Shoreland Zoning Act. The state coordinating agency is the State Planning Office.

4. **State Floodplain Management Activities**
   Principal activities include assisting in ordinance development and adoption, training local officials and promoting flood insurance. Assisting the community and citizens in the promotion of the NFIP is a priority action. Other activities include review of Community Development Block Grant applications and projects, review of coastal sand dune applications for coastal development, and inventory of all flooding data available for towns not in the regular phase of the NFIP.

5. **Problems**
   Problems are lack of staff and funds, and inadequate flood data.

6. **Innovations**
   Voluntary acquisition ("willing buyer/willing seller") using Community Development Block Grant in Fort Kent will result in the relocation of approximately 30 homes and families out of the floodplain.

   Changes in the state plumbing code no longer allow locating subsurface disposal units in the 10 year floodplain or V-zone. An inventory of mobile homes in the floodplain is being conducted. This will be used in a plan to relocate mobile homes during flooding. This was necessitated by changes in the NFIP. Legislation was enacted to expedite removal of ice jams.

For further information, contact:

State Coordinator
National Flood Insurance Program
Bureau of Civil Emergency Preparedness
State House Station #72
Augusta, Maine 04333

MARYLAND

1. **Number of Communities Subject to Flooding**
   115.

2. **Local Enabling Authority**
   Cities, counties, and incorporated municipalities have broad zoning enabling legislation. To qualify for the NFIP, communities have only to adopt a resolution recognizing the state's authority to regulate floodplains. The FIA has approved the state as having authority over all floodplain development and has approved the state's regulatory criteria.

3. **Existing State Floodplain Management**
   There is a statewide flood hazard management program and direct regulation of floodplains through a state permit. No filling is allowed if the tractive force (depth × slope) or stream power (velocity × slope) would be increased by more than 5%. No increase in flood elevations is allowed until an easement is secured from affected property owners. No construction is allowed within the natural meander pattern of the channel. The state coordinating agency is the Water Resources Administration, Flood Management Division.

4. **State Floodplain Management Activities**
   Contracts with FEMA to perform Flood Insurance Studies in 7 counties.

   State-sponsored training seminars in hydrology, hydraulics, flood preparedness, and stormwater management.

   Repository for all flood related data.

   Technical assistance to local governments, including on-the-job training, impact analysis of specific projects, and participation of task forces and steering committees.

   Preparation of zoning map overlays which show floodplain limits, elevations, and bench mark locations.

5. **Problems**
   Although new development in flood hazard areas is adequately regulated and enforced, significant improvements to existing structures are difficult to monitor.

   The requirement and sale of flood insurance is loaded with inaccuracies. A more accurate process needs to be developed if the insurance is to be equitable and a viable mitigation alternative.

6. **Innovations**
   Planning and regulation for the reduction of flood losses include the entire watershed rather than just the floodplain. There is a state law requiring stormwater management on all new construction, as well as a state law regulating construction in the floodplain. There are state funds available for technical studies of watersheds to determine existing problems, future problems based on expected development, and analysis of alternatives available to solve existing and future problems. There are state funds available for cost-sharing on flood management capital projects, such as acquisition, flood warning systems, and flood control projects.

7. **Selected State Floodplain Management Publications**
   Maryland Department of Natural Resources. "If You're Planning . . . You Need A Permit". March 1979.

   Maryland Water Resources Administration, "An Assessment of Flood Management Activities in Maryland"

   _____. "Appealing the FIA Maps".

   _____. "Flood Insurance Facts and Procedures for Appraisers".

_____. "Model Flood Plain Ordinance".

University of Maryland, Cooperative Extension Service, *Information Sheet No. 2.* "Intertidal Zone Uses—A Program for Regulation of Tidal Wetlands Alteration". January 1979.

For further information, contact:

Chief
Flood Management Division
Water Resources Administration
Tawes State Office Building
Annapolis, Maryland 21401

MASSACHUSETTS

1. **Number of Communities Subject to Flooding**
   349.
2. **Local Enabling Authority**
   Cities and town have broad zoning authority with specific flood language.
3. **Existing State Floodplain Management**
   There is direct state regulation of certain inland and coastal floodplains as part of the Wetlands Protection Act (which define wetlands to include floodplains). The Division of Water Resources and Water Resources Commission is the state coordinating agency. State Assistance Program funds a six-person staff to handle the NFIP and Floodplain Management Project.
4. **State Floodplain Management Activities**
   Principal activities are the distribution of information, review of projects, assisting communities to adopt and enforce floodplain regulations, training local officials. Providing technical data and assistance to communities in developing hazard mitigation plans including acquisition of high hazard coastal areas, is a priority of the project.
5. **Problems**
   Limited staff and funding is the major problem.
6. **Innovations**
   The Coastal Flood Proofing Program is designed to ultimately reduce the amount of housing damage sustained from flooding of low-lying coastal areas. The program will have a sliding scale of rebates granted after approved residential flood proofing has been completed.

   The Coastal Acquisition Program is designed to assist local communities to acquire high hazard coastal areas for low-impact recreational use.

   The Charles River Project is a nonstructural approach with emphasis on maintaining valley storage.
7. **Selected State Floodplain Management Publications**

   State of Massachusetts, "A Coastal Homeowner's Guide to Floodproofing" May 1979.

   State of Massachusetts, "Flood Hazard Mitigation" September 1982.

   State of Massachusetts, "Inland Wetland & Floodplain Regulation" September 1982.

   State of Massachusetts, "Coastal Wetland & Floodplain Regulation" September 1982.

For further information, contact:

State Coordinator
Flood Hazard Management Project
Division of Water Resources
Leverett Saltonstall Building
100 Cambridge Street
Boston, Massachusetts 02202

MICHIGAN

1. **Number of Communities Subject to Flooding**
   557.

2. **Local Enabling Authority**
   Cities, villages, townships and counties have broad zoning authority. They are authorized and encouraged to zone wetlands, natural river areas, floodplains, and high risk erosion areas along the Great Lakes. Under the State Construction Code, flood proofing of individual structures is encouraged.

3. **Existing State Floodplain Management**
   A statewide floodplain management program regulates floodplain occupation, land subdivision, mobile home and condominium developments, and coastal flood risks. The state requires permits for filling or otherwise occupying riverine floodplains. Floodplains in new subdivision developments must be identified and minimum building areas must be provided above these defined elevations. Similarly, mobile home subdivision pads and condominiums must be elevated above flood levels and individual mobile homes must be anchored. The Department of Natural Resources is the NFIP state coordinating office. There are presently 16.5 full-time employees and a budget of $670,000.

4. **State Floodplain Management Activities**
   The staff performs a wide array of floodplain management activities. Priorities include regulatory permitting, review and approval of hydrologic and hydraulic studies, distribution of NFIP information, estimating floodplain elevations and enforcement of violations. They also coordinate floodplain management with other regulatory programs and assist communities in the development of local programs.

5. **Problems**
   Problems include inadequate staff, funding, data and enabling legislation. In rapidly urbanizing communities, loss of storage and inadequate stormwater management present particular problems.

6. **Innovations**
   The regulatory program allows the state to review floodway encroachments to determine whether future urbanization will impact flood stage and discharges. The state program can regulate storage areas once data is developed to define how the removal of flood storage will impact flood stages.

7. **Selected State Floodplain Management Publications**

   Michigan Department of Natural Resources, Division of Land Resources Programs/Water Management Division. *The National Flood Insurance Program—Guidelines for Floodplain Management*. April 1978.

Michigan Department of Natural Resources, Water Management Division. *Are the Citizens in Your Community Protected from Flood Losses?* 1981.

_____. *The National Flood Insurance Program-Construction Code Alternative.* September 1981.

_____. *The National Flood Insurance Program-Community Administrator's Handbook.* January 1983.

Michigan Department of Natural Resources, Clinton River Watershed Council, Evaluation Associates. *Stormwater Management-Clinton River Basin* Assessment. 1981.

_____. *Stormwater Management-Clinton River Technical Assistance* Directory. 1982.

_____. *Stormwater Management-Technical Assistance Guide.* 1982.

For further information, contact:

State Coordinator
National Flood Insurance Program
Michigan Department of Natural Resources
Water Management Division
P.O. Box 30028
Lansing, Michigan 48909

MINNESOTA

1. **Number of Communities Subject to Flooding**
   525.
2. **Local Enabling Authority**
   Cities, counties and townships have broad authority to zone; the legislation has specific flood language. A special floodplain management act requires flood-prone communities to participate in the NFIP and to adopt floodplain regulations.
3. **Existing State Floodplain Management**
   There is a statewide floodplain management program. The state has minimum standards that must be adopted and administered by local governments. The state has power to adopt regulations if a local unit of government fails to act within a specified time. The Division of Waters of the Department of Natural Resources is the state coordinating agency for the National Flood Insurance Program. One full-time central office staff person is assigned to floodplain management. Twenty-five field personnel spend some portion of their time on floodplain management. The budget is approximately $200,000.
4. **State Floodplain Management Activities**
   Staff activities cover a wide range. Priorities are ordinance adoption and administration, training of local officials, and flood hazard mitigation activities (e.g., flood forecasting and warning, acquisition and relocation, etc.).
5. **Problems**
   Problems include inadequate funding for program enhancement due to state budget deficits.
6. **Innovations**
   The state has a long-standing commitment to develop informational materials; e.g., technical report series, model ordinance series and floodplain management informational brochures.

A state building code for floodproofing has been adopted and an administrative manual has been developed to aid in implementation. Acquisition and relocation have occurred in several communities. Computerized status of flood plain management and flood data retrieval system.

7. **Selected State Floodplain Management Publications**

Minnesota Department of Natural Resources, Division of Waters, Land Use Management Section. "Hazard Mitigation Plan — FDAA 5822."

_____. "Minnesota Status of Flood Plain Management." Published monthly.

_____. *DNR Reports No. 88.* "New Ways to Reduce Flood Damage."

_____. *Flood Plain Management Informational Brochure No. 1.* "Reducing Flood Damages by Acquisition and Relocation: The Experience of 4 Minnesota Communities."

_____. *Informational Brochure No. 2,* "Before You Buy or Build In The Flood Plain: What You Should Know."

_____. *Informational Brochure No. 3,* "Flood Hazard Mitigation Planning: What It Is and What It Can Do For Your Community."

_____. *Information Brochure No. 4,* "Urban Stormwater Management Another Alternative For Reducing Flood Damage."

_____. *Informational Brochure No. 5,* "Would A Flood Warning System Benefit Your Community."

_____. *Informational Brochure No. 6,* "Flood Plain Management in Minnesota."

_____. *Flood Plain Management Information Sheet No. 1,* "Preparing for Floods."

_____. *Flood Plain Management Information Sheet No. 2,* "Preparing to Evacuate."

_____. *Flood Plain Management Information Sheet No. 3,* "It's Time to Clean Up."

_____. *Technical Report No. 5.* "On-site Sewage Disposal in Flood Plain Areas." December 1974.

_____. *Technical Report No. 6.* "The Regulatory Floodway in Flood Plain Management." September 1977.

_____. *Technical Report No. 7.* "Procedures and Requirements for Flood Hazard Evaluation." April 1980.

_____. "Sample Flood Plain Zoning Ordinance for Local Units of Government. September 1978.

_____. "Flood Plain Management Program—Operations Manual November 1979.

Minnesota Department of Natural Resources in cooperation with the League of Minnesota Municipalities and the Association of Minnesota counties. "Sample Flood Plain Zoning Ordinance for Local Units of Government (Using Available Flood Information in the Absence of Detailed Engineering Studies)." December 1971.

_____. "Sample Flood Plain Zoning Ordinance for Local Units of Government (Using Detailed Engineering Studies)." February 1971.

U.S. Army Corps of Engineers, St. Paul District in cooperation with the Minnesota Department of Natural Resources, Division of Waters. *Flood-proofing Administrative Manual for Minnesota.* 1977.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Natural Resources
Division of Waters
Space Center Building, Third Floor
444 Lafayette Road
St. Paul, Minnesota 55101

MISSISSIPPI

1. **Number of Communities and Counties Subject to Flooding**
   296.
2. **Local Enabling Authority**
   Cities, incorporated towns and counties have broad zoning authority.
3. **Existing State Floodplain Management**
   There is no statewide floodplain management program. However, the state has adopted a statewide floodplain management regulation that pertains to state-owned buildings and structures.
4. **State Floodplain Management Activities**
   Principal activities include preparing a sample floodplain management ordinance, training local officials, supporting insurance activities, distributing materials, and assisting communities in enforcement. A priority is training of local officials. The state coordinating agency is the Mississippi Research and Development Center.
5. **Problems**
   Problems include inadequate mitigation funds and detailed flood data.
6. **Innovations**
   Using HUD Section 407 funding, plans were implemented to relocate 106 low income family units out of the floodplain and to elevate approximately 84 units.
7. **Selected State Floodplain Management Publications**

   State of Mississippi. *Flood Hazard Mitigation Plan—FDAA-577-Dr.* July 31, 1979.

   _____. *Floodplain Management Regulations for the State of Mississippi.* Adopted August 1, 1979, amended June 10, 1982.

   _____. *Flood Hazard Mitigation Plan—FEMA-618-Dr.* June 1981.

   _____. *The Development of an Automated Flood Warning System for Hattiesburg, Mississippi.* May 1982.

For further information, contact:

State Coordinator
National Flood Insurance Program
Mississippi Research and Development Center
P.O. Drawer 2470
Jackson, Mississippi 39205

MISSOURI

1. **Number of Communities Subject to Flooding**
   516.
2. **Local Enabling Authority**
   According to Missouri Revised Statutes, incorporated cities, town and villages, first class charter counties, counties with planning and/or zoning and those counties enabled by special Mississippi River legislation (1980) have the authority to participate in the NFIP.
3. **Existing State Floodplain Management**
   The Department of Natural Resources is the state coordinating agency for the NFIP, in which the Floodplain Management Section handles the program. Currently, there are 3.5 staff members funded under the SAP.
4. **State Floodplain Management Activities**
   Floodplain management efforts are directed toward the administration of the NFIP, reduction of future flood damages through advanced planning and preparedness, implementation of the Governor's Executive Order on Floodplain Management and Assistance to local governments.
5. **Problems**
   Problems include inadequate staff, funds, and enabling authority for some communities which thereby precludes their participation in the NFIP.
6. **Selected State Floodplain Management Publications**

   Missouri Department of Consumer Affairs in cooperation with the Missouri Department of Public Safety, Disaster Planning and Operations Office. "Flood Insurance Facts—A Consumer Guide to the National Flood Insurance Program in Missouri." August 1979.

   Missouri Department of Public Safety, Disaster Planning and Operation Office. *National Flood Insurance Program Handbook for Missouri Communities—Vol. I, Emergency Program.* May 1979.

   _____. *National Flood Insurance Program Handbook for Missouri Communities—Vol. II, Regular Program.* March 1980.

   _____. *Manual for Floodplain Management, Implementation of the Governor's Executive Order.* September 1981.

   Missouri Department of Public Safety, State Emergency Management Agency. "Reducing Flood Damages in Missouri." October 1982.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Natural Resources
P.O. Box 1368
Jefferson City, Missouri 65102

MONTANA

1. **Number of Communities Subject to Flooding**
   126.

2. **Local Enabling Authority**
   Broad zoning authority is granted to cities, incorporated towns. Localities must adopt regulations meeting state standards for floodplain areas designated by Board of Natural Resources and Conservation.

3. **Existing State Floodplain Management**
   The state designates floodway and floodplain areas. If localities fail to adopt adequate regulations, the state will directly regulate designated areas. The Department of Natural Resources and Conservation is the state coordinating agency. NFIP coordination is part of the statewide program, which two staff persons handle on a limited budget.

4. **State Floodplain Management Activities**
   The staff prepares model ordinances, assists in the adoption of ordinances, reviews technical data, assists local communities in enforcement, trains local officials and distributes information. The public hearing and state designation procedure for floodplain delineation are priority activities.

5. **Problems**
   Inadequate staff has been a major problem. The state hearing and notification requirement is cumbersome and time-consuming.

6. **Selected State Floodplain Management Publications**

   Montana Department of Natural Resources and Conservation, Flood Plain Management Section, Engineering Bureau. "Managing Montana's Flood Plains."

For further information, contact:

State Coordinator
National Flood Insurance Program
Montana Department of Natural Resources
and Conservation
Water Resources Division
32 South Ewing
Helena, Montana 59620
(406) 449-2864

NEBRASKA

1. **Number of Communities Subject to Flooding**
   327.

2. **Local Enabling Authority**
   Cities, villages and counties have general authority to zone. Legislation has specific flood language.

3. **Existing State Floodplain Management**
   The state delineates floodway and flood fringe areas. Local units are required to adopt adequate regulations to meet state minimum standards. Failure to adopt such regulations will result in direct state regulation. The Natural Resources Commission is the state coordinator with a staff of three and budget of $157,600 allocated. The Department of Water Resources also has two staff members assigned to floodplain management.

4. **State Floodplain Management Activities**
   The staff participates in a wide range of activities; priority actions include ordinance adoption, training local officials, public awareness, and delineation of hazard areas.

5. **Problems**
   Problems include inadequate funds and lack of detailed flood data.

6. **Selected State Floodplain Management Publications**

   Nebraska Civil Defense Agency. *Emergency Assistance Handbook for Local Government Officials of Nebraska.* June 1979.

   Nebraska Natural Resources Commission. *Flood Plain Study—Big Blue River, Vols. I-IV.* March 1977.

   Nebraska Institute of Agriculture and Natural Resources, Nebraska Civil Defense Agency, and the Nebraska Natural Resources Commission. *"Flood—Are You Prepared? Emergency Flood Information."* 1979.

   Nebraska Natural Resources Commission. *Flood Plains: What they are; How they affect us; and How they can be managed.* January 1982.

   Nebraska Natural Resources Commission. *Flood Plain Quarterly* newsletter Numbers 1-9.

For further information, contact:

State Coordinator
National Flood Insurance Program
Nebraska Natural Resources Commission
301 Centennial Mall South
P.O. Box 94876
Lincoln, Nebraska 68509

NEVADA

1. **Number of Communities Subject to Flooding**
   25.

2. **Local Enabling Authority**
   Broad zoning authority exists for incorporated cities and towns. Cities, counties and regional planning commissions have general enabling legislation for regulation to protect life and property in areas subject to flood. Other statutes specifically address Flood Control Districts, their adoption and funding procedures.

3. **Existing State Floodplain Management**
   The State Assistance Program serves as the only state-wide flood plain management program. The staff and budget are limited. Coordinating agency is the Department of Military, Division of Civil Defense and Disaster Assistance.

4. **State Floodplain Management Activities**
   Principal activities include informational and training workshops, flood map and study repository and information center, and special flood problem solving.

5. **Problems**
   Inadequate legislation, funds and data.

6. **Innovation**
   The State Assistance Program is conducting a pilot project on alluvial fan development and associated flood hazard reduction measures.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Military
Division of Civil Defense and Disaster Assistance
Capitol Complex
Carson City, Nevada 89710

NEW HAMPSHIRE

1. **Number of Communities Subject to Flooding**
   222 out of 234.
2. **Local Enabling Authority**
   Cities and towns have authority to master plan, zone, and regulate subdivisions and building construction.
3. **Existing State Floodplain Management Activities**
   There is no statewide floodplain management program or direct state regulation of floodplains. The Office of State Planning is the state coordinating agency for flood insurance and floodplain management. Two staff persons are assigned to the coordination responsibility. Funding is received through the FEMA State Assistance Program.
4. **State Floodplain Management Activities**

   Principal activities include:

   assistance to municipalities in ordinance development, adoption, floodplain development administration, enforcement, and monitoring of local activity.

   clearinghouse for floodplain management and flood insurance information (mapping, regulations, eligibility, etc.).

   preparation and distribution of newsletter addressing floodplain and coastal management topics as well as other state planning issues.
5. **Problems**
   None.

For further information, contact:

State Coordinator
National Flood Insurance Program
Office of State Planning
2½ Beacon Street
Concord, New Hampshire 03301
(603) 271-2155

NEW JERSEY

1. **Number of Communities Subject to Flooding**
   549.
2. **Local Enabling Authority**
   Cities, villages, boroughs, towns and counties have broad zoning authority with specific flood language. Municipalities must adopt floodplain regulations consistent with state standards.

3. **Existing State Floodplain Management**
   The state identifies floodplain and floodway areas and directly regulates floodways. Local governments regulate flood fringe areas according to the state's minimum criteria. The state will adopt regulations for areas that fail to adopt adequate regulations within a certain time. The state coordinating agency is the Department of Environmental Protection, Division of Waters Resources, Bureau of Flood Plain Management. A staff of 35 are involved: 25 of them are assigned to project review and permitting functions.

4. **State Floodplain Management Activities**
   The staff delineates flood hazard areas, prepares model ordinances, trains local officials, develops and reviews technical data, distributes program materials, monitors community administration and enforces violations. Priority actions are the delineation of floodways and flood hazard areas, issuance of floodway stream encroachment permits and coordination.

5. **Problems**
   Problems include inadequate staff and funds and legal challenges.

6. **Innovations**
   The state, under the Emergency Flood Control Board Act of 1978, is providing $22 million in matching funds to local governments to construct flood control works, and $3 million for preparation of a statewide flood control master plan and regional flood control planning.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Environment Protection
Bureau of Flood Plain Management
Division of Water Resources
P.O. Box CN 029
Trenton, New Jersey 08625

NEW MEXICO

1. **Number of Communities Subject to Flooding**
   89.

2. **Local Enabling Authority**
   Incorporated municipalities, villages and counties are authorized to zone with specific flood language. A special statute authorizes municipal and county floodplain regulations.

3. **Existing State Floodplain Management**
   There is a statewide floodplain management program administered by the Office of Civil Emergency Preparedness with a staff of 3 persons and an annual budget of $117,000. The State Coordinator's role for the NFIP is assigned to the Office of the State Engineer. Four staff persons are involved on a part-time basis with a budget of about $8,000.

4. **State Floodplain Management Activities**
   The Office of Civil Emergency Preparedness promotes public national flood insurance program. It conducts flood mitigation conferences and develops and informs communities about permit procedures in the flood plain. The office acts as clearinghouse for floodplain management data. The State Engineer Office staff prepares model ordinances and distributes information about the NFIP. A priority activity is assisting communities to gain eligibility for the NFIP.

5. **Problems**
   Problems have largely concerned inadequate coordination and communication by representatives of the federal government where federal agencies deal directly with the local units and do not involve the state.

For further information, contact:

State Coordinator
National Flood Insurance Program
State Engineer Office
Bataan Memorial Building
Sante Fe, New Mexico 87503
or
State Assistance Program
Office of Civil Emergency Preparedness
P.O. Box 2477
Sante Fe, New Mexico 87501

NEW YORK

1. **Number of Communities Subject to Flooding**
   1,475.
2. **Local Enabling Authority**
   Cities, towns, and villages are authorized to regulate floodplains. All federally designated flood-prone communities must participate in the NFIP.
3. **Existing State Floodplain Management**
   The state is authorized to regulate floodplains directly if local governments fail to do so. Other state regulatory programs impose indirect control over certain types of floodplain development. The Department of Environmental Conservation is the state coordinating agency. Five full-time central office staff, nine field staff (six on a part-time basis) and a budget of $250,000 are allocated for administration of the floodplain management program.
4. **State Floodplain Management Activities**
   The staff participates in a wide range of floodplain management activities with priority placed on assisting communities with adoption of ordinances, monitoring community administration and training local officials.
5. **Problems**
   Problems include inadequate staff and funding.
6. **Selected State Floodplain Management Publications**
   State of New York. Department of State, Division of Community Affairs. "Model Zoning and Subdivision Provisions for Flood Hazard Areas in New York State." April 1979.

For further information, contact:

State Coordinator
National Flood Insurance Program
New York State Department of Environmental Conservation
Flood Protection Bureau
50 Wolf Road - Room 422
Albany, New York 12233-0001

NORTH CAROLINA

1. **Number of Communities Subject to Flooding**
   369.

2. **Local Enabling Authority**
   Municipalities and counties have broad authority through state enabling statutes for zoning, subdivision regulation, and construction standards via statewide building codes. A Floodway Regulation Act empowers local governments to regulate by permits in floodways, including the 100-year standard. A Coastal Area Management Act (since 1974) provides specific regulations for 20 coastal counties and the municipalities included, administered via the local governments and a Coastal Resources Commission that was provided by the state statutes. (Building regulations in the special coastal area related closely to standards set for the National Flood Insurance Program (NFIP), plus others as established by the Coastal Resources Commission.)

3. **State Floodplain Management**
   The Floodway Regulation Act authorizes the Department of Natural Resources and Community Development (DNRCD) to provide technical assistance to local governments and, operating through the Environmental Management Commission, to delineate a floodway should a local government not act concerning a stream segment that the Commission determines should be regulated. The DNRCD also provides: (1) a NFIP State Coordinator and related assistance to local governments through planners in seven regional offices; (2) limited technical (engineering and resource planning) assistance to local governments through the Office of Water Resources; and advisory and regulatory services to the local governments in the 20 coastal counties under the Coastal Area Management Act through the Office of Coastal Management. The state regulates its own activities and a self-insurance provision related to the NFIP under a Governor's Executive Order for Uniform Floodplain Management. The Division of Emergency Management of the Department of Crime Control and Public Safety is designated as the state's lead agency for flood warning, evacuation, response and recovery.

4. **Current State Floodplain Management Activities**
   The DNRCD Division of Community Assistance provides the NFIP State Coordinator and administers the State Assistance Program (for floodplain management, which is partially funded via the Federal Emergency Management Agency (FEMA)). Recent efforts include assistance to local governments with ordinance and floodplain management programs, public information materials and programs on the NFIP and floodplain management practices, workshops and training, and coordination with the Division of Emergency Management plans and activities.

5. **Problems**
   Inadequate funding—state and federal—for staff and mapping needs. Lack of awareness concerning NFIP benefits and floodplain management needs. Hurricane threats in view of many years since serious coastal hurricanes have been experienced here and potential for lack of citizen concern.

For further information, contact:

State Coordinator
National Flood Insurance Program
Division of Community Assistance
Department of Natural and Economic Resources Development
P.O. Box 27687
Raleigh, North Carolina 27611

NORTH DAKOTA

1. **Number of Communities Subject to Flooding**
   247 (210 participating in NFIP; 37 with flood hazard area identified, but not participating).
2. ***Local Enabling Authority***
   Cities, counties and townships have general authority for zoning.
3. **Existing State Floodplain Management**
   North Dakota Floodplain Management Act of 1981 established authority for the state to be involved in floodplain management. It: 1) adopts the standards of the NFIP for North Dakota, 2) authorizes the Office of the State Engineer to work with local units of governments in their floodplain management efforts, and 3) encourages local units of governments to participate in the NFIP.

   The 1981-83 biennium had a budget of $117,000. The floodplain management staff includes two engineers, a program specialist, and a half-time information office. The State Assistance Program funds the latter two positions.
4. **State Floodplain Management Activities**
   Principal activities include technical assistance to local units of government for ordinance adoption and administration; preparation and/or review of hydrologic and hydraulic studies; coordination of the National Flood Insurance Program; and general education/information programs.
5. **Problems**
   Problems include inadequate staff, funds, and data.

For further information, contact:

State Coordinator
National Flood Insurance Program
State Water Commission
900 East Boulevard
Bismarck, North Dakota 58505
(701) 224-2752

OHIO

1. **Number of Communities Subject to Flooding**
   732.
2. **Local Enabling Authority**
   Cities, villages, townships and counties are authorized to zone.
3. **Existing State Floodplain Management**
   There is no statewide floodplain management program for regulation of floodplains. The Department of Natural Resources is the state coordinating agency. Four full-time and two part-time (college interns) staff members are assigned to coordinate the NFIP activities, provide flood information, and flood hazard mitigation assistance. The annual budget for this is approximately $120,000.
4. **State Floodplain Management Activities**
   The staff prepares model ordinances, assists communities in ordinance adoption and enforcement of violations, supports insurance activities, provides a limited review of technical data, trains lenders and agents, and monitors community enforcement. A priority is training local officials to properly regulate floodplains.

5. **Problems**
   Problems include inadequate staff, funds, flood data, and lack of statewide regulations.

For further information, contact:

State Coordinator
National Flood Insurance Program
Ohio Department of Natural Resources
Division of Water
Fountain Square Dr.-Building E
Columbus, Ohio 43224

OKLAHOMA

1. **Number of Communities Subject to Flooding**
   405.
2. **Local Enabling Authority**
   Cities, incorporated towns, and unincorporated counties have floodplain management authority sufficient to allow them to participate in the NFIP.
3. **Existing State Floodplain Management**
   A statewide floodplain management act was signed into law on May 13, 1980. Administrative regulations were adopted March 10, 1981. The Oklahoma Water Resources Board is the state coordinating agency. Two full-time staff members are assigned with limited budget.
4. **State Floodplain Management Activities**
   Principal activities are monitoring community administration and distributing floodplain information. A priority is placed on training local officials, informing the public, and enforcing community floodplain ordinances.
5. **Problems**
   The major problem is lack of funds.

For further information, contact:

Oklahoma Water Resources Board
1000 N.E. 10th Street
P.O. Box 53585
Oklahoma City, Oklahoma 73152

OREGON

1. **Number of Communities Subject to Flooding**
   253.
2. **Local Enabling Authority**
   Cities and counties have broad zoning powers. Zoning is mandatory.
3. **Existing State Floodplain Management**
   Floodplain management is primarily a local responsibility. Zoning ordinances are adopted to regulate development in the floodplain. Comprehensive plans must address statewide goals and guidelines which require provisions relating to natural hazards. The Water Resources Department has been designated as the state coordinating agency.

4. **State Floodplain Management Activities**
   Principal state activities include the review of technical data, distribution of information and materials and training of affected parties. Enforcement is accomplished through local zoning ordinances.

5. **Problems**
   There is a lack of informational material explaining the National Flood Insurance Program to lenders, insurance agents, citizens and zoning departments. Confusion resulting from the general lack of information on mobile home regulations is an increasing concern.

6. **Selected State Floodplain Management Publications**
   Oregon Land Conservation and Development Commission. *Oregon Coastal Management Program.* 1976.

For further information, contact:

State Coordinator
National Flood Insurance Program
Water Resources Department
555 13th Street N.E.
Salem, Oregon 97310

PENNSYLVANIA

1. **Number of Communities Subject to Flooding**
   2,428.

2. **Local Enabling Authority**
   State enabling legislation authorizes local municipalities (all boroughs, incorporated town, townships and certain classes of cities and counties) to adopt land use control regulations.

   The State Flood Plain Management Act requires federally identified flood-prone municipalities to adopt regulations that meet minimum requirements of the National Flood Insurance Program and State Act.

3. **Existing State Floodplain Management**
   The State Department of Environmental Resources has exclusive jurisdiction over the following obstructions within floodplain areas; (1) any flood control project constructed, owned, or maintained by a governmental unit; (2) any highway or other obstruction constructed, owned, or maintained by the Commonwealth or a political subdivision of the Commonwealth; (3) any obstruction owned or maintained by a person engaged in the rendering of a public utility service. In addition, the Department of Environmental Resources also has jurisdiction over any obstruction located within any floodway area. To carry out its responsibilities, DER has 18 staff members.

   The Department of Community Affairs serves as the statewide coordinating agency for the National Flood Insurance Program. It also has primary responsibility for administration of the State Flood Plain Management Act. The Department of Community Affairs has a staff of 12 people to carry out its responsibilities.

4. **State Floodplain Management Activities**
   The staff provides technical and financial assistance to communities and monitors their activities in floodplains. Among a wide range of activities, priority actions are technical assistance for ordinance adoption, administration and enforcement and providing a continuing training program for local officials on floodplain management.

5. **Problems**
   Problems include lack of state and local staff, inadequate flood data, and problems with state/federal coordination.

6. **Innovations**
   Flood stage forecast maps are being prepared for a number of municipalities. These maps depict the extent to which flooding will occur in a municipality, based upon the predictions which are developed concerning the anticipated height of a flood. Local officials use this information to develop evacuation plans that enable orderly and systematic evacuation of citizens in times of flooding. Such maps enable municipalities to target activities to specific areas, thereby promoting both efficient and cost effective operations in times of flooding.

   These maps are also a community development tool for the municipality. Any proposed community development can be evaluated to determine the possible or probable level of flooding, thus enabling an adequate assessment of the impact that various flood heights will have on the proposed development.

7. **Selected State Floodplain Management Publications**

   Flood Plain Management Subcommittee of the Pennsylvania Water Resources Coordinating Committee. *A Technical Manual for Implementation of Flood Plain Management by Local Governments*. July 1977.

   Commonwealth of Pennsylvania. Bureau of Community Planning, Floodplain Management Division. "Suggested Provisions to be Used for Compliance with National Flood Insurance Program Section 60.3 (b) (c) and (d)."

   _____. "Floodplain Management: Some Questions and Answers."

   _____. "The Pennsylvania Flood Plain Management Act (Act 166); Some Questions and Answers."

   _____. "Floodplain Management: Land Acquisition."

   _____. "Floodplain Management: Relocation."

   _____. *Regulating Floodplain Development: A Handbook for Municipal Officials*. 1982.

   "Industrial Flood Preparedness." Proceedings: Flood Warning and Flood Proofing Seminar for Industry. Williamsport, Pennsylvania. April 16-17, 1979.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Community Affairs
Bureau of Community Planning
Forum Building, Room 551
Harrisburg, Pennsylvania 17120

PUERTO RICO

1. **Enabling Authority**
   Municipality governments in Puerto Rico do not have zoning or land use powers. All such powers are vested in the Puerto Rico Planning Board, at the level of the central (state) government. The entire island is considered a single community for the purposes of the NFIP. Specific legislation enables control of development in areas susceptible to flooding.

2. **Coordination**
   The state coordinating office is the Puerto Rico Planning Board, which has first review of major changes in land use. Implementation of the Planning Regulations is through the Regulations and Permits Administration (RPA), which operates 11 regional and subregional offices for the issuance of construction and use permits. Although neither agency has budget or staff assigned specifically to floodplain management, all planning activities include floodplain awareness.

3. **Floodplain Management Activities**
   Principal activities of the Planning Board are the dissemination of materials to municipal and agency officials, property owners, developers and others in real estate, including appraisers, architects, engineers and lenders. RPA maintains data on floor elevations of new structures. Planning Board staff (as the State A-95 Clearinghouse) reviews proposals for location in or near flood-prone areas. The staff is also involved in a flood hazard mitigation effort, which is led by the Department of Natural Resources.

4. **Problems**
   Problems include lack of adequately trained inspectors and other staff, limited public funds for hiring additional specialized staff, and inadequate flood data. Local attitudes on the value and usefulness of land and the division of institutional responsibilities for land and water plans are impediments to effective monitoring of development.

5. **Innovations**
   The high proportion of low-income families living in flood hazard areas led to the consideration of subsidies on flood insurance at the state level early in 1979. After Hurricane David (August 1979), some 70,000 low-income families did not qualify for SBA loans, but did receive disaster assistance grants, from which the $25 minimum flood insurance premium was deducted. Local insurance agents refused to handle individual policy applications at the minimum fee. The FIA solution was to issue a single policy in the name of the Commonwealth of Puerto Rico, for which the Department of Social Services certified the families that were eligible to participate. The group policy has expired and presently there is no insurance policy program.

   There has been established on a trial basis a working agreement between DPR and RPA providing for a monitoring activity in the coastal zone (Parguera Area) to be carried out by the DNR's Ranger Corps. The Rangers have legal authority to issue cease and desist orders to individuals carrying out activities without proper authorization.

For further information, contact:

State Coordinator
National Flood Insurance Program
Puerto Rico Planning Board
P.O. Box 41119, Minillas Station
Santurce, Puerto Rico 00940

RHODE ISLAND

1. **Number of Communities Subject to Flooding**
   39.

2. **Local Enabling Authority**
   Cities and towns have broad general zoning authority including flood language.

3. **Existing State Floodplain Management**
   There is no statewide floodplain management program as such, but the State Building Code governs construction and the Coastal Resources Management Council regulates high hazard zone development. In addition, wetland controls apply to floodplain areas. The Statewide Planning Program is the state coordinating agency. With a budget of $74,250, three staff persons are allocated to it (one full-time and two part-time).

4. **State Floodplain Management Activities**
   The staff assists communities with ordinance revisions, distributes information and reviews and comments on Coastal Council Permit Applications. Training local officials, information dissemination, monitoring community administration and coordination are considered priorities.

5. **Problems**
   Problems include inadequate staff and data. An additional problem is that local administration relies on building inspectors, some of which are part-time. NFIP requirements are a small part of each community's overall responsibility and may not be receiving adequate attention and priority.

For further information, contact:

State Coordinator
National Flood Insurance Program
R. I. Statewide Planning Program
265 Melrose Street
Providence, Rhode Island 02907

SOUTH CAROLINA

1. **Number of Communities Subject to Flooding**
   216.

2. **Local Enabling Authority**
   Cities, villages, incorporated towns and counties have general enabling legislation some of which has specific flood language.

3. **Existing State Floodplain Management**
   There is no statewide floodplain management program. The state coordinating office is the South Carolina Water Resources Commission.

4. **State Floodplain Management Activities**
   Principal activities are assisting in ordinance adoption and administration, information distribution and limited monitoring of community ordinance administration.

5. **Problems**
   Problems have been inadequate funds, staff and enabling legislation.

For further information, contact:

State Coordinator
National Flood Insurance Program
P.O. Box 4515
3830 Forest Drive
Columbia, South Carolina 29240

SOUTH DAKOTA

1. **Number of Communities Subject to Flooding**
   146.
2. **Local Enabling Authority**
   Cities, counties and incorporated towns have general zoning authority.
3. **Existing State Floodplain Management**
   There is no statewide floodplain management program. The state coordinating office is the Planning Bureau where one staff member with a limited budget is assigned to coordinate the NFIP.
4. **State Floodplain Management Activities**
   Principal activities are training of local officials and distribution of materials.
5. **Problems**
   The major problem is apathy.

For further information, contact:

State Coordinator
National Flood Insurance Program
State Planning Bureau
State Capitol
Pierre, South Dakota 57501

TENNESSEE

1. **Number of Communities Subject to Flooding**
   462.
2. **Local Enabling Authority**
   Cities, incorporated towns and counties have broad power to zone. The legislation contains specific flood language and provides for response to the NFIP.
3. **Existing State Floodplain Management**
   There is a statewide floodplain management program that is the responsibility of every department of state government pursuant to the governor's Executive Order 65. The Local Planning Division of the Tennessee State Planning Office is the state coordinating office.
4. **State Floodplain Management Activities**
   Principal activities are preparing model ordinances, training local officials, distributing materials and monitoring community administration. The model ordinance, distribution of materials and monitoring are considered top priorities.
5. **Problems**
   Inadequate flood maps are cited as a chief problem.

For further information, contact:

State Coordinator
National Flood Insurance Program
Tennessee State Planning Office
660 Capitol Hill Building
Nashville, Tennessee 37219

TEXAS

1. **Number of Communities Subject to Flooding**
   1,240.
2. **Local Enabling Authority**
   A special act authorizes all political subdivisions to adopt floodplain regulations for flood insurance purposes.
3. **Existing State Floodplain Management**
   There is no statewide program or direct state regulation of floodplains. The Department of Water Resources is the state coordinating agency. Three staff members and a budget of $100,000 are allocated.
4. **State Floodplain Management Activities**
   The staff prepares model ordinances, assists in adoption and administration of ordinances, trains local officials and distributes materials. Priorities are monitoring community administration and enforcement and training local officials.
5. **Problems**
   Problems include inadequate staff and funds.

For further information, contact:

State Coordinator
National Flood Insurance Program
Texas Department of Water Resources
Community Services Unit
P.O. Box 13087
Austin, Texas 78711

UTAH

1. **Number of Communities Subject to Flooding**
   199.
2. **Local Enabling Authority**
   Cities, towns and counties have broad general zoning authority that allows them to regulate floodplains.
3. **Existing State Floodplain Management**
   The Division of Comprehensive Emergency Management is the state agency that coordinates the National Flood Insurance Program. It also functions as the state clearing house for all disasters including flooding.
4. **State Floodplain Management Activities**
   The State CEM assists communities to adopt floodplain ordinances, provides assistance to communities in the development of and adoption of floodplain maps and provides flood insurance data to insurance agents, home owners, developers, and real estate appraisers.
5. **Problems**
   More attention needs to be devoted to training new building inspectors, zoning commissions and newly elected community officials.

   Flooding in Utah is the most destructive natural occurrence (in terms of dollar damage to the private sector). Interest in NFIP is growing each year.

For further information, contact:

State Coordinator
National Flood Insurance Program
Division of CEM
1543 Sunnyside Avenue
Salt Lake City, Utah 84108

VERMONT

1. **Number of Communities Subject to Flooding**
   277.
2. **Local Enabling Authority**
   A special state statute authorizes towns, cities and incorporated villages to regulate floodplains.
3. **Existing State Floodplain Management**
   The state identifies the flood hazard areas which are then regulated by local government through a zoning permit process. State statutes require notification of floodplain development to be submitted to the state in designated floodplain areas. The Department of Water Resources is the state coordinating agency. One engineer and one secretary handle the program with a limited budget with considerable assistance from a second engineer under the State Assistance Program (SAP) whose primary activities are mutually agreed upon with FEMA.
4. **State Floodplain Management Activities**
   Principal activity is in assisting and providing technical assistance to communities in the administration of their flood hazard bylaws, maintaining a repository of flood information, and the gathering of new data and floodplain studies from sources other than FEMA. The SAP activities of the second engineer vary by contractual agreement with FEMA to complement the state program.
5. **Problems**
   Problems include inadequate staff, funds and flood data. Inadequate mapping particularly impedes the state's ability to provide accurate information to communities.

For further information, contact:

State Coordinator
National Flood Insurance Program
Water Resources Department
State Office Building
Montpelier, Vermont 05602

VIRGINIA

1. **Number of Communities Subject to Flooding**
   251.
2. **Local Enabling Authority**
   All local political jurisdictions have broad zoning authority with specific flood language.

3. **Existing State Floodplain Management**
   The Flood Damage Reduction Act authorizes the State Water Control Board to administer a floodplain management program and to preserve stream capacity to carry the 100-year flood. The uniform statewide building code regulates building construction practices in coastal hazard areas and 100-year floodplain. The state coordinating office is the State Water Control Board.

4. **State Floodplain Management Activities**
   Principal activities are coordination of the NFIP and assisting local communities in flood alert systems and ordinance review. The collection, review and distribution of floodplain management information and hydrologic data and coordination of federal floodplain management activities and studies are also part of the program.

5. **Problems**
   Problems are inadequate staff and flood data.

For further information, contact:

State Coordinator
National Flood Insurance Program
State Water Control Board
P.O. Box 11143
2111 No. Hamilton St.
Richmond, Virginia 23230

WASHINGTON

1. **Number of Communities Subject to Flooding**
   267.

2. **Local Enabling Authority**
   Cities, counties and towns are all delegated broad zoning authority. There is special county enabling authority for flood control.

3. **Existing State Floodplain Management**
   The state delineates and directly regulates flood control zones. The state may delegate authority to city, county or town. The Department of Ecology is the state coordinating agency. Five staff members and a budget of approximately $100,000 are involved.

4. **State Floodplain Management Activities**
   The principal activity is distribution of materials. Priority activities are training local officials and enforcement of violations.

5. **Problems**
   Problems include inadequate staff, funds, and flood data and a lack of clear definition of statutory responsibilities for floodplain management.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Ecology
Olympia, Washington 98504

WEST VIRGINIA

1. **Number of Communities Subject to Flooding**
   210.
2. **Local Enabling Authority**
   Cities, villages, towns and counties have broad zoning authority with specific flood language.
3. **Existing State Floodplain Management**
   There is no statewide floodplain management program or direct state regulation of floodplains. The state coordinating office is the Disaster Recovery Office within the Office of Economic and Community Development. One staff person with a budget of $20,000 is authorized.
4. **State Floodplain Management Activities**
   Principal activities are training local officials, lenders and agents; distribution of information; and monitoring of community administration. Distribution of material and monitoring community administration are considered priority activities.
5. **Problems**
   Problems include inadequate staff, funds, flood data and enabling authority.

For further information, contact:

State Coordinator
National Flood Insurance Program
Governor's Disaster Recovery Office
State Capitol Complex
Charleston, West Virginia 25305

WISCONSIN

1. **Number of Communities Subject to Flooding**
   557.
2. **Local Enabling Authority**
   Cities, villages and counties have broad zoning authority. Floodplain zoning is mandatory under a special act.
3. **Existing State Floodplain Management**
   The state establishes mandatory standards for floodplain regulations to be adopted by local governments. The state coordinating agency is the Department of Natural Resources. In the Department of Natural Resources, the Flood Plain-Shoreland Management Section has 10 central office positions and 17 part-time field positions, with a budget of approximately $450,000.
4. **State Floodplain Management Activities**
   The staff is involved in a wide range of activities, but priority is placed on training local officials and providing planning and engineering assistance to local units of government.
5. **Problems**
   Problems include inadequate mitigation programs for existing development; flood data; particularly good base maps; funds, and staff.
6. **Innovations**
   Innovations include acquisition and relocation projects that represent alternatives to structural solutions.

a. Soldiers Grove: downtown area is being relocated out of the floodway to high ground. The project has multiple objectives, with emphasis on energy management, economic development and flood hazard mitigation.

b. Prairie du Chien: over 100 homes on an island in the floodway of the Mississippi River are being acquired and relocated. A key to success in both projects has been strong local involvement.

c. Kickapoo Valley Flood Hazard Mitigation Study. FEMA funded an effort to help all communities in the Kickapoo River basin identify their problems and needs and to package existing federal programs to achieve the multiple goals of flood damage reduction, energy conservation, economic development, open-space recreation, and water quality.

d. State-funded mapping grant program. A program that provides financial aid to communities to cover 50% of the cost of developing large-scale topographic maps.

e. Restrictive local ordinances. Many local communities have floodplain zoning ordinances that prohibit structures in the entire floodplain. Only open space is permitted.

7. **Selected State Floodplain Management Publications**

Wisconsin Department of Natural Resources. "Flood Plain and Shoreland Mapping Grants." 1979.

_____. "Floods Affect Your Property." 1981.

_____. "Suggestions for Prospective Buyers of Waterfront Property in Rural Wisconsin." 1978.

_____. "A Helping Hand with Flood Plain Management." 1981.

_____. "Floodplain/Shoreland Management: A Guide for Local Zoning Officials." 1981.

For further information, contact:

State Coordinator
National Flood Insurance Program
Department of Natural Resources
Flood Plain-Shore and Management Section
P.O. Box 7921
Madison, Wisconsin 53707

WYOMING

1. **Number of Communities Subject to Flooding**
83.

2. **Local Enabling Authority**
Cities, towns and counties are delegated broad zoning authority.

3. **Existing State Floodplain Management**
There is no state floodplain management program or direct state regulation of floodplains. The Disaster and Civil Defense Agency is the state coordinating agency. The State Assistance Program provides funding for 1½ positions, a coordinator for the National Flood Insurance Program and a technician. There is an existing executive order signed by the Governor in 1979 which calls for attention by state agencies for any activity occurring in a floodplain. The state is currently trying to develop state statutory authority for floodplain management.

4. **State Floodplain Management Activities**
   The staff provides technical assistance to local governments in the implementation of the NFIP and any other flood hazard mitigation activity.

5. **Problems**
   Problems include inadequate staff, funding, flood data and specific state enabling authority.

For further information, contact:

State Coordinator
National Flood Insurance Program
Wyoming Disaster and Civil Defense Agency
P.O. Box 1709
Cheyenne, Wyoming 82003

APPENDIX II

Selected State Statutes

The following are some of the more innovative state floodplain management statutes from the last decade, arranged according to topic. An executive order on barrier beaches is also included.

MAPPING

Wisconsin

Wis. Stat. Ann. §87.31 (West)

FLOOD PLAIN AND SHORELAND MAPPING ASSISTANCE PROGRAM.

1. Department to Administer; Purpose. The department shall administer a flood plain and shoreland mapping assistance program to provide counties, cities and villages with financial assistance to produce adequate topographical mapping of flood plain and shoreland areas and to delineate flood plain and floodway boundaries, to assist in the establishment and administration of flood plain and shoreland ordinances.

2. Criteria. The department shall develop on a statewide basis a priority list for awarding mapping grants. The criteria for establishing the priority list includes but is not limited to:

(a) The adequacy of existing mapping.
(b) The existence of an approved flood plain or shoreland zoning ordinance.
(c) The status of studies to develop flood profiles for the areas to be mapped.
(d) The potential for future development in the areas to be mapped.
(e) The potential for flood damage in the areas to be mapped.
(f) Applications made by 2 or more counties, cities or villages which would enable mapping of an entire river system.
(g) The availability of funds for mapping from other sources.

3. Procedure. The department shall establish by rule the procedure for application for and awarding of mapping grants.

4. Application. A county, city or village which seeks a mapping grant shall submit grant application which includes:

(a) The location, length and extent of the river or shorelands to be mapped.
(b) The estimated cost of and time required to complete the proposed mapping.
(c) The information necessary to determine the priority of the applications under sub. (2).
(d) A statement that the applicant will assume responsibility for administering any subcontracts with mapping contractors.

entity shall adopt rules and regulations concerning the development and use of land in the flood fringe area which at least conform to the standard promulgated by the department.

§58:16A-58

FAILURE TO ADOPT OR ENFORCE LOCAL RULES AND REGULATIONS; ACTION BY DEPARTMENT

If any affected municipality or other responsible entity fails to adopt or fails to enforce rules and regulations concerning the development and use of land in the flood fringe area which at least conform to the standards promulgated by the department within the specified period, thereafter the department may adopt such rules and regulations which shall be applicable to the particular flood fringe area.

§58:16A-59

ADOPTION OF RULES AND REGULATIONS BY DEPARTMENT; REQUIREMENTS

No rule or regulation adopted by the department pursuant to sections four or seven of this act shall become effective until after notice and public hearing before the department as required by the Administrative Procedures Act.

§58:16A-61

ESTABLISHMENT OF FULL VALUE OF LANDS FOR ASSESSMENT

Local assessors shall consider the impact of rules or regulations issued pursuant to this act in establishing full value of lands designated as floodways or as flood fringe areas.

§58:16A-62

LOCAL RULES AND REGULATIONS MORE RESTRICTIVE THAN STATE STANDARDS; AUTHORIZATION

Any municipal or other entity vested with authority to adopt rules and regulations concerning the development and use of land may adopt requirements more restrictive than those contained in the rules and regulations adopted by the department for the floodway and than those contained in the minimum standards promulgated by the department.

§58:16A-63

VIOLATIONS; PENALTIES; INJUNCTIONS

(a) Any person who violates a provision of this act or a rule or regulation adopted pursuant to this act shall be subject to a penalty of not more than $2,500.00 for each offense, to be collected by the department in a summary proceeding under the Penalty Enforcement Law (N.J.S. 2A:58-1 et seq.), and in any court of competent jurisdiction wherein injunctive relief has been requested. The Superior Court, County Court and county district court shall have jurisdiction to enforce said Penalty Enforcement Law. If the violation is of a continuing nature each day which it continues shall constitute an additional, separate and distinct offense. The department is hereby authorized and empowered to compromise and settle any claim for a penalty under this section in such amount in the discretion of the department as may appear appropriate and equitable under all of the circumstances.

(b) If any person violates any of the provisions of this act or any rule or regulation promulgated pursuant to the provisons of this act, the department may institute an action in a court of competent jurisdiction for injunctive relief to prohibit and prevent such violation or violations and the said court may proceed in the action in a summary manner.

approved zoning and building codes where desired by local interests and where said local interests have, in the judgment of the department, sufficient funds and personnel to adequately administer the program. Should the department determine at any time that the program is inadequately administered, the department shall have authority to revoke the authority granted to the county or municipality.

FLOOD HAZARD PROVISIONS IN COMPREHENSIVE STATE COASTAL ZONE MANAGEMENT ACT

North Carolina

N.C. Gen. Stat. §113A-113 et seq.

AREAS OF ENVIRONMENTAL CONCERN; IN GENERAL.

(a) The Coastal Resources Commission shall by rule designate geographic areas of the coastal area as areas of environmental concern and specify the boundaries thereof, in the manner provided in this Part.

(b) The Commission may designate as areas of environmental concern any one or more of the following, singly or in combination:

* * * * *

(6) Natural-hazard areas where uncontrolled or incompatible development could unreasonably endanger life or property, and other areas especially vulnerable to erosion, flooding, or other adverse effects of sand, wind and water, which may include:

a. Sand dunes along the Outer Banks;
b. Ocean and estuarine beaches and shoreline;
c. Floodways and floodplains;
d. Areas where geologic and soil conditions are such that there is a substantial possibility of excessive erosion or seismic activity, as identified by the State Geologist;
e. Areas with a significant potential for air inversions, as identified by the Environmental Management Commission.

* * * * *

§113A-115

DESIGNATION OF AREAS OF ENVIRONMENTAL CONCERN

(a) Prior to adopting any rule permanently designating any area of environmental concern the Secretary and the Commission shall hold a public hearing in each county in which lands to be affected are located, at which public and private parties shall have the opportunity to present comments and views.

* * * * *

§113A-118

PERMIT REQUIRED

(a) After the date designated by the Secretary of Natural Resources and Community Development pursuant to G.S. 113A-125, every person before undertaking any development in any area of environmental concern shall obtain (in addition to any other required State or local permit) a permit pursuant to the provisions of this Part.

* * * * *

§113A-120

GRANT OR DENIAL OF PERMITS

(a) After consideration of submitted evidence and arguments submitted at the hearing, or otherwise in the case where no hearing was conducted, the responsible official or body shall deny the application for permit upon finding:

factors. Innovative programs have developed varied use policies and have applied different implementation techniques. For example, acquisition and relocation may be appropriate for a developed area while regulations may be applied to an undeveloped area.

Packaging State and Federal Assistance

Programs can combine or package state and federal assistance such as floodplain mapping, technical and disaster assistance, or grants in aid for acquisition with local regulations, floodproofing, education, and flood warning systems to achieve multiple purposes in floodplain management.

Persistence

Program implementation requires persistence. All programs take time to implement, ranging from a few months to ten years. Persistence is essential to arrange necessary federal assistance, to educate landowners, and to implement the program.

Preflood Planning

Unless preflood planning lays the groundwork for intelligent decisions following a serious flood, rapid rebuilding may occur with no thought of the consequences. Although a single major flood may precipitate planning and discussion, a second is often required to stimulate funding and actual implementation. This two-flood phenomenon may be explained in part by the added impetus given by a second flood and in part by the planning and preparation that was done between the two disasters.

Community Awareness After a Disaster

After a disaster, a community is in the best position to develop and implement an innovative floodplain management program, beginning with moratoria on redevelopment until coherent proposals for response are developed. However, more permanent regulations should be combined with a mitigation plan, relocation, floodproofing, flood warning systems, and other measures.

Combining Regulations with Nonregulatory Approaches

In some situations, regulations are best combined with nonregulatory techniques to deal with existing uses and to allocate other floodplain areas to more appropriate uses. Communities with innovative programs and extensive development consistently apply some combination of regulatory and nonregulatory approaches. Acquisition, flood warning systems and floodproofing are most commonly used.

RECOMMENDATIONS FOR FEDERAL INCENTIVES

Because of their fragmentary, uncoordinated approaches and inflexibility in standards, some federal programs have tended to discourage local innovation in floodplain regulation. However, others have helped. Recent NFIP initiatives encouraging innovation include: technical assistance; training; education; support for local acquisition through constructive total loss payments; Section 1362 payments; and emphasis on preflood planning. The U.S. Water Resources Council in-

itiatives to strengthen state and local reliance on nonstructural floodplain management measures have also helped. Federal actions such as these should be continued and expanded and other federal programs should be evaluated and revised to remove impediments to local innovation.

Additional recommendations are:

Nonstructural Measures

Federal agencies, Congress, and the White House should treat nonstructural floodplain management measures and flood control works equally. Regulation, acquisition, flood insurance, and flood warning systems should have the same priority as structural measures in benefiting from cost-sharing, grants-in-aid, and other federal support. This would encourage communities to choose innovative combinations rather than stress flood control simply because 80-100% of the cost of flood control works is federally subsidized. Similarly, if flood insurance rates were revised to reflect actual risks, the tendency to rely on insurance alone would also be reduced.

Minimum Nature of Federal Standards

Federal agencies should emphasize the minimum nature of federal mapping and standards such as the floodway standards and the 100-year protection elevation established by the NFIP. Agencies could encourage more creative local approaches by providing maps tailored to local needs and by modifying flood insurance rates to reflect actual risk. They could also further support local programs by providing technical assistance, education and training.

Distribution of Materials

FEMA, WRC, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers, the Soil Conservation Service (SCS), and other agencies should act as clearinghouses to document innovative floodplain management programs and provide such documentation to communities that are looking for leadership examples and "how to" information. This documentation should stress the "nuts and bolts" aspects of innovation, including financial costs and benefits.

Technical Assistance

FEMA, the Environmental Protection Agency (EPA), SCS, the U.S. Geological Survey (USGS), the Tennessee Valley Authority (TVA), the Corps, and NOAA should provide additional assistance to communities or enhance state capabilities to provide assistance with innovations. This assistance could include: detailed mapping for land capability and flooding analysis; map interpretation; dissemination of information on the packaging of federal grants and programs; and distribution of materials on floodproofing, acquisition, and flood warning systems.

Training and Education

In cooperation with states, regional planning agencies, and universities, federal agencies should train local government officials, lenders, municipal attorneys, and planners in innovative and integrated floodplain management strategies and techniques. This may best be accomplished directly by FEMA after a major flood disaster or at the point a community converts to the regular flood insurance program. However, universities or private groups familiar with local conditions should

also provide ongoing assistance. Training materials may include case studies of innovative community experiences, slide shows, and booklets.

Federal agency staffs should also be trained in innovative approaches and in implementation of the Floodplain Management and Protection of Wetlands Executive Orders (E.O. 11988 and 11990). The WRC, FEMA, the Corps, USGS, or other agencies should hold workshops to familiarize federal staff with the components of innovative community programs; what motivates the innovations; and how federal agencies could encourage their development. Local government officials and planners from innovative communities could speak about their communities' experience at these workshops.

Tailoring Federal Programs to Local Conditions

Federal flood insurance, disaster assistance, mapping, and other programs should be tailored to the needs of communities with common sets of problems, such as those located on barrier islands, those prone to flash floods, or those with long-term fluctuation in water levels (e.g., lakeshores). Until recently, federal programs generally followed the "norm" in technical assistance and mapping. To some extent, this was necessary during early program phases: more sophistication is needed now.

Specific tailoring could begin by having FEMA, the National Science Foundation (NSF), WRC, the Corps, or SCS survey major categories of flood problems in communities. Standards for particular situations then could be developed. For example, FEMA could provide more specific standards for erosion problems, areas behind levees, lakeshore flooding, and "supercritical flow" areas.

Implementation of Executive Orders

To minimize federal investment and reinvestment in hazard areas, federal agencies should aggressively implement the Floodplain Management and Protection of Wetlands Executive Orders for federal and federally licensed, permitted or funded projects. Implementation in both preflood and postflood contexts would support and encourage local innovation by establishing examples of sound federal floodplain management for locals to follow; better informing the public; encouraging nonstructural approaches; and providing a community infrastructure (*e.g.*, roads, sewers) consistent with regulations.

Encouragement for State Programs

Strong federal support for innovative state programs will, in turn, encourage innovative local programs, particularly in rural areas. State programs often play a role in local innovation by providing a regulatory framework, technical assistance and training, and assistance in packaging federal and state programs. Continuation of FEMA grants provided by its State Assistance Program is important to encourage such state roles. Additional federal encouragement may take the form of technical assistance, training and education, mapping, and stronger involvement of the states in postdisaster response.

Mapping

Specialized and accurate federal and state floodplain maps are needed to encourage and support community innovations. States, federal agencies, and local communities should agree on specifications for such maps which then would be selectively produced. Often such a map can be developed as a "restudy" of an area.

Coastal areas need data on wave heights and erosion; inland areas also need data on erosion and more specialized data on "supercritical flow," lake flooding, and erosion. Soil and wetland maps are also needed in some areas.

After a disaster, mapping is particularly critical to help guide redevelopment. Flood maps should be large-scale (*e.g.*, 1"=200') and should be on a photographic or topographic base showing existing uses. Floodways shown on maps should reflect community decisions for acceptable backwater increases or alternative floodway boundaries. Urban areas need watershed mapping with projections of urbanization in calculation of flood flows. The specific mapping could be carried out on a cost-sharing basis among federal, state, and local units.

Ancillary Data Gathering

Mapping can often provide only a portion of the data needed for innovative floodplain management. Additional site-specific data gathering is needed for acquisition and relocation, flood control works, flood warning systems, floodproofing, and other management techniques. Flood velocities, soil erosion potential, flora and fauna, and land ownership are types of information commonly needed. Such site-specific data gathering may be carried out by federal agencies such as the Corps, SCS, USGS, and NOAA as individual plans and programs are developed after a flood disaster or as projects are proposed for the flood hazard area.

Preflood and Postflood Planning

Federal agencies should work closely with local communities and the states in developing hazard mitigation plans for use before and after a disaster. The plans should address land capability, floodproofing or relocation of existing structures, regulation, acquisition, flood warning systems, drainage, and evacuation. These plans should be sensitive to relationships among uses upstream and downstream, across the waterway, and elsewhere within the drainage basin.

Coordination and Packaging of Federal Programs

WRC, the Council on Environmental Quality (CEQ), FEMA, the Office of Management and Budget (OMB), and other agencies should coordinate and package federal policies addressing preflood and postflood situations. They should also encourage local innovation through a combination of flood insurance, grants-in-aid for open space, floodplain mapping and other programs. In the past, communities usually had to shop for grants and apply for assistance on a piecemeal basis. Implementation of the floodplain and wetland Executive Orders and the July 10, 1980 OMB directive that requires ten federal agencies to enter into interagency agreements to mitigate flood damages after disasters will improve such coordination. A coherent federal policy on flood hazard mitigation has been lacking. Moreover, the sheer complexity of procedures and forms for disaster relief, open space grants, and flood control measures has discouraged communities (particularly smaller ones) from applying for assistance.

Case Study Profiles

To develop this report, publications and reports on local floodplain regulatory programs were analyzed to identify the more creative ones. Then state floodplain management programs were surveyed through a questionnaire and personal interviews with floodplain management experts across the nation. Approximately 600 reports prepared during meetings between field staff in the NFIP and local officials were also examined.

From these sources, 150 study communities were selected for more detailed investigation. Each was telephoned and visits were made to 40 communities. The results of the survey and case studies were used to prepare profiles for each of the 150 communities. Seventy-five of these profiles are included in this appendix. The first section contains descriptions of programs in inland communities, listed alphabetically by state. Programs from coastal locales make up the second section.

Scottsdale, Arizona

Innovation: Aggressive regulation of floodplain and flood fringe areas has been combined with public acquisition (purchase in fee, easements, and dedication) of the floodway, channel modifications, and levees.

Background: Scottsdale is a community of 97,000 people east of Phoenix. It is bisected from north to south by the Indian Bend Wash—a tributary of the Salt River which flows for six miles through the city. The Wash is dry most of the time because rainfall averages only eight inches per year. However, heavy rains in the surrounding mountains produce dramatic flooding. Floodplain lands account for about 3% of the town's area (a total of 1,660 acres). About 1,400 people and 520 dwellings are at risk in the flood hazard area. Major floods occurred in 1943, 1970, and 1972. The 1972 flood caused $2,646,000 in damages.

In response to urbanization and flood problems, the Maricopa County Flood Control District was created in 1954. In 1960, the U.S. Army Corps of Engineers began to investigate structural channel improvements to alleviate flood problems in the Scottsdale area. In 1964, the city passed a resolution opposing structural solutions. In 1966 the electorate in a county-wide bond election defeated structural proposals calling for a concrete channel. Following this, the city developed a modified plan involving a low flow channel in a greenbelt (defined to include the floodway of a 100-year flood), land acquisition, and floodplain regulations. The Corps accepted the alternative approach.

With the greenbelt concept in mind, Scottsdale adopted floodplain regulations in 1967. These regulations prohibited new construction that would increase 100-year flood heights. The burden is on the developer to show no increase. New construction (where it would not increase flood heights) was to be raised above the level of the 100-year flood. Emergency access to and from a property was to be possible during a 100-year flood. Regulations also included vegetation protection requirements and drainage requirements. Subdivision and zoning density transfer provisions were included to encourage dedication of floodplain lands.

In 1973 a city bond issue of $10 million was adopted by a 7 to 1 margin by voters to support the overall greenway project.

Since 1967, development on fill in the outer flood fringe has taken place, as permitted by the ordinance. However, the greenbelt floodway (600 to 1,100 feet wide) has been totally protected. Much of this area has been dedicated to the city.

The Indian Bend Wash project, which is nearing completion, incorporates four elements: and inlet and interceptor channel, a greenbelt floodway, side channels, and outlets. Estimated total costs are close to $30 million. The greenbelt floodway is six miles long and is being acquired jointly by the city, the Flood Control District of Maricopa County, and the state. All 1,055 acres of floodway have now been acquired. City responsibilities in the total project include (in addition to acquisition) making bridge improvements to provide passage of 100-year flows, managing the greenbelt, providing recreation facilities, regulating fringe developments, and providing flood control measures to protect adjacent developments.

Scottsdale was the first city in Arizona to join the NFIP in 1971.

Problems: Problems have been encountered with floodplain maps because they become outdated too quickly. Delays in funding have slowed acquisition of the floodway.

Keys to Success: Severe flood problems, a high community awareness not only of flood problems but also of aesthetic values, plus technical assistance and funding from the Corps.

General Applicability: Scottsdale's regulation of floodway and flood fringe areas combined with acquisition of the floodway may be applied in other communities, particularly where floodway areas have not yet been developed or after a disastrous flood. Floodplain management to reduce flood losses while serving broader recreational, aesthetic and other objectives is also broadly applicable to many communities.

Sources of Information:

(1) Sheaffer and Roland, Scottsdale, Case Study of Floodplain Regulations, prepared for FIA, 1977

(2) CAPE, Region IX, February 1978

(3) Richard Shaner, Engineering Services
3939 Civic Center Plaza
Scottsdale, Arizona
(602) 994-2720

Klamath, California

Innovations: Open space floodplain regulations have been adopted to prevent building of permanent dwellings in a severely flooded area. A new town site, protected by levees, was prepared about 1,000 yards from the old one.

Background: Until 1964, Klamath was a small northern California community on the Klamath River. It was seriously flooded in 1927, 1953, 1955 and 1964 with all but two buildings washed away by the 1964 flood. Damages from 1953 to 1964 totaled $14 million.

Permanent evacuation was considered after the flood of 1955 but was not carried out. However, after the 1964 flood, Del Norte County adopted emergency regulations preventing rebuilding in an eight-mile "floodway" designated by the state. The ordinance prevented the use of old Klamath for permanent residences, commercial, industrial, public and quasi-public buildings, and farm buildings. Use for trailer parks and open space recreation was permitted during the dry season. The area is now used for trailers and camping.

A new townsite was assembled from land owned by the county and the U.S. Forest Service and by purchase of private land with loans and grants from EDA and the state. The Corps constructed a highway levee to protect the new town site from flooding and cleared the new site. As part of the agreement between the Corps and the county, residents must comply with the ordinance. Total cost of the levee was approximately $1,450,000. An additional $550,000 in grants and loans were used to prepare the new town site, equipping it with water, sewers, a sewage treatment plant, and a jail.

The California Court of Appeals sustained the open space floodplain regulations for this severely flooded area in *Turner v. County of Del Norte.*

Problems: The project has been only partially successful due to many delays in completing the new site—five years of planning and development. During this period most of the residents moved from the area; landowners received no financial compensation. Serious financial problems are still affecting the Klamath town site due to a lack of tax base and water users.

Keys to Success: Severity of the flood problem, court's affirmation of the regulations.

General Applicability: The Klamath experience is a valuable precedent for restrictive interim or permanent regulations for floodway or coastal high hazard areas seriously damaged by floods.

Sources of Information:

(1) Profile by Stuart Braman, Ralph Field Associates

(2) Examination of Del Norte County Zoning Ordinance

(3) Joe Creisler
Humboldt/Del Norte County
Department of Public Health
909 Highway 101 N.
Crescent City, California 95531

Lake Elsinore, California

Innovation: Regulations for protection from fluctuating lake levels and to prevent rebuilding of certain flooded properties have been supplemented with acquisition.

Background: Lake Elsinore, a city of 6,200, lies along Lake Elsinore. The lake is subject to fluctuating water levels due to its limited outlet and seasonal rainfall.

In 1967 the city adopted an ordinance prohibiting building below the 1,265 foot elevation in the lake's floodplain. Below that, only recreation and agriculture were allowed. The city entered the emergency phase of the NFIP in 1974. In that year FIA published a map and the city adopted a resolution incorporating minimum regulations—a relaxation of existing ordinances. Consequently at least three buildings were constructed, in compliance with NFIP standards. In 1980, the community entered the regular phase of the NFIP, and experienced a severe flood (approximately the 100-year flood) due to heavy rains. Over 255 properties were inundated; 400 mobile homes were removed from the floodplain. During the long period of flooding, the Corps of Engineers issued daily flood warning predictions, and a local radio station conducted daily programs on the flooding.

An interim ordinance was adopted prohibiting building below a 1,270 foot elevation to provide a margin of safety for new structures. A new ordinance was adopted in May, 1980, which prohibits new development beyond the 1,265-foot elevation, unless the structure is on land, not simply elevated. Fill is prohibited.

After the flooding began, the governor formed an interagency task force of federal, state, and local representatives. The city has also developed a plan for acquisition of flood-prone properties, to be funded in part with Section 1362 funds, to acquire 37 properties for $2.2 million. The city hopes to acquire 63 additional developed properties and many that are undeveloped. The state park system will also acquire some land. Additional acquisition will be accomplished with EPA funds. Work has also been done to partially alleviate flood problems by deepening the outlet channel.

Problems: Lack of adequate flood data, lack of money, absence of an easy structural solution, failure of other communities around the lake to adopt regulations, existing development, inadequate maintenance of the flood overflow channel, inadequacy of minimum NFIP regulations for long-term flooding problems.

Keys to Success: Recurrent flooding, highly supportive city manager, incentives and technical assistance from the NFIP and the Corps, good public education, state help.

General Applicability: Lake Elsinore's experiences are broadly applicable to communities with flood problems due to long- or short-term fluctuations in lake or wetland water levels.

Sources of Information:

(1) Alvin J. Brown, California Water Board
Department of Water Resources
P.O. Box 388
Sacramento, California 95802
(916) 445-2985

(2) Manuel A. Rede, City Manager
City Hall
Lake Elsinore, California 92330
(714) 674-1324

Riverside County, California

Innovation: Floodplain regulations for creeks and streams have been combined with special regulations for alluvial fans and flood control improvements such as channelization. Flood control districts have been created to provide technical services, evaluate projects, and construct flood control works.

Background: Riverside County is a large, arid southern California county with 6,895,397 acres of land—the size of some states. Much of the county has periodic flooding along creeks and streams and alluvial fans. Since the county is very large, two separate flood control districts have been created to provide protection for the cities and unincorporated areas within their boundaries. These areas include 15 cities and a total population of over 650,000.

The county entered the emergency phase of the NFIP in January, 1971 and the regular phase in April, 1980. The county floodplain zoning ordinance incorporates minimum NFIP standards for floodways and minimum protection elevations. Additional mapping and special requirements are provided for alluvial fans and runoff from subdivisions.

Regulations for alluvial fans include density controls and floodproofing requirements. In the Cabazon area, subdivision regulations require combining existing lots, anticipating how debris will be moved by flood waters and planning for open areas around existing and proposed floodproofed structures. A density development curve has also been applied to mapped flood hazard areas and unmapped alluvial fans as a guide in determining lot sizes in areas subject to shallow, low velocity flows.

The flood control districts, the Riverside County Flood Control District and the Coachella County Valley Water District, act as advisors to the county. Both agencies provide onsite review of subdivisions and other development within their respective floodplains.

In the 1950s the Riverside County Flood Control District initiated a strong topographic mapping program for most urbanizing areas in the county as well as an extensive hydrologic data collection program. These data and the maps (1"=400') on a 4-foot contour interval provide a sound data base.

Most cities within the Riverside County Flood Control District have technical assistance agreements with the district. These agreements authorize the district to provide onsite review of individual permits. Cities usually take the advice of the district. The state has also delineated several "designated floodways" in the county.

The Riverside County Flood Control District spends about $800,000 a month constructing levees, channel improvements, and other flood control works. In 1970 the county approved a $30 million flood control bond for the Riverside area. Flood control measures, including drainage channels, are also constructed by the Coachella County Valley Water District.

Problems: Difficulties with maps, inconsistencies between county and FEMA maps, lack of maps in many areas, preexisting small-scale lots in some flood hazard areas, lawsuits.

Keys to Success: Strong technical assistance by flood control districts, county motivation, incentives of state and federal government, funding by bond issue, good topographic maps and hydrologic data base, strong intergovernmental agreements.

General Applicability: The use of special districts to provide maps and project review and the application of special restrictions to alluvial fan areas are broadly applicable.

Sources of Information:

(1) Ken Edwards, Chief Engineer
Bob Nelson, Assistant Chief Engineer
1995 Market Street
P.O. Box 1033
Riverside, California 92502
(714) 787-2016

(2) Dave Parkinson
Coachella County Valley Water District
(714) 398-2651

Sacramento, California (City and County)

Innovation: Restrictive floodplain regulations have been combined with extensive acquisition to protect an undeveloped floodplain.

Background: Sacramento is a county of approximately 800,000 residents and contains the city of Sacramento, capital of California. The American River runs through the city for nine miles. It continues for another 14 miles through Sacramento County. The Sacramento River also runs through the city. A number of creeks are subject to flooding. Flood damages occurred in the city and county in 1940, 1955, 1964, 1970, 1974, and 1980.

County floodplain regulations were first adopted in the mid-1960s. These required that finished floor elevations be three feet above the 10-year floodplain. These were subsequently upgraded to require one foot of elevation above the 100-year elevation. The county board has been very reluctant to permit any new development in the floodplain. The county entered the emergency phase of the NFIP in 1971 and the regular program in September 1978. New structures (where they are permitted) must be elevated to the 100-year elevation. Floodway conveyance must be maintained and drainage requirements must be met. Floodplain zoning regulations have been supplemented by a subdivision drainage ordinance based on a projection of flows from fully developed conditions.

The county has adopted a natural stream plan for one section of the county which included 13 small tributaries flowing into the Sacramento River. Very restrictive regulations have been applied to these areas, including restrictions on grading and vegetation removal.

The concept of a greenbelt for the American River dates from 1915 when a plan for the city was being prepared. However, implementation did not begin in earnest until 1947 when two parcels were acquired along the river. In 1950 two additional lots were acquired. A new Department of Parks and Recreation prepared a new county plan in 1959, proposing a 5,000 acre American River parkway.

As flooding threats along the river were reduced by upstream dams, the floodplain became attractive for development. In 1961 after the county planning commission approved subdivision plans for a portion of the floodplain, citizens strongly reacted and formed the Save the American River Association. Public pressure forced the county board of supervisors to adopt the 1959 parkway plan. Monies for acquisition were raised from a state bond issue and a private fund-raising effort

by the Association. A more complete plan for the parkway was developed in 1966 and, with revisions, adopted in 1968. A 1972 county bond issue provided further funding.

Three thousand acres along the 23-mile parkway (both city and county portions) are now in public ownership. The remaining 1,900 acres are in mixed public-private ownership and controlled through leases and special arrangements. A recreation trail follows the river for about 22 miles. A special "county park corridor overlay zone" has been adopted to prevent incompatible adjacent development. The floodway is used for agriculture and as a source of sand and gravel.

Problems: Existing development, development pressures, inadequate funding for acquisition, some private landowners object to public acquisition and use of land, limited funding for program administration resulting from Proposition 13.

Keys to Success: Active citizen lobby, high public awareness, excellent staff, citizen task force, open condition of the lands, flood problems, funding sources for acquisition.

General Applicability: This is an excellent example of how planning and a combination of regulations and acquisition can reduce flood losses while also meeting broader community objectives.

Sources of Information:

(1) Heritage Conservation and Recreation Service, *Urban Waterfront Revitalization, The Role of Recreation and Heritage*, Volume Two. Eighteen Case Studies. Heritage Conservation and Recreation Service, Department of Interior, Washington, D.C. 20243

(2) Joe Allessandri
Sacramento County Water Resources Division
827 7th Street, Room 301
Sacrmento, California 95814
(916) 440-6851

(3) Water Veda, Director, Planning and Development
Sacramento County Parks Department

San Bernardino, California

Innovation: Restrictive regulation of rebuilding for a mud flow area has been combined with acquisition.

Background: San Bernardino is a city in southern California. When a 1979 forest fire in Harrison Canyon north of the city denuded 750 acres, the Hampshire Avenue area became susceptible to mudslides. In 1980 four mud flows occurred, damaging 25 structures (January 14, January 29, February 9, February 29). The city spent more than $2 million to clean up after each of the mud flows. After the third, it passed an emergency ordinance declaring the area unsafe and prohibiting further repair. The city had joined the NFIP in 1976, so most of the structures damaged in the 1979 events were insured.

After the emergency ordinance was adopted, the city began to acquire damaged structures. To help the city, FEMA is acquiring 21 units at an estimated cost of $1,647,115 through their 1362 program. The remaining five are being relocated using assistance from the Small Business Administration. The homes were sold to a contractor for relocation and rehabilitation. The open land will be used as a city park. Retaining walls are also being constructed to protect adjacent lands from future mud flows. In addition, the city has erosion control measures under way for the upper canyon to reduce future events. A city "risk management" office has played a role in this relocation work. Strong community support was developed through public education.

Problems: Some confusion concerning allocation of damaged property, problems with use of existing properties, lack of funds for preventive measures.

Keys to Success: Severity of problem, federal financial assistance, public awareness, good staff, support of city council and mayor, good public education and assistance.

General Applicability: Restrictive regulations for mud flow areas, acquisition, and limited structural works are generally applicable to other areas.

Sources of Information:

(1) FEMA (Washington) files, Larry Zinsinger

(2) Scotty Wallace, City Risk Manager
City Hall
300 D Street
San Bernardino, California 92418
(714) 383-5308

San Diego, California

Innovation: Aggressive floodplain mapping and regulation have been combined with some acquisition and flood control measures.

Background: San Diego County is one of the largest and fastest growing in the nation with a 1980 population of 1,800,000. The county is transected by the San Diego River and numerous other rivers and streams flowing from the mountains west to the Pacific. Flood problems are deceptive since most of the streams are dry or have low flows much of the year. However, torrential flows have occurred when there are heavy rains. Severe flooding in 1916 destroyed all of the bridges to the city. More recently, severe flooding occurred in 1969 and 1978. Several persons died in a 1980 flood. In addition, storms and tsunamis cause occasional flooding along the nine miles of Pacific coast.

Due to early efforts at floodplain mapping and management, floodplain development is not extensive except in Mission Valley along the San Diego River. This portion of the river contains development worth hundreds of millions of dollars but has only a 300-foot floodway reserved for flood passage. Repeated and severe flooding has occurred here. The Corps has constructed a channel in the lower portion of the San Diego River. In addition, plans for channelization of streams were prepared by the Corps in the 1960s to extend the channel through Mission Valley. Anticipation of this channel construction encouraged much of the development in the floodplain. Environmentalists objected strongly to the channel in the early 1970s and the project was dropped.

Floodplain mapping was first carried out in 1962. Regulations were adopted in the mid-1960s. Although there are many proposals for flood control structures, public sentiment shifted to nonstructural approaches in the late 1960s. In 1970 the county board of supervisors adopted a comprehensive floodplain management program involving more intensive regulations, detailed mapping, flood insurance, and other nonstructural measures. The county prepared detailed flood studies for almost 300 miles of streams at a scale of 1"=200' with 5-foot contour intervals. Computer digitization of stereoscopic photos has permitted cross-sections and flood profiles accurate to one foot.

Floodplain regulations define floodways as the 10-year floodplain. High velocities are also considered. Structures in outer fringe areas must be elevated to the 100-year flood elevation. Regulations for most streams restrict channelization and retain the natural character of the floodplain.

Lands are also being acquired in some areas. Sweetwater River Regional Park has been created along a 6-mile reach of river. Much of this land is in open space. Plans were under way to acquire areas along other rivers, but subsequent to the passage of Proposition 13 virtually all of these have been dropped. A county flood warning system has been created and is being updated.

Problems: Lack of perception of flood problems due to normally low flows, the effect of rapid urbanization on flood peaks, lack of initial flood data, severe development pressures and diminishing funds for flood control construction and management since 1978.

Keys to Success: Public awareness of flood and environmental problems, an active and excellent mapping program and good floodplain management staff, persistence.

General Applicability: A similar combination of careful planning, detailed mapping, floodplain regulations and some acquisition could be applied to other flood-prone communities.

Sources of Information:

(1) H. Crane Miller, Sheaffer and Roland, Inc.

(2) Joe Hill, Principal Engineer
San Diego County Department of Public Works
Flood Control Division
5555 Overland Avenue, Building One
San Diego, California 92123
(714) 565-5335

Santa Barbara, California (City and County)

Innovation: Restrictive floodplain regulations have been combined with stormwater management regulations.

Background: Santa Barbara is a southern California county with a population of approximately 270,000. Flood problems occur along many rivers and creeks. There is some coastal flooding, but most of the coast has high bluffs.

The county adopted floodplain regulations in the late 1960s. It also adopted a coastal setback line for bluff areas subject to erosion. County floodplain regulations require elevation to two feet above the 100-year flood level. It has a stream setback of 50 feet from small streams and 200 feet from rivers. A successful density credit ordinance was adopted in 1963 to encourage preservation of open space along creeks.

The county subdivision control ordinance prohibits development in floodway areas, controls it in floodplains, and requires onsite detention for subdivisions not along major streams. Peak runoff cannot be increased. As a result of these requirements, many detention basins have been constructed. Since 1978, new basins are being designed for groundwater recharge. Some basins have also been used for parks.

The county has adopted stormwater drainage "benefit assessment" related to quantities of runoff and has prepared master drainage plans for some areas.

The city entered the emergency phase of the NFIP in December 1971 and the regular phase in March 1979.

The Santa Barbara County Flood Control and Water District provides technical services to the county and city. The District has also coordinated work of FEMA, the Corps, and other agencies and has carried out extensive construction projects, primarily to protect existing development. These include levees, channelization, and stormwater drains and basins.

Problems: Difficulties with maps (lack of a topographic base), development pressures.

Keys to Success: Aggressive action and technical assistance by the Flood Control District, interested citizens, good staff at the District, perserverance.

General Applicability: A combination of regulations with flood control measures and strong technical assistance and guidance by an expert agency is broadly applicable.

Sources of Information:

(1) James Stubchaer, Flood Control Engineer
Santa Barbara County Flood Control and Water
Conservation District
123 E Anapamu Street
Santa Barbara, California 93101
(805) 963-7125

Arvada, Colorado

Innovation: A strong floodplain zoning ordinance has been combined with subdivision regulations requiring onsite detention and dedication of floodplain land. Implementation has been careful and aggressive.

Background: Arvada is a suburb of Denver with a population of about 85,200. Several creeks are subject to flooding. The floodplain accounts for about 5% of the total acreage. At least 4,900 individuals (1981) live in the floodplain. Severe flooding has not occurred in the recent past, although a 1973 10-year event caused $100,000 in damages.

The city has adopted a series of complementary floodplain zoning, building code, and "unit drainage fee" ordinances. The latter requires a developer to install drainage improvements and/or compensatory storage. In addition, the developer must deed 6% of the land to the city (wherever possible, floodplain land). The floodplain zoning ordinance establishes floodway and flood fringe districts. Only open space uses are permitted in floodways. New structures in outer fringe areas must be elevated at least two feet above the 100-year flood elevation. All permits are checked in the field.

The city joined the emergency phase of the NFIP in 1971 and the regular phase in 1972. Regulations have been supplemented by nonregulatory techniques including acquisition of some floodplain areas and channel improvements.

Problems: Waning public interest in floodplain regulation as the threat of flooding faded from memory, court challenges, changing flood conditions resulting from rapid urbanization.

Keys to Success: Severe flooding in adjacent watersheds; technical assistance from the Corps, the Denver Urban Drainage and Flood Control District and the state floodplain management program; flood insurance incentives; a bond issue for channelization and bridges.

General Applicability: The combination of strong ordinances, effective enforcement, and supplementary nonregulatory techniques can be applied in virtually all communities.

Sources of Information:

(1) Sheaffer and Roland, Inc., case study, prepared for the Federal Insurance Administration.

(2) CAPE, Region VIII, September 23, 1976

(3) Ronald K. Culbertson, Director of Public Works
City of Arvada
8101 Ralston Road
Arvada, Colorado 80002
(303) 421-2550

Big Thompson Canyon, Larimer County, Colorado

Innovation: Regulations (first a rebuilding moratorium and later more detailed regulations) have been combined with a flood warning system, signs indicating flash flood problems, and partial acquisition of the floodplain.

Background: Big Thompson Canyon stretches approximately 20 miles with steep, narrow walls and a high gradient between Estes Park and Loveland, Colorado. In 1976 it had a population of 600 year-round residents and 1,200 seasonal residents. It is an area of repeated flooding. On July 31, 1976, 10 inches of rain in four hours sent a wall of water surging through the canyon. This killed 139 (confirmed, plus five or six bodies never found) and caused $56 million in public property damage and $16 million in private damage.

No floodplain regulations were in effect in the canyon prior to the flash flood. However, after the disaster, Larimer County adopted a 6-month moratorium on rebuilding, despite considerable local opposition by canyon residents. In 1977 the county adopted permanent regulations controlling development in the 100-year floodplain and limiting the reconstruction of structures damaged over 50% of their market value before the flood.

A plan to acquire some of the damaged properties called for the acquisition of 166 parcels at preflood values at a cost (including rehabilitation and relocation) of $2,969,200. A total of 123 parcels have been acquired on a voluntary basis at a cost of $2,200,000. Many of the less seriously damaged homes have been rehabilitated at homeowner or public expense. Some have been floodproofed. The roads and bridges destroyed by the flood have been rebuilt at a public cost of $24 million. In addition, considerable stream improvement has been carried out. Signs throughout the canyon warn of flood problems.

Problems: Landowner opposition to regulations was strong. Minimum redevelopment occurred since land acquisition was on a voluntary basis. The acquisition plan was partially implemented because of at least nine holdouts. Delays and undertainties in acquisition funding by federal and state agencies hindered implementation of the overall plan. The major road (Highway 34) in the canyon and many small bridges serving private residences were rebuilt, thereby encouraging private redevelopment.

Keys to Success: The program has been only partially successful. Success was due to the severity of the flood, availability of state and federal monies and acquisition programs/legislation, federal and state technical assistance, determination of the county to prevent future recurrence.

General Applicability: The flash flooding and loss of life in the Big Thompson Canyon are lessons for similarly situated canyons throughout the nation. The partial success of the regulatory-acquisition program offers both suggestions and cautions for future efforts.

Sources of Information:

(1) Onsite visit

(2) Rutherford Platt, University of Massachusetts, Amherst

(3) Nona Thayer, Larimer County Commissioner
Box 1190
Fort Collins, Colorado 80522
(303) 221-2100, Ext. 266

Denver, Colorado

Innovation: A comprehensive floodplain management/stormwater managment plan has been adopted for the Denver area. Urban renewal and land acquisition have been used to supplement regulations along the South Platte River.

Background: The Denver metro region consists of 34 units of local government with 1,100 miles of major drainage ways, more than 1,600,000 people, and about 1,200 square miles. The area has been subject to repeated and severe flood problems along the South Platte River and Cherry Creek throughout its history as well as on many of the other smaller drainageways. Serious encroachment has occurred along 30% of the floodplains.

The Colorado legislature created the Urban Drainage and Flood Control District in 1969 to address drainage and flood control problems since local entities cannot deal with multijurisdictional problems. This district includes Denver and urban portions of Adams, Arapahoe, Boulder, Douglas, and Jefferson Counties. It is governed by a 15-member board of directors. Funds are obtained through a tax levy.

Each year the district has selected several major drainageways for master planning. Priorities are based on requests from local governments and the seriousness of problems. Consulting engineers prepare the actual plans, which involve delineation of the 100-year floodplain, determination of present and future basin problems, identification of major drainage concepts, selection of a plan and preparation of a preliminary design. Local governments must contribute a percentage of the master planning costs.

The District's enabling legislation gives the board of directors authority to adopt and enforce floodplain regulations. Pursuant to this legislation, the board established a deadline for local adoption that was consistent with District standards.

The cornerstone of implementation has been floodplain regulations. The 28 local governments with at least one designated floodplain within their boundaries have all developed floodplain regulations. All 28 communities are also in the NFIP.

Other activities of the District are designing and constructing drainage and flood control facilities, providing assistance to local governments in formulating floodplain management programs, delineating the 100-year floodplain, collecting flood and water quality data, assisting local governments in the formulation and implementation of flood warning systems, and educating landowners.

Thirty-one master plans had been prepared as of December 31, 1979. Master planning efforts were under way for six other areas. Fifteen delineation studies had been completed and four were under way. Twenty-eight construction projects were completed or under way.

The District compiled a list of all properties in a defined floodplain and sent a brochure about the flood hazard to each address. In 1981, the District mailed approximately 22,000 brochures.

The metropolitan area has strong citizen and interest group support for nonstructural floodplain management. Beginning in 1974 the Platte River Development Committee pushed for the protection and restoration of this river which flows through most of downtown Denver. The committee prepared a plan to protect and preserve the 100-year floodplain. The plan encourages maximum use of nonstructural measures and minimum use of fill. Since then over 350 acres of "greenway" stretching over 10 miles have been acquired at a cost of over $10 million. The Greenway Foundation, a nonprofit corporation, has been a major mover through publicity and private fundraising. Improvements in the greenway are designed to withstand major flood damage and to reduce (where practical) the flood risk to adjacent areas. Pedestrian bridges are designed to break away. Boat chutes have been constructed to allow boaters and tubers to get around obstacles in the river.

The committee has also worked to prevent future problems and to rejuvenate the river through removal of debris and rubble, creation of bike paths and parkways, terracing, creation of boat chutes and other measures. Water quality has been greatly improved. Confluence Park, which has been created along the Platte, includes multilevel concrete and brick ter aces creating a plaza adjacent to the river. The plaza is designed to withstand and convey flood flows.

Problems: Substantial existing development, some local resistance to District activities, lack of sufficient flood data, inadequate funds for acquisition and relocation.

Keys to Success: Special enabling legislation, citizen support, staff leadership, a careful public education program, careful coordination of many activities.

General Applicability: The District enabling legislation may serve as a model for other metropolitan areas. The flood mapping, master planning, education, and other activities may also serve as models.

Sources of Information:

(1) *Flood Hazard News.* A report published by the Urban Drainage and Flood Control District

(2) L. Scott Tucker, Executive Director, Denver Urban Drainage
and Flood Control District
2480 W. 26th Avenue, Suite 156B
Denver, Colorado 80211
(303) 455-6277

(3) *Activity Summary,* Urban Drainage and Flood Control District, January, 1980

Littleton, Colorado

Innovation: Floodplain zoning and subdivision regulations require stormwater management, floodproofing, and dedication of land or money for open space uses. Regulations have been combined with land acquisition for parks and the construction of a reservoir by the Corps of Engineers.

Background: Littleton is a small (34,000) affluent suburb of Denver that has been subject to repeated flood problems, including riverine flooding, urban runoff, and mountain flash flooding. A 1965 flash flood took 13 lives and caused more than $300 million in damages in the Denver metropolitan area, including Littleton.

Following the 1965 flooding, Littleton undertook extensive studies to reduce future flood losses. Floodplain regulations adopted in 1971 include zoning, subdivision regulations, and building codes. Floodway development that would increase flood heights is prohibited. Residential structures in outer areas must be elevated one foot above the 100-year flood elevation. No new mobile home parks may be placed in the floodplain. A 200-foot setback from the channel is required for all new development. The city entered the regular phase of the NFIP in December 1978.

The Corps began an earthen dam in 1969, which was completed in 1975 at a cost of $86 million. This provides considerable protection for Littleton. Further protection is to be provided by a proposed $10.5 million channelization project for 6.5 stream miles (4.5 in Littleton). These projects, which are scheduled for completion in 1984, will permit redevelopment of 350 acres of floodplain (150 acres in floodway). A 25-acre "Littleton Riverfront" project has recently been approved to redevelop a segment of reclaimed floodplain. This is a $4.8 million urban renewal project using a combination of small cities grants and increment financing.

Limited acquisition has been combined with these regulations and flood control measures. A total of 750 acres along 2.5 stream miles is proposed for acquisition in the Littleton "floodplain park" at an estimated 1975 total project cost of $3.6 million. To date $1,706,445 has been committed.

Problems: Lack of funds, strong development pressures, an unjustified sense of security due to the dam.

Keys to Success: Strong local leadership, state and federal technical assistance, federal funds, and persistent and serious flood problems.

General Applicability: The combination of nonstructural and structural measures may be applicable to many other inland areas, although the combinations may differ.

Sources of Information:

(1) Onsite visit

(2) Steve French, Raymond J. Burby, Edward Kaiser, *Managing Flood Hazard Areas: A Field Evaluation of Local Experience.* University of North Carolina, Chapel Hill.

(3) CAPE, Region VIII, May 21, 1980

(4) Jon Payne, Director of Planning
City of Littleton
Community Development Department
2255 West Berry Avenue
Littleton, Colorado 80165
(303) 795-3748

(5) Kirk Douglas, Director of Economic Development
City of Littleton
Community Development Department
2255 West Berry Avenue
Littleton, Colorado 80165
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Glastonbury, Connecticut

Innovation: The entire 100-year floodplain around Glastonbury is subject to restrictive regulations that essentially prohibit all development in order to reduce flood losses, protect prime agricultural lands, and serve other socioeconomic and environmental objectives. State channel encroachment regulations and local wetland regulations also apply to much of this area.

Background: Glastonbury is a community of 25,100 in central Connecticut near Hartford. It has been repeatedly and severely flooded by the Connecticut River, with serious flooding in 1936, 1938, and 1965. About 1,900 acres are in the 100-year floodplain.

In 1963 the town adopted a floodplain zoning ordinance that applied to all lands within the 100-year floodplain. The ordinance was updated in 1978 not only to reduce flood losses but to serve broader community objectives. Most open space uses are permitted, but most residences are prohibited in the 500-year floodplain. Special exception uses include airfields, golf courses, certain government and quasi-government uses, and certain accessory uses. For nonresidential uses, protection must be provided to the 500-year flood level. A density transfer scheme has also been adopted that permits the shifting of development rights from one part of a parcel to another, at a rate of one unit per acre. Emphasis is now on easements rather than fee simple transfers due to the lessened maintenance needs of easements. The 7.5 miles of Connecticut River within the town is also subject to the state stream encroachment law, which requires a permit from the state for any obstruction.

Floodplain regulations were supplemented in 1974 by wetland and watercourse regulations which apply to alluvial, poorly drained, or very poorly drained soils. Wetlands have been mapped at a 1″=100′ scale. Structures are prohibited within 100 feet of wetlands. Strong enforcement is provided for these regulations. In addition, the town has acquired floodplain land. A private "Glastonbury Trust" is also acquiring land in the floodplain and wetlands. Several special exceptions have been issued, but only where floodproofing was to be undertaken. In some instances tax reductions have also been authorized for wetlands and floodplains.

Problems: Adjacent floodplains of the town of Wethersfield have not been zoned, thereby creating potential problems for Glastonbury. Development pressures continue.

Keys to Success: Motivated local citizens, the severity of the flood threat, flood data supplied by the state, state floodway regulations, soil data from the Soil Conservation Service, the rural and undeveloped nature of the floodplain, and local leadership.

General Applicability: A creative combination of local floodplain regulations, state regulations, and local wetland controls can be widely applied to other areas.

Sources of Information:

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

(2) John Pagini
2108 Main Street
Glastonbury, Connecticut 06033
(203) 633-5231, Ext. 217

DuPage County, Illinois

Innovation: Stringent floodplain regulations prohibiting new construction in the floodplain, requiring developers to provide onsite retention for stormwater runoff, and protecting aquifer recharge areas have been combined with an acquisition and relocation plan of the *DuPage County Forest* Preserve Commission.

Background: DuPage County is a rapidly urbanizing county in the Chicago Metropolitan Area with a 1980 population of approximately 675,000. About 52 square miles of the county lie within the basin of Salt Creek which has a long history of serious flooding. At least 500 structures in the county are located in the floodplain of Salt Creek and its tributaries, where average annual flood damages exceed $800,000. A 1972 50-year flood caused $5 million in property damage (for the whole basin) and resulted in a Presidential disaster declaration.

Following the 1972 flood, the state department of transportation undertook a detailed flood assessment of one reach of Salt Creek and recommended several structural control measures. However, the DuPage County Regional Planning Commission, which had been formed in 1970 and had adopted a set of natural resource protection and management policies, objected to the state plan and proposed to conduct its own assessment. Six communities formally endorsed the need for a new study. A consulting firm was therefore retained to prepare a new plan for the DuPage County Forest Preserve Commission.

The plan called for public acquisition of key flood-prone areas, including 15 sites totaling 3,000 acres along Salt Creek and its tributaries. Only one structural measure—a dike—was incorporated in the plan. After the planning commission adopted the plan in June 1974, implementation began. As of Febr[illegible]ary 1978, more than one-third of the land proposed for acquisition had been either purch[illegible] condemned. This included acquisition and relocation of *Kingery West subdivision*, which has had a history of severe flood problems.

The new plan did not include land use regulations. Consequently, property owners organized an interest group, the Flood Land Action Committee, to lobby for floodplain regulations. In 1974 the Commission prepared and adopted a comprehensive floodplain management ordinance tightly controlling any modification of the floodplain. It essentially banned any further building or rebuilding on the floodplain, protected aquifer recharge areas, and required residential developers of more than five acres or commercial developers of more than 2.5 acres to provide 100% water retention for the 100-year storm. Density transfers are allowed within the floodplain permitting site design flexibility in PUDs and cluster development. The county is in the emergency phase of the NFIP, but will shortly enter the regular program. Most of the communities in the Salt Creek area basin are already in the regular program.

Problems: Multijurisdictional nature of the flood problem, rapid urbanization and strong development pressures, failure of a few communities to support the planning and regulatory approaches of the commission, inadequate funding for the acquisition effort, inadequate flood maps.

Keys to Success: The severity of the flood problem, public support for not only flood hazard reduction but also open space and recreation, state and federal technical assistance, leadership

by the Commission, able consulting assistance, funds for acquisition from the area's Forest Preserve District, and Community Development Block Grants.

General Applicability: This regional planning approach to flooding and stormwater runoff problems with implementation through a combination of regulations, acquisition, and other techniques has widespread applicability in other areas.

Sources of Information:

(1) Rutherford Platt, University of Massachusetts, Amherst

(2) CAPE, Region V, April 3, 1979

(3) Lance Loucks
Forest Preserve District, DuPage County
881 West St. Charles Road
Lombard, Illinois 60148
(312) 620-3800

(4) Joseph H. Abel
DuPage County Development Department
421 N. County Farm Road
Wheaton, Illinois 60187
(312) 682-7230

Highland Park, Illinois

Innovation: *Restrictive floodplain* regulations have been adopted as well as performance control ravine and bluff regulations as part of a strong floodplain management effort.

Background: Highland Park is an affluent, low-density suburb of Chicago with a population of approximately 30,250. It has flood and erosion problems along Lake Michigan and the Skokie River in the western half of the community. Erosion problems along the Lake Michigan banks and ravines are severe. Much of the riverine floodplain is now is public lands and private golf courses.

Based on the community's own flood study done by a consultant, floodplain regulations were first adopted in 1962 and extensively revised in 1975. Development was permitted if structures were elevated two and one-half feet above the identified flood elevation and compensatory storage was provided. At present the community has two floodplain regulations: one linked to NFIP standards (adopted in November 1980 when Highland Park entered the regular program) and one linked to 1975 community standards. The more stringent is controlling. Strong overall planning and zoning has also been adopted. In 1980, the city adopted riverine and bluff protection ordinances which require extensive studies prior to any modification of the ravines or bluffs. Hydrology, vegetation, and geology must be considered. The city encourages clustering on upland areas.

The city has acquired some Lake Michigan bluff and beach areas. The Park District of Highland Park has acquired floodplain areas as the land became available.

Problems: Development pressures, less restrictive federal and state standards.

Keys to Success: A broad citizen concern with the environment, sound studies of flooding and erosion problems, good staff.

General Applicability: Similar restrictive floodplain and bluff regulations are broadly applicable to coastal communities.

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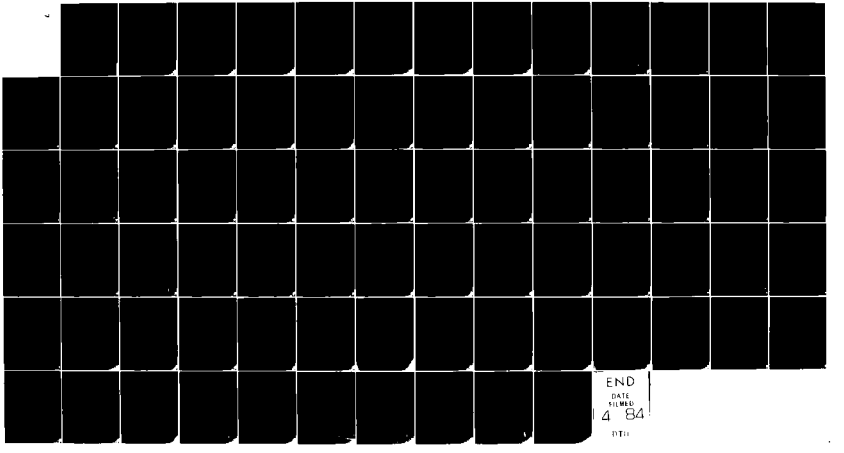

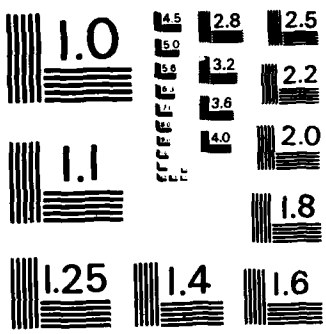

Sources of Information:

(1) Mr. Paul Dittmar
Mr. Robert Piper
Community Development Office
1701 St. Johns Avenue
Highland Park, Illinois 60035
(312) 432-0800, Ext. 220

Lake County, Illinois

Innovation: Restrictive floodplain regulations have been adopted as part of broader resource management planning for floodplains, wetlands, and other areas.

Background: Lake County is an urbanizing area of 440,000 people approximately 40 miles north of the Chicago loop. It is rapidly growing but still has extensive undeveloped land. Flooding occurs along the Fox River, Des Plaines River, and North Branch of the Chicago River. Flooding also occurs along hundreds of inland lakes that have fluctuating water levels due to riverine flooding or fluctuating groundwater levels.

The county, which regulates unincorporated areas of the county, adopted restrictive floodplain regulations in 1966 and entered the emergency program of NFIP in April 1973. Floodplain regulations prohibit virtually all development in the 100-year floodplain. Subdivision developers may not include floodplain areas as lots for buildings.

The county developed a natural resources protection plan which limits the amount of impervious surface permitted and requires that a certain proportion of new developments be set aside as open space. It covers beaches, dunes, bluffs, wetlands, floodplains, watercourses and slopes. Begun in 1977, the plan was officially adopted as an amendment to the comprehensive plan in 1980. An amendment to the county zoning in 1980 permitted clustering of development on upland areas adjacent to wetlands, floodplains, and watercourses. Ordinances are now being drafted to implement the comprehensive plan as a whole. Density restrictions will apply to various zones.

A strong public education program has been under way during the preparation and implementation of the plan. Along the Des Plaines River, the county forest preserve has purchased many acres of floodplain for open space use. Much of this land is heavily forested.

Problems: Development pressures, existing uses, enforcement (in some instances).

Keys to Success: A careful public education effort; expert staff; public awareness of "problems" in the nearby Chicago metropolitan area; reasonably accurate flood maps from the Illinois Department of Transportation, USGS, FEMA; public acquisition funds.

Applicability: A similar resource protection and management approach may be broadly applied.

Sources of Information:

(1) Lake County Department of Planning, Zoning and Environmental Quality, *Environmental Resources Policy Plan* (1979)

(2) Lane Kendig, Robert Mosteller
Lake County Department of Planning, Zoning and
Environmental Quality
Lake County Administration Bldg.
Room 803
Waukegan, Illinois 60085
(312) 689-6350

Palatine, Illinois

Innovation: A strong zoning ordinance prohibiting building in the floodplain is combined with density rights transfer provisions and requirements for onsite detention of stormwater. Floodplain acquisition and other nonregulatory measures are also used.

Background: Palatine is a suburb of Chicago with a population of about 32,000. Approximately 17% of the village (920 acres) lies within the 100-year floodplain of Upper Salt Creek Watershed. Flooding occurs during rapid, severe rainfall which floods basements, garages, and roads.

The community entered the emergency phase of the NFIP in 1972 and the regular phase in 1973. The community developed strong regulations which go beyond minimum NFIP requirements. Regulations prohibit new buildings in the 100-year floodplain, prohibit substantial improvement of structures, provide for density rights transfer from floodplain to nonfloodplain tracts, and require onsite detention of stormwater. Areas one foot above the base flood elevation are also regulated; however, filling is permitted there.

Palatine's program has also included nonregulatory approaches. State and other local funds are being used for watershed improvements, including improvement of existing floodway channels and regular maintenance (clearing and dredging). Some floodplains have been purchased outright for park use. Others are being dedicated by developers of subdivisions. In cooperation with other municipalities, park districts, and the Chicago Metropolitan Sewerage District, the city is cosponsoring the Upper Salt Creek Watershed Project, which SCS will complete by 1985. This will involve five floodwater retarding structures, one multipurpose flood prevention and recreation facility, 261 acres of floodplain acquisition, and 1.8 miles of channel improvement.

Problems: Lack of funds, uncooperative individuals.

Keys to success: Concern for parks and open space as well as reduction of flood hazards, repeated flooding, NFIP incentives, state floodplain regulations, local leadership assistance from federal agencies such as the SCS.

General Applicability: The combination of restrictive regulations, acquisition and flood control measures is applicable in other areas.

Sources of Information:

(1) CAPE, Region V, March 2, 1979

(2) Jim Considine
Community Development
200 East Wood Street
Palatine, Illinois 60067
(312) 358-7500

Fort Dodge, Webster County, Iowa

Innovation: Restrictive regulations have been combined with land acquisition and relocation.

Background: Fort Dodge is a city of approximately 30,000 with a severe flood problem. The floodplain bisects the city.

The city has been in the NFIP since 1971. Its regulations exceed NFIP standards by prohibiting most development within the 100-year floodplain except agricultural and other open space uses. Some elevated structures are permitted.

Through the use of Urban Renewal and Community Development funds much of the floodplain has been acquired. Since 1968 between 150 and 200 buildings have been removed from the floodplain and replaced with golf courses and greenbelt areas. Only a small number of commercial buildings

remain in the floodplain which is now being developed for open space use. A bike route is planned. Owners of one industrial building have implemented some remedial floodproofing by constructing a floodwall. The city is developing drainage criteria for subdivisions outside the floodplain.

Problems: Existing development, some development pressures.

Keys to success: A motivated planning department, motivated citizens, severity of flooding problem, consideration of multiple benefits, coordination with other funding programs.

General Applicability: A similar combination of regulations and acquisition is broadly applicable to virtually all developed floodplains.

Sources of Information:

(1) Cape, Region VII, October 17, 1978

(2) Dennis A. Plautz
Director of Planning
819 First Avenue, South
Fort Dodge, Iowa 50501
(575) 573-8321

Iowa City, Iowa

Innovation: Floodplain and stormwater management regulations have been combined with some acquisition.

Background: Iowa City is a growing community with an approximate population of 50,000. It has flood problems along Ralston Creek and two tributary streams. Quite severe flooding occurred in 1972.

The city entered the regular phase of the NFIP in May 1977. Floodplain zoning regulations were adopted requiring that new structures be at or above the 100-year flood elevation. To reduce runoff from developing areas, the city has also adopted a stringent stormwater management ordinance for subdivisions. Onsite retention must be provided.

In the city's "small cities" program, approximately 4.8 acres of floodplain with 18 structures have been acquired along Ralston Creek. The city also provided for channel improvements and acquired channel retention basins using Community Development Block Grant funds. Control of those areas has been achieved through easements and fee acquisition.

Problems: Inadequate map scale, maintenance of stormwater management basins, inadequate information for home buyers about detention basins, cost of dam construction and flowage easement acquisitions.

Keys to success: Motivated citizens, good staff, support from city council, federal incentives.

General Applicability: A similar combination of techniques is applicable to many inland communities.

Sources of Information:

(1) CAPE, Region VII, July 11, 1978

(2) Doug Boothroy
Planning Department
410 East Washington
Iowa City, Iowa 52240
(319) 356-5240

Lewiston, Maine

Innovation: Floodplain regulations meeting NFIP standards have been based on detailed flood maps. The community also adopted resource protection regulations.

Background: Lewiston is an inland community with an approximate population of 40,000. Flood problems occur along the Androscoggin River, which had major floods in 1936, 1952, and 1977.

The community entered the emergency program of the NFIP in December 1973, and the regular program in September 1979. Entry into the emergency program was through adoption of a resource protection zone, which was part of shoreland zoning and applies to essentially the whole floodplain. In addition to floodplain regulations meeting NFIP standards, Lewiston has established additional requirements including building set-backs of at least 75 feet from the mean high water line, use restrictions and special requirements for sewage disposal, drainage, erosion control and vegetation removal. Building permits are carefully evaluated if construction is proposed in the floodplain.

Public acquisition of the floodplain has taken place in three or four areas. A public information program on floodplain and shoreland areas has also been adopted.

Based on USGS base maps, the city has improved flood maps to a scale of 1"=200'. Community development monies have been used to channel Jepson Brook to handle the 500-year flood.

Problems: Considerable existing development in the floodplain; initial maps were at inadequate scale.

Keys to success: High community awareness of flood problems, additional maps, good press coverage.

General Applicability: The combination of flood hazard regulations (with detailed maps) and resource protection regulations has broad application to other areas.

Sources of Information:

(1) Gerard Raymond, City of Lewiston, Maine
Planning Department, City Building, Room 308
Lewiston, Maine 04240
(207) 784-2951

Saco River Commission, Maine

Innovation: This is a unique planning and regulatory commission with authority over the Saco River floodplain of 20 Maine municipalities. The commission educates and supports local communities in their floodplain regulation and planning efforts. A resource protection approach has been taken to floodplain regulations.

Background: In April 1973 the Maine legislature established the Saco River Commission to protect the river and adjacent lands. The Saco River, Ossipee and Little Ossipee rivers under the jurisdiction of the Commission, meander for 127 miles through or touching 20 municipalities in Maine. The Saco had a history of recurrent and severe flooding with the largest flood in 1936, damaging 500 buildings. Flooding was the major concern that led to the formation of the commission. Other concerns included protection of scenic, recreational, wildlife, water supply, and other resources. This 40-person Commission (one representative and one alternate from each town) was created at the request of and with cooperation of the 20 towns. Impetus for its creation also came from individual valley citizens.

The Commission has planning and regulatory power over all areas within 500 feet of both sides of the river and for the 100-year floodplain to a maximum limit of 1,000 feet where it extends beyond 500 feet. In some flatlying areas the 100-year floodplain exceeds this 1,000-foot limit.

The Commission's planning and regulatory powers were to supplement rather than replace those of the 20 towns. However, most of the corridor towns are rural, and had only minimal land use controls. In some corridor towns, the Saco River Corridor Act replaces the state's mandatory shoreland zoning along the river. All corridor lands are divided into three districts: resource protection, limited residential, and general development.

The Commission's first task was to determine general commission boundaries and specific district boundaries. Once this was completed, the processing of permits became its major role. Regulatory standards prohibit residential structures and septic and sewage disposal systems within the 100-year floodplain in resource protection and limited residential districts. In addition, no building is to be located closer than 100 feet from the normal or mean high water line of the Ossipee, Little Ossipee, or Saco Rivers. In processing permits, the Commission is to consider (among other factors) danger of flood damage, obstruction of flood flows, protection of wetlands, and increase in erosion or sedimentation. Regulatory standards also permit protection of wildlife, wetland, and recreation values.

Despite a small budget, the Commission has been very successful, due in part to close cooperation with the towns which perform most of the monitoring and continue to exercise responsibility in regulating and planning land development. As of March 1978, 18 of the 20 towns were in the NFIP.

Problems: Lack of funding for staff, development pressures, lack of public awareness and understanding of the regulations. The 1,000-foot jurisdiction does not encompass all floodplain lands.

Keys to Success: General public awareness of the recreational and wildlife values of the corridor, awareness of the present and potential value of the river as a public water supply, cooperative attitude of the towns, strong state concern with the environment, existence of several types of state regulations (large-scale development, shoreland zoning) prior to adoption of the corridor.

General Applicability: The Commission is in many ways a model approach for intergovernmental planning and regulation of other floodplain corridors to achieve resource protection as well as floodplain regulation objectives.

Sources of Information:

(1) Rutherford Platt, University of Massachusetts, Amherst

(2) Margaret M. Roy, Executive Director
Saco River Corridor Commission
P.O. Box 283, Main Street
Cornish, Maine 04020
(207) 625-8123

Baltimore County, Maryland

Innovation: This is an integrated floodplain regulation, acquisition, and public works program to clear and maintain in open space the 100-year floodplain. Floodplain zoning, subdivision controls, and building codes have been adopted on a watershed basis. Regulations have been combined with a $27 million, 6-year floodplain acquisition program to move properties from the floodplain. Primary reliance is on local funding.

Background: Baltimore County covers 610 square miles and six watersheds with 6% of the land in the floodplain. It has a population of 680,000. The county had serious flooding in the 1930s and 1950s, with particularly serious problems in August 1971 and 1972 when Tropical Storm Agnes caused 13 deaths and $50 million in damage. Baltimore County's flood-related costs from 1972 to 1976 totaled $85 million.

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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SEDA Council of Governments
Timberhaven Rd. 1
Lewisburg, Pennsylvania 17837
(717) 524-4491

(2) Kathie Hunter
Community Planner
Lycoming County Planning Commission
Lycoming County Courthouse
48 West Third Street
Williamsport, Pennsylvania 17837
(717) 327-2230

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
State Emergency and Disaster Service
State Capitol Building
Pierre, South Dakota 57501
(605) 394-3231

(4) Bonnie Hughes, *Community Development Office*
22 Main Street
Rapid City, South Dakota 57701
(605) 394-4181

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
224 West 9th Street
Sioux Falls, South Dakota 57102
(305) 339-7104

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
Maryville, Tennessee
(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
Program Manager, Storm Water Management
1500 West Mockingbird
Dallas, Texas 75235
(214) 670-6188

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
Gate City, Virginia 24251
(703) 386-6521

(5) Franklin Crochett, Executive Director
Scott County Redevelopment and Housing Authority
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Gate City, Virginia 24251
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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
Kelso, Washington 98626
(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
900 King County Administration Bldg.
Seattle, Washington 98104
(206) 344-3874

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:

(1) Mike Casey
Assistant Zoning Administrator
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305 East Walnut
Green Bay, Wisconsin 54302
(414) 497-3231

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
(414) 278-2508

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:

(1) Joe McGorn
Arnold Clement
Racine County
14200 Washington Avenue
Sturtevant, Wisconsin 53177
(414) 636-3408

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
P.O. Box 121
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.