coastal resources collaborative, ltd.

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North Carolina Coastal Zone Management Program

HURRICANE HAZARD MITIGATION AND POST-HURRICANE RECONSTRUCTION PLAN

NAGS HEAD, NORTH CAROLINA

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I. The Nature of the Hurricane Event

A tropical hurricane is a cyclonic meteorological event which is formed and fueled through the release of latent heat from ocean water condensation (see Simpson and Riehl, 1981). Its major features are high circular winds (counter clock wise) and a substantial drop in atmospheric pressure. Atlantic hurricanes (formed in the Atlantic Basin) typically develop between the months of June and November. Between 1899 and 1980 there have been 138 hurricanes which have crossed the United States coastline for an approximate annual average of 1.7 per year. While the State of Texas has received more hurricanes than any other state, followed by the states of Florida and Louisiana, North Carolina is the fourth state in terms of hurricane strikes. Between 1890 and the present, North Carolina has experienced 21 hurricanes, or an average of approximately one hurricane every four years (Newman et al., 1978). Of these, 8 were considered major hurricanes (categories 3 to 5 under the Saffir/Simpson scale, see Table 2)

Table 1

Number of Hurricanes (Direct Hits) Affecting U.S. and Individual States, 1899-1980, According to Safir/Simpson Hurricane Scale

Area	Category Number 1	2	3	4	5	All	Major Hurricanes (> 3)
U.S. (Texas to Maine)	49	33	41	13	2	138	56
Texas (TX)	9	9	8	6	0	32	14
(North)	4	3	2	4	0	13	6
(Central)	2	2	1	1	0	6	2
(South)	3	4	5	1	0	13	6
Louisiana (LA)	5	5	7	3	1	21	11
Mississippi (MS)	1	1	4	0	1	7	5
Alabama (AL)	4	1	4	0	0	9	4
Florida (FL)	16	14	15	5	1	51	21
(Northwest)	9	6	5	0	0	20	5
(Northeast)	1	7	0	0	0	8	0
(Southwest)	5	3	5	2	1	16	8
(Southeast)	4	10	7	3	0	24	10
Georgia (GA)	1	4	0	0	0	5	0
South Carolina (SC)	6	4	2	1*	0	13	3
North Carolina (NC)	10	3	7	1*	0	21	8
Virginia (VA)	1	1	1*	0	0	3	1
Maryland (MD)	0	1*	0	0	0	1	0
New Jersey (NJ)	1*	0	0	0	0	1	0
New York (NY)	3	0	4*	0	0	7	4
Connecticut (CT)	2	1*	3*	0	0	6	3
Rhode Island (RI)	0	1*	3*	0	0	4	3
Massachusetts (MA)	2	1*	2*	0	0	5	2
New Hampshire (NH)	1*	0	0	0	0	1	0
Maine (ME)	4	0	0	0	0	4	0

Notes: Asterisk (*) indicates that all hurricanes in this category were moving in excess of 30 miles per hour. (Data derived from Hebert and Taylor (42)).

Source: Neumann et al., 1978.

Table 2

Scale No. 1 -- Winds of 74 to 95 miles per hour. Damage primarily to shrubbery, trees, foilage, and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. And/or: storm surge 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings.

Scale No. 2 -- Winds of 96 to 110 miles per hour. Considerable damage to shrubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. And/or: storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.

Scale No. 3 -- Winds of 111 to 130 miles per hour. Foliage torn from trees; large trees blown down. Practically all poorly constructed signs brown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. And/or: storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

Scale No. 4 -- Winds of 131 to 155 miles per hour. Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. And/or: storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.

Scale No. 5 -- Winds greater than 155 miles per hour. Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. And/or: storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.

Source: Neumann et al., 1978.

The State of North Carolina has not experienced a hurricane event in some 13 years (the last hurricane being Ginger in 1971), and has not experienced a major hurricane in over twenty years (Donna in 1960). Consequently, the North Carolina coast would appear to be overdue for a hurricane event. Unfortunately, the more distant the last hurricane is from people's memories the less concern there typically is to prepare for such hazards. It must be recognized that the current lull in hurricane activity on the North Carolina coast will not last, and that it must prepare for inevitability of future hurricanes.

In addition to hurricanes, the North Carolina coast is also subject to damage inflicted by tropical storms, northeasters and lesser coastal storms. While the hazards created by these storms will typically be less severe than those of hurricanes, they can create enormous property losses and pose serious threats to human life. The following forces are common to all these events.

II. Hurricane and Storm Hazards in Nags Head

1. Winds. Hurricanes create tremendous sustained wind force, ranging from 75 to 200 mph. Gusts can increase these speeds by 50%. Hurricane force winds for an average hurricane can extend approximately 100 miles in diameter (Dunn and Miller, 1960). Wind forces create both lateral and unplifting aeordynamic pressures, which can destroy roof and wall systems, and place tremendous loads on the structural elements of buildings (see Dames and Moore, 1981). Hurricane winds can pick up and project as flying missiles loose objects and storm debris, in turn increasing the impact of these winds. High winds topple trees, electrical and telephone poles which in turn often cause structural damage to buildings.

Hurricane wind damages, say to roofs, can also provide structural openings through which rain and wind driven salt water can enter, producing substantial damages to interior belongings.

2. Stillwater flooding. The storm surge created by a hurricane can induce major flooding in coastal areas, typically inundating entire communities. It is the flooding which is responsible for most losses of life in hurricane events. Flood waters place substantial pressures (lateral and uplifting) on structural elements and cause erosion of foundations. Stillwater flooding typically inflicts substantial "wetting" damages to buildings and their contents, sewer and water systems, as well as softening road base material (Collier et al., 1977). Early stillwater flooding creates additional hazards to evacuating residents by inundating roads and bridges in low lying areas.

3. Wave action. In addition to the stillwater surge, hurricanes and severe coastal storms have the potential of generating powerful wave action. Structures closest to the ocean, and least protected by features of the natural and built environments (e.g. sand dunes and seawalls) experience the greatest wave effects. Waves can create enormous physical impacts on buildings, often severely damaging walls, floor systems and other structural elements. Houses and structural members can be picked up and transported, and in turn used as battering-rams to damage other buildings, often further inland. Wave action can cause tremendous erosion, undermining the foundations of buildings near the ocean. Roads and bridges can be undermined or destroyed by similar forces.

Hazard Areas in Nags Head

Given the general discussion of hurricane and storm forces above, where generally can we expect these forces to appear in the Town of Nags Head? This question is answered through a dilineation and discussion of critical natural hazard zones in the community, based on several different sources of information.

Flood Hazards

Under the National Flood Insurance program, the Town of Nags Head has been mapped according to its flooding potential. The Town has been divided into four flood hazard zones, which vary in their extent and type of flood hazard. These zones are used for applying actuarial insurance rates and for implementing required building and land use provisions. These are described below and their location in the Town identified.

- V-Zone/Coastal High Hazard Zone. This zone indicates areas of the Town which will be subject to substantial wave action during the 100 year storm (technically, areas of the coast which could support a minimum three-foot wave). The V-zone constitutes one continuous stretch of oceanfront from the southern to the northern borders of the Town. It extends inland furthest in the southern oceanfront of the Town (South of the causeway). Here most land east of the beach road is in the V-zone. Lesser amounts of beachfront are in the V-zone north of the causeway, with the V-zone extending approximately 200 to 300 feet inland on average. No V-zones have been designated on the sound side.
- A-Zone/100 year flood. This zone represents those areas in the community which have an annual probability of being flooded of 1% (i.e. areas which will be inundated by the 100-year flood).

In Nags Head, these zones are located over much of the jurisdiction. Specifically, these areas are located over much of the Town south of Jockey's Ridge (south of Soundside Road), including Cedar and Pond island. In addition, in the northern sector of the Town, much of the land between the bypass and the Beach Road is in the A-zone, as well as the largely undeveloped Nags Head Woods.

- B-zone/100 to 500 year flood. These are areas where the chances of inundation are substantially less in any given year. In Nags Head this zone constitutes a continual line located along the dune ridge on the oceanfront side.
- C-zone/areas of minimal flooding. These are areas where flooding is unlikely. These are areas of relatively high elevation and extend in Nags Head from Jockey Ridge North, and east of the bypass, to the Town's northern boundary (excluding the estuarian area to the west.)

Ocean Erodable Zone. Under North Carolina's Coastal Area Management Act, development along the coast must be setback landward from the first line of stable vegetation. The distance of this setback for most buildings is determined by multiplying the longterm average annual rate of erosion for a particular stretch of coast by 30. For instance, if the average annual rate of erosion is 5 feet, development in this area must be setback 150 feet from the first line of stable vegetation. For the Town of Nags Head, several different average rates of erosion have been determined for different stretches of the coast.

The required building setback is generally determined on a case-by-case basis. It will, of course, vary with the identification of the

stable line of vegetation, and the appropriate average annual rate of erosion.

Whalebone Junction/Incipient Inlet. In any major storm or hurricane, the formation of new inlets is a possibility. While the prediction of inlet formation, and their precise locations, is highly uncertain, particular physical features can be used to identify likely sites. Lynch (1983) in a recent analysis of potential inlets on the North Carolina coast identified one location in Nags Head where such an inlet might form in the event of a major storm. This incipient inlet was identified based on several factors: maximum elevation, island width, canal dimensions, and rate of erosion. Width and elevation of a barrier island appear to be the most important factors.

The potential Nags Head inlet identified by Lynch is a canal which enters the island near Whalebone Junction (USGS Quad - "Roanoke Island" Lot. N 35 54.4', Long. W 75 35.8'). Lynch calls this site "extremely hazardous," based on a composite of several crucial primary and secondary factors:

Primary Factors		
Island Width	2000'	Extremely Hazardous
Maximum Elevation	17.5'	Dangerous
Secondary Factors		
Lagoon Width	10.1 miles	Hazardous
Canal Approach	1600'	Dangerous
Canal Width	100'	Hazardous
Erosion Rate	0.3'/year	Dangerous

Source: Lynch, 1983.

Drawing a straight line across the island from this canal, and placing a buffer strip of 500 feet on each side of this line, yields an incipient inlet hazard zone.

Nags Head Cove/Incipient Inlet. An additional potential inlet has been identified in the Nags Head Cove area. Here a canal has been excavated from the sound side approximately 1000 feet long, at a right angle to the shoreline. This means that storm waters from the sound side would have a clear funnel traversing the island halfway to its ocean side. This represents a serious inlet threat, and unfortunately is located in the center of a large housing development. Extending this canal path to the Atlantic ocean, and placing a 500 foot buffer on each side of this line, yields an identifiable hazard zone. This is a crude delineation and meant only to provide decision makers with a general idea of the geographical area of concern.

III. Stage of Hurricane Response

Traditionally, human response to natural hazards and disasters is conceptualized to occur in four stages: 1) pre-storm mitigation, 2) warning, 3) emergency response, and 4) recovery and reconstruction. The actual disaster occurs between the second and third stages. This report seeks to address actions that the Town of Nags Head can take in stages 1 and 4; that is, in pre-storm mitigation and post-storm recovery and reconstruction. While the warning and emergency response stages are critical, the management and crisis response issues which they raise are largely outside the purposes of this planning document.

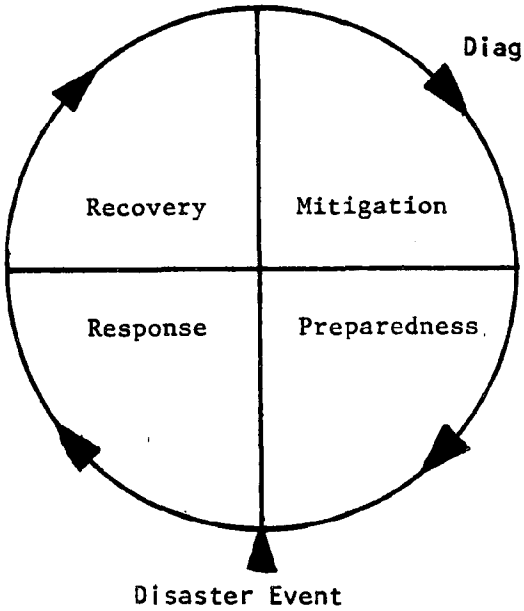

Diagram 1

The Four Phases of
Disaster-related Activity

Source: McElyea, Brower and Godschalk, 1982.

This document (plan) has been divided in its discussion of local policies and actions according to this mitigation/reconstruction distinction. After the nature of the hazard is described, and community goals and objectives delineated, a policy section is provided for each of these stages of response. Clearly, a sharp separation at either a practical or conceptual level is unwarranted, and the reader should keep this in mind. Pre-storm mitigation activities can influence in important ways the nature of reconstruction activities and decisionmaking. Moreover, reconstruction policies can serve to reduce future damages from hurricanes and in this sense serves an important mitigative function. The fact that these response stages run together is depicted in the circularity of the above diagram.

IV. Pre-Storm Mitigation Plan

Preface

Before the Town of Nags Head can consider productively specific programs and policies for mitigating the effects of hurricanes and coastal storms, it must have a clear idea of the goals and objectives to be pursued. What follows is a set of goals for discussion and consideration. Those adopted should provide the foundation for subsequent consideration of more specific actions and decisions. General mitigative goals are defined first and then more specific objectives to be used in achieving these goals are defined. The more specific objectives are presented in a separate listing, rather than as subheadings under individual goals because these goals are likely to be considered as a package, with each objective likely to advance (albeit in varying degrees) each of these broader goals. For instance, reducing the amount of development in storm

hazard areas of the community is likely to increase public safety and to reduce the amount of property at risk.

As noted above, this plan addresses the pre-storm mitigation and post-storm reconstruction stages. Consequently, the more specific objectives which follow the goals are organized according to these two stages.

The goals and objectives listed below are "ideal" statements. Some factors and decisions may be, at least in the short run, beyond the control of Nags Head, such as the building code. Yet while certain goals and objectives may not be achievable by Nags Head unilaterally, they may be achievable through collaboration and coordinated action with other actors and levels of government. These goals and objectives are targets for the Town of Nags Head to accomplish through its programs, policies and actions, and by working with and through others.

Following this listing of goals and objectives, the plan presents more specific "mitigation opportunities" for the Town of Nags Head, as well as describing alternative implementation options which could be adopted to bring them about. In large part, what is occuring in this plan is a movement from the general to the more specific, and from the ideal to the currently practical.

Mitigative Goals. The Town of Nags Head shall advance the following hurricane/storm hazard mitigation goals. They are presented here in order of priority.

1. To reduce damage to existing private property in the event of a hurricane or severe coastal storm.

Extensive private property damage typically accompanies a hurricane. Surge and wave forces exert tremendous pressures on homes and other structures in high hazard areas. Hurricane winds create substantial

lateral and uplifting pressures on structural members. It is a goal of the Town of Nags Head to reduce, to the degree possible, the extent and severity of these damages to private property already in place. More specifically, programs and policies of the Town will seek to reduce damages to existing homes, businesses, and industrial structures, and to accompanying privately-owned facilities (e.g. roads, septic and water systems).

II. To reduce damage to future private property in the event of a hurricane or severe coastal storm.

As with existing private property, the Town of Nags Head will reduce, to the degree possible, the extent and severity of damages to future private property locating in the Town. Future development of the Town is inevitable, and it will be the policy of the town to reduce the extent of this new private property which is vulnerable to hurricane and storm damages. The Town will undertake, to the extent feasible, programs and policies which reduce this vulnerability, and mitigate damage risks, prior to the location and construction of this development. The Town will take advantage of the opportunities to prevent the future placement of the private property at risk.

III. To reduce damage to public facilities and structures in the event of a hurricane or severe coastal storm.

Hurricanes and severe storms, as with private property, can cause tremendous damage to public investments. These public investments are of several types: roads, water service, and the structures which accompany fire, medical and police services. The Town of Nags Head will in the future, to the extent practical, make decisions concerning these public investments so as to reduce the possibility that they will be damaged or destroyed by hurricane or storm forces. All future capital

investments in the Town of Nags Head will be made with the hurricane/storm threat in mind.

IV. To protect the health and safety of the general public in the event of a hurricane or severe coastal storm.

The wind, wave and surge effects of a hurricane create serious threats to the personal safety of individuals remaining in coastal areas. Residents and visitors of the Town of Nags Head are highly vulnerable to these personal risks, and it is a primary goal of the Town to reduce, to the extent feasible, their magnitude and severity.

The general public should have sufficient opportunities either to vacate the storm area, or to find adequate shelters through which to weather the storm forces.

V. To reduce the public expense for local emergency and recovery service required by a hurricane or severe coastal storm.

Before, during and after a hurricane the public expends substantial resources in providing emergency services (e.g. evacuations, search and rescue), and clean-up and recovery assistance (e.g. debris clearance, public health). The Town of Nags Head will, to extent feasible, seek to reduce these direct public (non-capital) expenses by reducing the need for them.

VI. To achieve a more equitable relationship between the costs and benefits of coastal development.

Historically, coastal communities, as well as other levels of government, have subsidized the location of homes and other activities in high hurricane hazard areas. The Town of Nags Head will in the future seek to reduce this subsidy, and to more equitably assess beneficiaries of high risk locations for the full costs of this development.

Overall Community Goals

As with most plans and policy documents, numerous public goals are typically involved. It is important for the Town of Nags Head to coordinate and integrate the pursuit of storm hazard mitigation goals with other community goals. For instance, the following appear to be important goals in the Town of Nags Head which should be considered when reviewing the more specific objectives and mitigation opportunities identified later.

- The protection and enhancement of the natural environment and ecosystem;
- The enhancement and improvement of the local economy and the adequate provision of employment and income for residents.
- The availability of sufficient and affordable housing stock for existing and future residents;
- The protection of aesthetic and scenic characteristics of the coastal environment.
- The preservation of the high quality-of-life and small town atmosphere of the community;
- The achievement of efficiency in the provision of public services and facilities.

A. Pre-Storm Mitigation Objectives

1. The Town of Nags Head will formulate a capital facilities program which encourages the extension of future growth away from high storm hazard areas and into low storm hazard areas. This should discourage the location of new development in high risk locations.
2. The Town of Nags Head will unilaterally, or in collaboration with public and private agencies, find ways to purchase land, or appropriate interests in land, in high hazard areas. These lands could

then be used for open space, recreational and other non-intensive uses. This would then prevent or reduce the amount of property placed at high risk in the future.

3. The Town of Nags Head will seek to encourage the maintenance of hazardous parcels in an undeveloped state, through the use of taxation and other incentives. These programs may include the use of preferential property tax assessment to reduce the holding costs of undeveloped hazardous lands, site value and other techniques which will increase the holding costs of non-hazardous or less-hazardous parcels, and programs which permit the transfer of development potential from hazardous to non-hazardous sites.

4. The Town of Nags Head will avoid the location of public structures and other public investments in high storm hazard areas. This will reduce the amount of public property at-risk, and will discourage the future placement of private property at risk.

5. In circumstances where new development in high hazard areas is permitted, the Town of Nags Head will attempt to assess this development for any and all public costs (direct or indirect) which result from this location.

6. Nags Head will, wherever possible, preserve and enhance the natural features of the coastal ecosystem. This will entail protection of the dunes and beaches which serve to buffer wave and surge effects, and wetlands, natural drainage features, and other attributes of the natural environment which reduce or lessen the impacts of hurricane forces.

7. When new development is permitted in storm hazard areas, it should be at a sufficient (maximal) distance from those areas subject to the most severe storm forces. This will include setbacks from shore and beach, areas of severe erosion, and potentially-active inlets.

8. The Town of Nags Head will, to the extent possible, seek to coordinate its pre-storm mitigation programs and policies with those of other relevant communities and jurisdictions in the region.

9. New construction in hazard areas, when permitted, should be constructed to better withstand the structural forces placed on it by hurricanes and severe coastal storms. This may be achieved through improvements to building and construction standards, which will require certain state actions and through voluntary improvements in development standards in the development industry.

10. The Town of Nags Head will through subdivision and site review procedures encourage or require project designs that reduce vulnerability to hurricane and storm damage. For instance, through clustering it may be possible to orient development away from the most hazardous portions of a site, and may facilitate the undertaking of other mitigative design practices (e.g. flood proofing through landscaping and small structural works that would not be feasible in a more decentralized development).

11. The Town of Nags Head will make every effort to ensure that wouldbe buyers of land and buildings in hazard areas are fully apprised of the hurricane and storm risk. This may consist,

for example, of a requirement that real estate agents and others selling homes or land inform potential buyers of the susceptibility of this property to storm damage. It might also entail the required designation of hazard zones on subdivision plats, and the production and distribution of information packets describing the hazards for prospective homeowners.

12. The Town of Nags Head should make every effort to consider other relevant non-hazard community objectives and attempt to integrate hazard reduction programs and policies with them. For instance, when deciding which of several competing parcels of hurricane-prone land to purchase the deciding factor may be which of these will be most responsive to the Town's future recreational needs. There will be many instances in which hazard mitigation and non-hazard mitigation objectives can be advanced through the same or similar policies and programs. The Town of Nags Head will constantly be aware of these interconnections and package its programs accordingly.

13. The Town of Nags Head will identify and track all non-local (federal, state, regional) policies, programs, and decisions which will influence the local hurricane hazard, and attempt to affect these in ways which reduce the hazard locally. Actions here may range from expressing opposition to a federally-funded project which is likely to impede local evacuation, to lobbying the state legislature for funds to improve evacuation.

14. The Town of Nags Head will seek to facilitate and enhance, to the extent feasible, the ability of the public to evacuate should a hurricane or severe storm threaten. At the least, the Town will

not take actions which impede efforts by the county or other governmental bodies to enhance local evacuation capability.

15. The Town of Nags Head will recognize that a significant number of residents will be unable to evacuate and will seek to provide sufficient shelters to house them during the storm. Where appropriate, for example, the Town will require new developments to construct such shelters, or contribute to this construction commensurate with the extent to which it increases need.

B. Pre-Storm Mitigation Opportunities

What follows are more specific "mitigation opportunities" that can be pursued to advance the more general mitigation goals and objectives listed above. For each mitigation opportunity, alternative "implementation options" by which to fulfill these opportunities are listed. These mitigation opportunities and options are meant to guide the more specific decisions and actions of the Town.

1. Changes to existing Zoning:

Reduction in allowable density in high hazard areas. Under this option the Town would seek to modify its development regulations in order to reduce the quantity of property at risk in beachfront areas. Commensurate with this reduction would be an increase in allowable density in areas further inland and less susceptible to storm forces.

Existing

Zoning Provisions

The Town of Nags Head currently has in place a zoning ordinance which regulates the type, intensity, and configuration of land uses. The following represents a brief synopsis of the primary land use classifications, the regulatory provisions

attached to these classifications and their geographical location in the Town.

R1 (residential): This is a low density residential district which permits detached single family dwelling units on lots which must be a minimum of 15,000 square feet in size, or 20,000 square feet when served by individual wells or septic tanks. Under Planned Unit Development (PUD) provisions for maximum density in this zone cannot exceed 3.5 DUs per acre. This district encompasses part of the oceanfront between Jockey Ridge and Diamond Street (east of the beach road), as well as the major portions of Pond and Cedar Islands.

R2 (residential): This is a medium density residential zone which permits duplexes in addition to single family detached units. The minimum lot size required for a duplex is 22,500 square feet, and 20,000 square feet per dwelling unit for development using individual wells and septic tanks. [Under PUD provisions maximum density in this district cannot exceed 6 DUs per acre.] Much of the Town of Nags Head is designated R2 -- including most land South of Whalebone Junction; and, land north of Forest Street, South of Jockey's Ridge and west of the bypass.

R3 (residential): This is considered a high density residential district and permits, in addition to single family detached units and duplexes, multifamily units. The same lot dimension, for the above uses apply, with an additional 3500 square feet of lot size required for each additional dwelling unit. Where individual wells and septic tanks are used, lots must include

20,000 square feet for each dwelling unit. R-3 is found primarily between the beach road and the bypass, north of Forest Street and South of Enterprise Street. A substantial R-3 district is also located farther north in the French Avenue area.

C-R (Commercial/residential): This district permits both single-family and multifamily residential (see above) and motel, hotel and restaurant commercial uses. The total floor area of all structures on the lot cannot exceed two times the land area of the lot. The CR district encompasses almost the entire oceanfront (east of the Beach Road) from North Street (just south of Whalebone Junction) to the Town's northern borders.

C-1 (Commercial): This district is considered neighborhood commercial and permits such small scale activities as food markets, banks and drugstores. These areas must be at least 2 acres in size, but not more than 4 acres. No C1 districts currently exist in Nags Head.

C-2 (Commercial): This is a general commercial district permitting postoffice, retail and service activities. These districts must be at least five acres in size. In addition, single family, duplex and multifamily residential uses are permitted by right (subject to R-3 dimensional requirements). C2 is found along the approach to the island and along the bypass north to Jockey Ridge. Substantial areas of C2 are also found north of Jocky Ridge, between the bypass and Beach Road.

C-3 (Commercial): This is a commercial services district, permitting such uses as warehousing and processing, and equipment storage and servicing. Only one C3 zoning district has currently been designated in the Town. It is located on the

northern border, between 8th Street and Carolinean Circle.

SPD-20: This is a special Planned Development District. In addition to single family detached dwellings, it permits single family dwellings in townhouse or cluster configurations with no more than 6 units permitted per cluster. Lot sizes for cluster development must not be less than 20,000 square feet for the first unit, and 10,000 square feet for the 2nd through 6th residential unit. Clustering provisions permit this development to circumvent normal dimensional requirements -- more than one unit is permitted on a lot, with units in relatively close proximity. Special provisions and conditions are delineated here to protect certain unstable sand dune areas. The SPD20 district is located in the areas directly north and south of Jockey Ridge State Park.

SPD-40: Also a special planned development district. Here, single family detached units are permitted as well as residential units arranged in clusters. A minimum lot size of 40,000 square feet is required for a single family detached unit (not in a cluster), while the minimum lot area required for cluster residential is as follows: 40,000 square feet for the first unit, 20,000 for each of the second, third and fourth units, 15,000 square feet for the fifth and sixth units, and 10,000 square feet for each additional unit. Special dune protection provisions also exist. The SPD40 district includes most of the Nags Head Woods area of the Town.

SPD-C: This is a special planned development-community district, "intended to provide for the complete and orderly development of a

district containing not less than one hundred and fifty (150) acres under central ownership or control to produce a balance and coordinated range of residential densities and housing type along with commercial areas to serve the development district itself and the entire community."(Section 8.04). Under the zoning provisions a development must submit an application for an SPDC zone, and this is considered as a zoning amendment. Development with such a designated zone is subject to the following conditions and standards (Section 8104-H):

(1) Not less than twenty (20) percent of the total acreage of an SPD-C district shall be designated as common open space. Common open space shall not include any land covered by streets or parking areas or residential or commercial buildings but may include unimproved lands, required buffers or setbacks and common facilities such as swimming pools, tennis courts or golf courses.

(2) Not less than forty (40) percent of the dwelling units within the SPD-C district shall be detached single family dwellings.

(3) Not more than thirty-five (35) percent of the dwelling units within the SPD-C district may be townhouses.

(4) Not more than twenty-five (25) percent of the dwelling units within the SPD-C district may be multi-family dwellings.

(5) The over-all dwelling unit density for any SPD-C district shall not exceed six (6) dwelling units per acre.

(6) Permitted and conditional uses in the C-2 general commercial district may be approved as part of the total development plan provided that:

   a. No more than twelve (12) percent of the total SPD-C district acreage is devoted to commercial use.

   b. No commercial use shall be located within 500 feet of any residential district not a part of the SPD-C district.

   c. All commercial uses shall comply with Article VI general requirements of the ordinance.

d. No part of the area shown on the development plan as commercial acreage shall be included in the computation of residential density for the total SPD-C district.

e. Primary vehicular access shall be from a public thoroughfare and shall be designed to minimize conflict with the flow of traffic, to reduce congestion and avoid potential hazards for vehicles and pedestrians.

a. Implementation options.

1) Modify pre-existing zoning framework - A longer term mitigation solution could be to review existing zoning designations and to modify them so that they are more appropriate to storm hazard reduction objectives. For instance, it may be appropriate to construct a new zoning designation which will permit hotel/motel uses of small size and which could then be applied to beach areas. Such a zone would then allow such smaller scale uses, but would prevent the location of large hotel/motel complexes.

2) Zoning changes within existing framework - A feasible mitigation option within the existing regulatory framework would be to rezone beachfront areas currently under a CR designation, to an R1 or R2 designation. This would prevent the future location of hotel/motel uses and high density residential uses in the highest hazard areas. This would result in a substantial reduction in the quantity of ruture property exposed to high hurricane risks. Because this option appears,

in contrast to the above, to be highly feasible in the short-term period, we recommend that such zoning changes be undertaken.

3) Reduction of permissable densities for selected districts - One approach is to leave existing zoning designations largely intact but to selectively decrease the densities permissible in particular key districts. In many cases this may simply constitute raising (perhaps doubling) the minimum lot size required for certain uses in high hazard zones. For instance, under current zoning provisions the permissable lot size for a single family dwelling in most parts of Nags Head is 15,000 square feet, or 20,000 square feet where an individual well or septic tank is used. Increasing this requirement to 40,000 square feet (roughly an acre) may reduce the number of dwellings exposed to high storm risks.

Minimum Lot Sizes/Permissable Density

Existing Zoning Designations

Zoning District	Types of Use	Minimum Lot/ Permissable Density
R1	Single Family Detached	One unit per 15,000 square feet, 20,000 square feet when individual wells and septic tanks used
R2	Single Family Detached	Same as R1
	Duplex	22,500 square feet, and 20,000 square feet per unit when individual wells and septic tanks are used.
R3	Single Family Detached	Same as R1
	Duplex	Same as R2
	Multi-Family	Same as duplex, 3500 square feet for each additional unit; 20,000 square feet per unit where individual wells and septic tanks are used.
CR	Single Family	Same as R1
	Multi-Family	Same as R3
	Commercial (hotel/ motel/restaurant)	Total floor area cannot exceed 2 times land area of lot.
C1	Neighborhood Commercial	Minimum 2 acres, no more than 4 acres.
C2	General Commercial	Minimum of 5 acres in size.
	Single Family, Duplex and Multi-Family	Same as R3
C3	Commercial Services	

Zoning District	Types of Use	Minimum Lot/ Permissable Density
SPD-20	Single Family Detached	Same as R1
	Townhouse or Cluster	20,000 square feet for first unit, 10,000 Square feet for 2nd through 6th units; maximum size units.
SPD-40	Single Family Detached	40,000 square feet.
	Townhouse or Cluster	40,000 square feet for first unit, 20,000 square feet for 2nd, 3rd and rth units, 15,000 square feet for the 5th and 6th units, and 10,000 square feet for each additional unit.

Given the proximity of these zoning districts to high storm hazard areas, density changes in the R2 and the CR zone would appear most promising. A density decrease between 10 and 50% should be considered.

In addition, density of construction along the sound coastline may also be reduced in this manner. This might be accomplished by specifying in the relevant zoning districts that homes and structures wishing to locate within 500 feet of the water must be situated on lots which are a certain percentage larger than for similar proposed uses beyond this boundary.

To maintain the overall level of development permissible in the Town, it may be desirable to accompany these density reductions with density increases in other existing zoning districts in safer locales.

The Town of Nags Head should review its entire zoning ordinance to highlight other changes which can reduce storm hazards. The above represent the most obvious and immediately needed modifications.

2. Mitigation opportunity:

The Epstein Track. This piece of land consists of approximately 400 acres, encompassing both beach front areas and island areas (land between the bypass and the beach road). The undeveloped nature of this large tract of land presents the Town of Nags Head with a unique opportunity to mitigate future damage from hurricanes and coastal storms. Again, the attempt should be to move future developments away from beachfront areas.

a) Implementation Options:

1) Negotiated development agreement. Under this implementation option, the Town would agree to permit increased development in inland portions of the tract (between the bypass and the Beach Road), or offer to enhance the development ability here in exchange for an agreement on the part of the owner/developer to reduce the extent of development seaward of the Beach Road.

This reduction could take several forms: 1) complete reduction, i.e. leaving this area of the tract as open space (in either public or private lands), 2) reduction to R1 or R2, i.e. restricting its development to lower density residential or 3) leave for private recreational uses.

2) Voluntary transfer of development potential. This

option would present the developers of the Epstein Tract with the option of transferring density from the high hazard beach area to inland areas. This could be arranged as well so that an incentive for this transfer existed in the form of increased development units inland (i.e. raising overall density).

3) Changing zoning designations. One option is simply to lower allowable development density seaward of the Beach Road, while increasing density in the area between the bypass and the Beach Road.

3. Mitigation opportunity:

Mandatory coastal setback. Under the Coastal Area Management Act, new development is required to be setback from the ocean based on the average annual rate of erosion for that particular stretch of coast. While this setback requirement goes far in reducing property at-risk, it could be increased to offer more extensive protection to new development. We recommend that the CAMA-required setback be supplemented by an additional increment in certain locations, providing a uniform development setback in the Town.

The Town should closely monitor erosion rates and adjust this uniform setback periodically.

In addition, it is recommended that a setback also be required for the coast of the Town. These policies are consistent with previously established Town development policies (See Nags Head, 1980).

4. Mitigation opportunity:

Mandatory or optional clustering. This approach would seek to induce the site planning and placement of development such that either 1) its proximity to high hazard zones is reduced, or 2) such developments require lesser amounts of public and private property at-risk, or 3) the quality and type of development which results is less vulnerable to storm hazards. This approach could be either voluntary or mandatory. If the latter, clustering might be a requirement stipulated in return for development permission. If optional, clustering might permit the developer to circumvent certain zoning provisions, or might be permitted to develop at a higher density. In either case, such negotiations would occur during the Town's normal site plan review process. Because large scale types of development in Nags Head are not likely to occur in the future (except in the case of the Epstein Tract, see above) clustering provisions cannot be expected to be very effective at reducing storm risks. This, however, may be one important implementation option available in connection with the Epstein Tract, and the Town should consider the mechanism for this purpose.

5. Mitigation opportunity:

Subdivision ordinances. The Town of Nags Head presently has a subdivision ordinance which regulates the size and configuration of building lots. One approach to reducing the amount of new development at high storm risk is to increase the minimum lot size required in the community. Currently, a minimum lot size of 15,000 square feet is required. Because the majority of buildable lots in close proximity to high hazard areas have already been subdivided, changes in this area would not substantially reduce future storm damage, at least on the ocean side.

However, it is recommended that the Town consider raising the minimum required lot size, primarily in order to reduce the amount of development occurring in close proximity to the sound coast. Raising the minimum lot size from 15,000 to between 30,000 and 45,000 would appear a reasonable policy change. These changes would need to be coordinated with the density limitations specified in the Nags Head zoning ordinance. Such requirements would also serve to enhance the environmental quality of the sound ecosystem, a stated objective of the Town of Nags Head (Nags Head, 1980).

In addition to changes in the minimum size of permissable lots, the Town should consider changes to dimensional requirements as well. Specifically, lots in close proximity to the ocean (i.e. east of the Beach Road) or sound shorelines should be required to provide for a significantly greater depth than is currently the case. This additional lot depth is necessary for several reasons. It will protect the option of periodically moving structures away from the shoreline, commensurate with storm and erosion forces, while maintaining the structure on the same lot. In essence, such a lot preserves a "back-door" escape for homes and structures that may not be possible under different platted dimensions. Moreover, such a lot will permit the placement of a septic tank and field at a maximum distance from erosional force, in turn preserving the integrity of this system and better protecting local groundwater resources.

6. Mitigation opportunity:

Fee simple acquisition of undeveloped land in high storm hazard areas: maintenance of undeveloped state. The Town of Nags Head should engage in a program to purchase undeveloped land located in high hazard areas; parcels in the following areas of the community.

1st priority: parcels in the V Zone.

2nd priority: parcels located seaward of the Beach Road.

3rd priority: parcels in the incipient inlet zones.

4th priority: parcels in the A Zone.

5th priority: parcels in the B Zone.

More specifically, emphasis should be placed on securing parcels adjacent to or seaward of the Beach Road. The identification of specific parcels to be acquired should occur as a second stage, and should generally not take place until the town is prepared to purchase these parcels. In addition, the Town should make every effort to coordinate its land purchases with those of other private groups.

The focus of this acquisition program should be on reducing the quantity and density at close priximity to the ocean's edge, and particularly in the V Zone. A substantial number of vacant parcels currently exist in these areas. A recent tabulation of platted lots east of the Beach Road (the major focus of acquisition) yielded the following count, listed by plat map sheets.

Table

Undeveloped Platted Parcels East of Beach Road

Plat	Number of Undeveloped Platted Lots	Zoning Designation
Sheet # 1: (Pelican Court south to Town Border)	106	R2
Sheet # 2: (Oregon Drive north to Indigo Street)	87	R2

Sheet # 3:	70	R2
(Indigo Street north to approximately Holden Street)		
Sheet # 4:	38	CR
(Holden Street north to Forest Street)		
Sheet # 5:	21	CR
(Forest Street north to Enterprise Street)		
Sheet # 6:	15	CR
(Enterprise Street north to Jockey Ridge)	4	R1
Sheet # 7:	44	CR
(from Jockey Ridge north to Baltic Street)		
Sheet # 8:	8	CR
(from Baltic Street north to the city limits)		
TOTAL platted vacant lots east of the Beach Road:	393	

Approximate Number of Undeveloped Platted Parcels

Near Whalebone Junction Incipient Inlet Area

(approximately 500' north and south of canal line extended to ocean)

South of canal/west of Beach Road	20
North of canal/west of Beach Road	25
South of canal/east of Beach Road	17
North of canal/east of Beach Road	1
TOTAL:	63

Approximate Number of Undeveloped Platted Parcels

Near Nags Head Cove Incipient Inlet Area

(approximately 500' north and south of canal line extended to ocean)

South of canal/west of bypass	38
North of canal/west of bypass	43
South of canal/east of bypass	7
North of canal/east of bypass	15
TOTAL:	103

a. Implementation options: Funding

1) Funding through general revenue. One approach is to finance the acquisition of these high hazard parcels through general revenue sources, i.e. through local property taxes. This option may be preferable in circumstances where the public at-large will benefit from the use of such lands once they have been secured, e.g. through public parks and recreational areas. Because the benefits of such acquisitions will be "public" in nature, the use of local general revenue sources to finance at least a portion of the acquisition appears appropriate.

2) Funding through external sources. The Town of Nags Head should make every effort to take advantage of outside funding sources, including programs that may exist at either federal or state levels. For instance, FEMA's Section 1362 program has been the source of funds for the purchase of a substantial number of coastal parcels subject to flooding.

3) Funding through special assessment districts. This approach would attempt to assess existing property and residents within a particular delineated district for the costs of such acquisitions. This would be a sensible option if these acquisitions clearly served to benefit a specific and non-general set of individuals. While this premise is likely to be true to some extent, the practical difficulties of establishing such a system, and determining a logical delineation of "beneficiaries," suggest that such a approach would not be appropriate.

4) Impact fees. One option for securing funds for acquisition is to obtain such funds from the imposition of an impact fee on new development in the Town. Such a fee could be imposed at the time of site plan approval, and could be assessed commensurate with a) the number of planned dwelling units, or number of bedroom units in the case of residential

uses, and b) number of square feet of proposed development in the case of commercial and industrial uses.

Funds from this fee could be placed in a special hurricane hazard mitigation fund, and in turn used to cover the costs associated with the acquisition and holding of parcels in high hazard areas of the community. The philosophy behind this strategy would be that the permission of new development which increases the amount of property at-risk must be compensated through the reduction or prevention of storm damage in other sites or parcels in the community.

This fee could be imposed in a graduated fashion as well, to take into consideration the relative extent of risk to which new development is subjected. For instance, a larger impact fee might be imposed on a new development located in a beachfront area, than a similar development farther inland. This fee graduation should correspond with specific designated zones, so that developers and builders know in advance roughly what this fee requirement will be.

This impact fee might also be used to fund non-acquisition hazard mitigation projects. For instance, the fee may also be imposed to cover the costs of constructing and maintaining hurricane shelters in the community. Again, a logical argument can be made that such developer contributions are required to compensate for and mitigate the additional risks to hurricane safety created by their projects.

5) Acquisition through development exactions. An alternative approach would be to require the contribution of land and certain improvements (i.e. hurricane shelters) as a condition of subdivision or site plan approval. Because most development in Nags Head is of relatively small scale, an impact fee appears to be a more sensible approach. However, in the case of

larger projects this approach may be more appropriate. The impact tax would, however, provide the flexibility to deal adequately with both large and small developments.

6) Sales tax. A local sales tax might be used as a supplemental source of general revenue for land acquisition. This approach would lessen the opposition of existing property owners who would otherwise, under the local property tax, incur most of the costs of such a program.

7) Donations or partial donations. Where possible the Town should seek donations or donations of partial interests in land in high storm hazard areas.

8) A combined approach. Given the above brief review, it appears that an equitable and feasible approach is to combine the funding of land through general revenue sources, and developer impact fees. This would both place a responsibility on new development to mitigate the storm risk it creates in the community, it also acknowledges a similar responsibility on the part of the public at-large, as well as an acknowledgement that the public at-large will benefit (in varying degrees) from the eventual use of these lands(if only used for scenic purposes).

b. Implementation Options: Use of Acquired Lands

1) Retain public ownership. Maintaining these acquired lands in public hands has both advantages and disadvantages. Its primary advantage is that it permits maximum control over the use and management of this land; in essence, the public retains the full bundle of rights to this property. In most cases where this land is to provide direct public use or access, full fee simple ownership by the Town will be necessary. A disadvantage of such an approach would be that additional public resources must be expended in managing such lands. In addition, keeping these lands

in public hands will reduce the Town's tax base, and deprive it of the receipts that would be obtained from its sale (or sale of some portion of the rights). The use of such acquisitions for public parks, open space and beach access appear most feasible, and from this perspective maintaining full public ownership should be encouraged.

2) Leasing fee-simple public lands. While it is unclear what such lands would be used for, publicly-acquired parcels could be leased to private parties, for either short or long-term periods. For instance, a public parcel adjacent to a residential or hotel/motel use might be leased for exclusive use by these private parties (e.g. a patio and pool area) for a number of years. This would both maintain the public's control over this parcel, and also provide a certain amount of revenue, which might then be used to finance subsequent purchases. While the Town should certainly pursue this option where it appears appropriate, this is not likely to be feasible as a general policy.

3) Sale with deed restrictions. An approach which would accomplish a similar end, would be to sell public lands to private parties with certain deed restrictions placed on their use. Presumably, such deed restrictions would prevent the land's development in the future. As with the above option, this approach has the advantage of reducing public expenses -- in this case placing a portion of the parcel's value back on the Town's tax rolls.

7. Mitigation opportunity:

Fee simple acquisition of land to reduce density at-risk. Both approaches 2 and 3 above could also be used as an alternative to "downzoning" high hazard parcels, in turn reducing the inequity often perceived to exist when land is devalued as a result of such actions. For instance,

instead of rezoning a parcel of land from an R4 to R1 zone (i.e. permitting a fewer number of residential units), the Town might purchase this land (at its R4 value), place a deed restriction on its density of development which equates to the density allowable under an R1 zone, and then resell the land at new reduced-density value. The result of this strategy is a lower density, with the public absorbing the costs in land-value reduction rather than the property owner. We recommend, however, that acquisition be used as a strategy to keep high hazard parcels in an undeveloped state, and that generally changes in the zoning provisions (uncompensated) be used for reducing density in those hazard areas where some amount of development is permitted.

Implementation Options: (See above for full discussion).

8. Mitigation opportunity:

Less-than-fee simple acquisition. Less-than-fee simple purchases of land in high storm hazard areas. The Town could consider the purchase of easements or "development rights" which would prevent the location of a substantial amount of future private development in high hazard zones. These techniques involve the same questions concerning financing options as are presented under fee simple. However, depending upon the development value of this land, this purchase alternative will tend to be less costly. We feel, however, that because the development value of an average parcel of land in Nags Head (as in most resort coastal areas) comprises such a large proportion of the lands' total value, that the Town is better off purchasing such parcels in fee simple. This will provide greater public control over the use of these lands and increase the flexibility of such a technique in advancing other community goals and objectives.

If such rights or easements are donated, however, (with property owners receiving substantial tax benefits), then the Town should be willing to accept, and indeed encourage, such donations. Because such donations must typically be made in perpetuity, though, the Town must be careful to accept open space easements only in locations where it is certain that future development should not occur.

9. Mitigation opportunity:

Mandatory or optional transfer of development potential. Much like a clustering provision, this approach would permit the transfer of development potential from a designated high storm hazard zone (sending zone) to a development zone (receiving zone), and would in this sense permit the severing of development potential from the actual parcel of land. Under a mandatory program high hazard parcels would only be permitted to be used for non-development uses (e.g. recreation, open spaces, etc.), and excess development potential could then be transferred to non- or less-hazardous areas. Under an optional program, the landowner would have the choices of either developing the land, or transfering this development potential to receiving development zones. We recommend that the Town seriously consider implementing such an approach, albeit on a limited and small scale. Sending zones might be designated in the following areas of the Town:

- east of the Beach Road
- within 500 feet of the sound coast
- in the area of identified incipient inlets.

Development receiving zones might be designated in the following areas:

- between the Beach Road and the bypass
- existing developments west of the bypass (and set-back from the sound).

10. Mitigation opportunity:

Restrictions to Public Services and Facilities; designation of public service districts. One option is simply to restrict the availability of certain key services and facilities to designated urban or development areas -- e.g. sewer, water and roads. While development regulations may permit certain uses in the high hazard zone (e.g. residential) commensurate service may not be available, in turn encouraging growth to occur in other locations where they are available. Important facilities and services over which the Town of Nags Head has control include the following:

- police
- fire and ambulance
- water
- streets and roads.

While it will be difficult to legitimately restrict police, fire and ambulance service to new and proposed development areas, the provision of water service and the designation and improvement of public roads can act as deterrents to development in high risk areas.

The Town should, to the extent feasible, refuse to approve roads in areas where future development will be placed at high risk. Moreover, it should prioritize road improvements so that they occur first in areas where storm risks are lowest, and last where storm risks are greatest, all other factors being equal.

Similarly, the Town should seek to restrict the extension of water service, where possible, to parcels in or in close proximity to high storm hazard areas. Priority should be given in water system improvements to expanding service to "safer" parcels, away from areas where storm risks are greatest.

11. Mitigation opportunity

Evacuation and hurricane shelter provisions. Located on a barrier island, the routes of egress from the Town of Nags Head in the event of a hurricane threat are limited. Residents and visitors can evacuate either to the north through Kill Devil Hills and Kitty Hawk by bridge to the mainland, or more logically across the bridge to Roanoke Island and then to the mainland. In a recent application of an evacuation methodology developed by Stone (1982) it was estimated that over 16 hours would be required to completely evacuate all residents of Nags Head (Brower, et al., 1984). It is clear, then, that a substantial portion of the Town's populace will be unable to evacuate should a hurricane or severe storm threaten. Future development, adding additional demands to this evacuation system, can be expected to raise this evacuation time. The implications of these observations are that (a) actions should be taken to increase and enhance the ability of residents to evacuate, and (b) in the absence of substantial advancement in (a), that a substantial number of residents of Nags Head will simply be unable to evacuate.

Actions which can be taken on the part of the Town of Nags Head to advance (a) are few, if existent at all. While the Town should do all it can to lobby for regional improvements (such as an additional two or three lane bridge system, see Nags Head 1980, p. 7), there is little control over evacuation which it can exercise itself. Nags Head is but one element in a larger "evacuation shed," extending from Currituck Banks to Ocracoke Island, and unilateral actions are largely futile.

However, the Town of Nags Head should and must strive to enhance its capacity to accommodate residents in sheltered structures in the

likely event that complete or even nearly-complete evacuation is not possible. The current Dare County hurricane evacuation plan identifies 4 shelters for Nags Head residents. However, not one of these shelters is actually located in the Town itself (Dare County, 1983). There is a strong need, then, for the Town to increase the number of shelters available.

a. Implementation options: Financing and Provision

1) Mandatory

Construction or provision of shelters by new development. Under this option, developers could be required to provide sufficient shelter arrangements for all or a substantial portion of the number of new residents their developments are adding. This requirement might be satisfied through the actual construction of a separate shelter structure, or through making adequate arrangements to ensure "vertical evacuation," (i.e. providing shelter in multi-storied engineered structures). The latter may be provided through the development's own buildings, or developers may reach agreements with the owners of nearby structures to permit residents to stay there (i.e. where there is excess shelter capacity over and above the space required by their own residents).

2) Collection of impact fees from new development. The concept here is similar to that suggested for the acquisition of hazardous lands. In fact, the two fees could be collected jointly from new development (two components of the same fee) and would again be assessed commensurate with the shelter demand created by the new development, (e.g. assessed according to number of new dwelling units, bedrooms, square footage). (See the earlier discussion of this option as an approach to financing the acquisition of undeveloped parcels in hazardous areas; also, see the appendix for a fuller discussion of impact taxes).

3) Financing through special assessment district. This option would tax existing property owners for the provision of new shelter facilities. It would be a logical alternative if beneficiaries and nonbeneficiaries of this good were sharply differentiated. Unfortunately, there are no adequate existing shelters to speak of and the entire Nags Head public should in theory be beneficiaries. A more feasible and sensible approach to the provision of sheltering for the general public is to finance these provisions through general revenue funds.

4) Financing through general revenues. Because shelters are needed to accommodate existing residents of Nags Head, as well as new and future residents, there is a clear need to finance such projects through general local funds. This is needed basically to "catch up" with post impact needs. Once these existing needs have been sufficiently addressed, future shelter facilities and accommodations may be provided entirely through the impact fee system. In the short-term, however, the impact fee should be coupled with a substantial contribution from the general town budget.

4. Shelter capacity for new public structures. The Town of Nags Head is currently considering the construction of several new public buildings, including a public works building and a new town hall. To the extent possible, these and other public structures should be designed and built so that they may effectively serve as hurricane shelters for Nags Head residents. In addition to their construction and design, these buildings should be placed where possible in locations which are better able to withstand storm forces.

At some point in the near future the Town should conduct a study which would identify the size, number and approximate location of such shelters, as well as catalogue existing private and public structures which could be used for such purposes.

V. Post-Storm Reconstruction Plan

Post-Storm Reconstruction Objectives

1. The Town of Nags Head will, to the extent feasible, prevent the reconstruction of structures in high storm hazard areas which have been substantially damaged. Where reconstruction on such sites is allowed to take place, it will occur only at substantially reduced densities.

2. Both minor and major reconstruction, when permitted, will be subjected to protective building standards. (See building and construction objective in pre-storm section). The Town of Nags Head will make all efforts to ensure that where reconstruction is permitted that it satisfies existing building code provisions.

3. During reconstruction Nags Head should limit, if not prohibit, the extension of public facilities or public structures or the reconstruction of damaged facilities and structures in high hazard areas.

4. If reconstructed, public facilities will, where possible, be flood proofed and upgraded to better withstand future hurricanes and storms. This might suggest, for instance, the elevation of roads, or more adequate structural protection for water lines. Again, where possible, these costs should be assessed to current or future residents of the hazard zone.

5. When reconstruction is permitted in a storm hazard area, it should be required to be at a sufficient distance (setback) from the most serious storm forces. This will require reconstruction set sufficiently back from dune and beach areas, high erosion areas, and active or potentially-active inlets.

6. During reconstruction, the Town of Nags Head will attempt to enhance the ability of residents to evacuate should another hurricane or severe coastal storm threaten.

7. During reconstruction, the Town of Nags Head will seek to increase the number of hurricane/storm shelter facilities available to the local public in the event a hurricane threatens.

8. Where the reconstruction of public facilities damaged by the hurricane is permitted, the Town of Nags Head will adopt fiscal and institutional mechanisms which will more equitably distribute these reconstruction costs to beneficiaries. This may take the form of a special facility assessment, or an impact tax. This institution should be developed and enacted prior to a hurricane, and the financial responsibilities for such reconstruction made public.

9. The Town will take advantage of the disaster by purchasing, to the extent feasible, land and property in the hazard zone. Given the disaster, it may be possible to purchase cleared land, or interests in such, at reduced prices. The opportunity may also exist to purchase damaged properties (perhaps through eminent domain) at relatively low prices, through flood insurance programs.

10. When undertaking recovery/reconstruction decisionmaking the Town will seek to encourage redevelopment and redevelopment patterns which better utilize the natural mitigative features of the coastal

environment. This might include, for instance, prohibiting the reconstruction of homes which interfere with the natural functioning and dynamics of dunes, wetlands, drainage patterns, and so on. Reconstruction should permit and encourage the restoration and enhancement of these features where possible. This might suggest, for instance, the need for a buffer between a wetlands and area of development, and the need to prevent reconstruction in this intermediate area.

11. The Town of Nags Head will constitute a special damage assessment and planning team prior to the storm to undertake recovery analysis and to serve as professional input to recovery/reconstruction decisionmaking.

12. The Town of Nags Head will, to the extent feasible, seek to coordinate its recovery decisions with other relevant communities and jurisdictions in the region. Moreover, the Town will provide opportunities in the recovery structure for the expression of these extralocal concerns.

13. The Town of Nags Head will make every effort to develop its capacity to identify and harness various post-storm recovery resources, while at the same time ensuring maximum local control over the recovery process. This will include the identification of relevant federal and state programs, and an understanding of the procedures necessary to utilize these programs. This will also include an identification of private sources. For instance, during recovery, the resources and objectives of such groups as The Nature Conservancy may be harnessed to achieve public reconstruction goals, such as the purchase and protection of coastal open space.

14. The Town of Nags Head will seek to integrate recovery and reconstruction planning with the broader set of planning goals and objectives for the community. In addition to opportunities to mitigate hurricane and storm hazards, a hurricane-striken community may also be presented with

opportunities to advance other important community goals, such as economic development, environmental quality, traffic and pedestrian safety among others. Pre-recovery planning should attempt to identify these potential opportunities and the extent of their overlap with mitigation opportunities.

Recovery and Reconstruction Mitigation Opportunities

1. Mitigation opportunities:

Damage assessment team. Immediately following the storm event the Town of Nags should be prepared to convene a special damage assessment team, composed of local officials and citizens with particular expertise. The primary tasks of this group immediately following the storm, will include the following:

a) To assess the extent and location of storm damage, both to the natural and built environment.

b) To document the type and location of storm forces, including the identification of following:

   1) incipient inlet areas

   2) high wave action areas and areas of high erosion

   3) high flooding and overwash zones.

c) From the above information, to determine, to the extent possible, the likely causes of damage (e.g. faulty construction, proximity to an incipient inlet).

This information will be collected and then presented to the hurricane recovery committee, preferably in graphic form. The damage team will also be asked to compare actual damages with the hazard maps available prior to the storm, and to adjust the delineation of local hazard areas

accordingly.

The damage assessment team should consist of the following individuals or their appropriate counterparts:

- town planning director
- town building inspector
- town engineer
- local tax assessor
- director of public works
- an environmental scientist.

It is important that this group of individuals be appointed as quickly as possible so that they may organize procedures and develop appropriate forms for this assessment function. The assessment team will also serve as an expert advisory group during the period in which specific reconstruction decisions are being made. For instance, in the case of a proposal to prohibit reconstruction in a particular portion of the Town, they may be called upon to provide more detailed information about the degree of damages.

2. Mitigation opportunity:

Increased decisionmaking capacity: The formation of a reconstruction committee/task force. Because the reconstruction period offers unique mitigation opportunities, the Town of Nags Head should consider the creation of an additional decisionmaking unit to address and hopefully capitalize upon these opportunities. This group could meet immediately following the hurricane, and consider the feasibility and appropriateness of mitigation and other reconstruction opportunities. They would facilitate and match specific factors attributed to the storm (e.g. the nature and extent of damage) with reconstruction goals and opportunities identified before the

storm. (What the following reconstruction plan is meant, at least in part, to provide.) While this body will convene shortly after the storm strikes, they should convene periodically prior to the storm event to review the specific policies and recommendations contained in this document, and to modify these as circumstances in the community change over time.

a. Implementation options

1) A newly formed committee. This reconstruction committee should be broad-based in its representation of community interests. The committee might be comprised of the following individuals:

- one or more elected officials
- planning director or planning department representative
- one or more representatives of the business community
- public works official
- representatives from specific neighborhoods/geographical areas of the Town
- [representatives of Dare County and adjoining jurisdictions?]

2) The town planning board. These reconstruction policy issues could be given to the Town planning board, a body particularly well acquainted with local development and planning in Nags Head. Allocating responsibilities to this group would consequently have the advantage of capitalizing on existing knowledge and expertise of the development process and the actions involved in it. Unlike the creation of a new recovery committee, commissioners would generally not have to be brought up to speed on development issues. Moreover, using the planning board would still serve to release the elected board from many of these decisions (at least to the detail or level of consideration), a highly desirable

feature given the number and growth of decisionmaking requirements these individuals are typically faced with in the aftermath of a hurricane.

3) The Town Board. One option is simply to place these reconstruction opportunities squarely and completely in the hands of elected officials, with the body serving the function as the reconstruction committee. This option has the advantage of placing these reconstruction issues and decisions in the hands of those officials who will be ultimately responsible for their ramifications. This often may be more politically-expeditious, as well. A major disadvantage is that elected officials are typically faced with myriad and numerous decisions in the storm aftermath and it may seem appropriate to ciphor, rather than add to, their decision-making responsibilities.

3. Mitigation opportunity:

Delineation of the damage "triage." An initial task of the reconstruction committee, in collaboration with the damage assessment team and other relevant local officials, is to classify and categorize different areas of damage by type and severity. We propose a classification scheme based on the medical concept of "triage," in which damage areas would be grouped into three categories, for the purpose of moving and quickly responding to local reconstruction needs. These three categories might be called the following: Minor damage areas, moderate damage areas, and major damage areas, and defined more precisely in the following way:

a. Minor damage areas. These are areas in which a relatively small number of structures have received low-average amounts of damage. For instance, structures in this area may have windows broken and some roofing tiles missing, but no serious structural damage. More precisely, this damage zone shall include structures which on average have incurred damage amounting to less than 20% of the assessed valuation.

b. Moderate damage areas. These are areas where structures have received substantially more damage from the storm, and including serious structural damage to many buildings. The majority of structures in these areas however, are repairable in their present condition. More precisely, this damage zone shall include structures which on average incur damages of more than 20% but less than 50% of the assessed valuation.

c. Major damage areas. These are areas where many structures have been completely destroyed and others beyond reasonable repair in their present condition. These are the areas which have received the brunt of the storm's forces. More precisely, this damage zone shall include structures which on average have incurred damages in excews of 50% of the assessed valuation.

This categorization of damage areas when they are used to arrange and apply of the post-storm mitigation actions of the Town. An initial decision is that areas placed in the "minor" damage category ought to be permitted to rebuild immediately and under no new conditions or standards.

4. Mitigation opportunity:

Reconstruction moratorium. For those areas which are classified as moderate and major, immediate reconstruction will be prohibited. This temporary moratorium on reconstruction will last no later than 30 days During this time attention will first be focused on determining whether and under what conditions structures in "moderate" damage areas will be permitted to reconstruct, and then, whether and to what extent structures within "major" areas will be allowed to reconstruct. We propose that reconstruction policies apply to these two districts commensurate with the following options for reducing the future vlunerability of properties:

5. Mitigation opportunities.

Reduction of amount of private reconstruction permitted following a storm. The above classification system provides the basis for managing reconstruction so that the amount of private property at risk from future storm damage is reduced. This can be accomplished in a number of ways.

a. Implementation options

1) Permanent moratorium. One approach to achieving this reduction in property at risk is simply to prohibit the reconstruction of structures in highly damaged areas. We propose that such a technique only be applied to structures which have been damaged by more than 50% of their assessed value. Under this assumption, such a moratorium could apply in either of the two zones where substantial property damage has occurred.

a) Prohibit reconstruction of structures incurring damage over 50% of their assessed valuation in both (either) major or moderate damage areas.

b) Prohibit reconstruction of structures incurring damages over 50% of their assessed valuation in major damage areas only.

2) Reduction in permissable density through post-storm zoning changes. In lieu of complete prohibition of reconstruction in certain high damage areas, reconstruction may be permitted to occur, but only at substantially reduced densities.

For instance, overall permissable density in a major damage area may be reduced automatically by 50% (?). This can be accomplished in the following ways:

1. Increase in minimum lot sizes in an existing zoning designation.

2. Rezoning from an existing higher to a lower density zone (e.g.

a change from an R3 to an R1).

3. Creation of a special floating zone which reduced density in a pre-defined damage zone by a predetermined amount.

Under this situation, a homeowner would not be permitted to rebuild (if his structure were damaged by 50% or more) unless he was able to satisfy the new density requirements: This would require those who wished to redevelop to purchase additional land and damaged structures of others located in the damaged area.

Depending upon the precise approach used to reduce the density, this may require that a higher density damaged structure (e.g. a hotel or multi-family unit) be torn down and replaced with a single family, or perhaps a duplex structure.

3) Non-conforming uses. The Town may be able to reduce the quantity of development at risk by preventing the reconstruction of certain uses through nonconforming use provisions. For instance, under this option the Town would rezone areas to low densities, even though these areas have already been built-up. Thus, in the event of a damaging hurricane, the rebuilding of these high density uses would not be permitted, as they would be considered to be "non-conforming."

4) Reconstruction subject to clustering and siting restorations. It is possible that in many cases redevelopment could occur in a clustered fashion which would place greater distance between structures and coastal hazards. Clustering may be required before reconstruction permission is granted.

6. Mitigation opportunity:

Reconstruction subject to conditions.

a. Implementation options

1) Reconstruction subject to stronger building standards. While Nags Head cannot legally impose more stringent building requirements than those available through the state building code, it can make efforts to ensure that reconstruction does occur consistent with these provisions. This may require the allocation of additional resources and personnel to the town building inspector in the period following the storm.

2) Reconstruction of public facilities and structures to be more storm resistant. Where public facilities, such as roads and water lines, are damaged from the hurricane or storm event, and where it has been determined that these should be reconstructed, this reconstruction should be undertaken in such a way as to increase their resistance to future storm forces. For instance, public roads in reconstruction areas may be elevated, to increase their protection against future storms.

3) Reconstruction subject to impact fees and shelter provisions. (See below for a fuller discussion of these requirements).

7. Mitigation opportunity:

Land and property acquisition. In the aftermath of a storm, the Town of Nags Head may be presented with the opportunity of purchasing land and properties at reduced or "bargain" prices. Vacant land flooded by the storm may be considerably less attractive on the open land market than before the storm. Damaged houses and structures may as well be purchased at such reduced prices. The reconstruction committee should identify prime/potential land and property purchases following the storm, should list and prioritize these and present them along with its other recommendations to the Town board.

The identification and actual purchase of such land and properties should be based on the following criteria, listed in order of priority:

1. Land and property located in major damage zones.
2. Land and property located in moderate damage zones.

In combination with the following criteria:

1. Land located in V-zones.
2. Land located seaward of the Beach Road.
3. Land located in the close proximity to an actual or incipient inlet.
4. Land located in the A-zone.
5. Land located in the B-zone.

a. Implementation options:

Funding.

1) Funding through general revenue. (See discussion contained in pre-storm mitigation section).

2) Funding through external sources. Nags Head should be prepared to take advantage of acquisition funds available from federal and state sources following a hurricane or severe storm. Section 1362 funds are typically available from FEMA following a disaster to acquiese high hazard lands on which property has been destroyed.

3) Funding through special assessment districts. (See pre-storm mitigation section).

4) Impact fees. One option is to require homeowners and developers wishing to reconstruct to pay an impact fee which can be used during (and after) reconstruction to finance high-hazard acquisitions. This impact fee would vary with the size of the reconstruction proposed.

This fee would also create an incentive for lower-density reconstruction, as the amount of this fee would be less for such uses (or perhaps certain density reductions could be exempted from the fee altogether).

5) Development exactions. The Town may require that developers and homeowners wishing to reconstruct must acquire and dedicate to the Town a certain amount of land (and/or damaged properties) in high hazard/damage zones. This amount would vary with the amount and scale of reconstruction desired. An incentive for low density reconstruction may be created by lessening this requirement (e.g. require a fewer number of uses) for such proposed projects.

6) A combined approach. As for acquisition in the pre-storm mitigation stage a combined approach to financing such purchases appears most feasible and equitable.

b. Implementation options:

Use of acquired lands and property. (For a full discussion of this issue see the prestorm mitigation section).

8. Mitigation opportunity:

Reconstruction contingent upon hurricane shelter provisions. As established in earlier sections of this report a serious need exists in the Town of Nags Head to provide additional storm shelters. Permission for reconstruction might be made contingent upon the homeowner or developer contributing to the provision of these shelters.

a. Implementation options:

Financing and provision.

1) Mandatory construction or provision of shelters. (See

pre-storm mitigation section for a discussion of this option).

2) Impact fees. (See pre-storm mitigation section for a discussion of this option).

3) Financing through general revenue sources. (See pre-storm mitigation section for a discussion of this option).

APPENDIX

APPROACHES TO THE REDUCTION OF COASTAL STORM HAZARDS

Several alternatives exist for the reduction of hurricane and storm hazards. These fall into three main categories or mitigation strategies: (1) programs designed to structurally alter the coastal environment so that it can better withstand the forces of coastal storms; (2) programs designed to strengthen buildings and other structures; and (3) development management. A brief outline and description of the programs follows.

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I. STRUCTURAL PROGRAMS

These take the existence or future presence of development as a given and are designed to reinforce the shoreline environment to better protect this development from storm wave and surge forces. Four primary types of programs exist within this category.

A. Sandtrapping Structures

The beach and dune structures in the coastal environment serve as effective protection against storm forces. Beaches and dunes can absorb much of the impact and energy of a storm. Groins are structures designed to increase the deposition of beach materials, or to arrest the further erosion of these resources (or more typically both). They are structures extending into the ocean at right angles to the coast, and are typically constructed of concrete, timber, steel sheetpiling or riprap. Such structures induce deposition of sand on the updrift side, and in turn block lateral deposition in down drift areas. Jetties generally extend further into the ocean, are often constructed in pairs, and are often built to prevent shoaling in coastal inlets.

B. Sandmoving Programs

Natural processes of beach acretion can be supplemented through programs designed to move sand from other areas where

it is in greater abundance. Beach nourishment programs are designed to transport large amounts of sand from one area to another area typically one experiencing high rates of erosion. In this way beach and dune structure are preserved by redistributing sand resources to correct for acretion-erosion imbalances. Large scale nourishment programs can be very expensive, and on a smaller scale, in areas of high erosion, may require constant investment even to maintain existing shoreline levels. Sand-scraping activities may be undertaken to reinforce a beach structure, e.g., filling-in behind protective seawalls and bulkheads.

C. Shoreline Protection Works

These types of structures are designed to protect buildings and property from shoreline forces. Seawalls are typically constructed from heavy concrete sheetpile, with a stepped-down or curved face (Yasso & Hartman, 1976). Bulkheads are usually smaller in scale and used to protect headland areas and inlet channels. A revetment is similar, though typically involves rip-rap or interconnecting concrete blocks used to protect dunes and beaches from erosion. Terraces are also used in cliff areas, and involve the insertion of vertical pilings and planks at different levels.

D. Flood Control Works

These are structural improvements designed to manage and reduce the damaging effects of flooding. They range from

relatively small projects such as the construction of retaining ponds, to the undertaking of large dam and dike projects. The construction of ditches and channels also falls into this category. A number of examples can be cited of the use of these approaches in addressing hurricane and coastal storm risks. A series of levees and locks are being constructed on Lake Ponchartrain (New Orleans) to protect against and manage hurricane flooding (COE, 1980). Kiawah Island, South Carolina, has developed a stormwater management plan which includes a lagoon system, which can be emptied prior to a storm landfall (S.C. Water Resources Commission, 1982). Texas City (near Galveston, Texas) is nearing completion of a 16-mile long, earthen levee system (maximum height of 23 feet MSL), along with a concrete floodwall drainage system, a closure gate, and pumping drainage stations (Texas Division of Emergency Management, 1984). It is designed to provide protection from storms creating 15-foot surges. A similar project is found in Freeport (also near Galveston). It includes 38 miles of earthen levee, as well as drainage and pumping facilities, and a tide control gate.

II. PROVISIONS TO STRENGTHEN BUILDINGS AND FACILITIES

Programs and policies falling in this category do not rely on improvements which strengthen the surrounding coastal environment, but rather seek to strengthen the building or structure itself, and accompanying facilities such as sewerage collection lines, water distribution lines, and roads. Discussion

below is organized under two headings: (1) provisions designed to strengthen buildings and structures, and (2) provisions designed to strengthen facilities and services.

A. Strengthening Buildings

The adoption of building codes and construction standards has perhaps been the most popular response to hurricane and coastal risks. Storm-resistant building requirements received their most substantial impetus from the National Flood Insurance Program. Created in 1968 under the National Flood Insurance Act, the program provides for the identification and mapping of flood-prone communities and the availability of federal flood insurance for property within participating communities. To qualify for flood insurance communities must adhere to federal guidelines in the regulation of flood plain lands (Miller, 1975; Baker, 1979). Under the "emergency" phase of the program new construction in floodplain areas (in accordance with Flood Hazard Boundary maps) has to satisfy anchoring requirements and use flood-resistant materials.

After more detailed Flood Insurance Rate Maps (FIRMS) are drawn for a community, it has the option (within a certain period of time) to enter the "regular" program, or lose its flood insurance coverage. Under regular participation, additional building requirements are specified. In the "A-Zone," the lowest floor of a new residential structure must be elevated to at or above the 100-year flood mark (The BFE, or Base Flood Elevation).

Commercial and Industrial Sturctures must either be elevated or flood-proofed (e.g., flood resistant materials, floodwalls) (see FIA, 1976). Furthermore, all new construction must be prohibited in the "floodway." (For a definition and discussion of what a floodway is, see Kusler, 1972.) Because there is typically not a floodway in coastal communities, the provision is of less importance here. In many coastal jurisdictions "Coastal High Hazard Areas ("V" or "Velocity-Zones") have been identified, in which special building requirements apply. These are areas where the incoming storm surge is expected to support a minimum three-foot wave (see U.S. Army Corps of Engineers, 1975). V-Zones are currently being delineated under a new wave height methodology developed by the National Academy of Sciences (NAS, 1983). Within V-Zones, buildings must be elevated to at or above 100-year wave heights and built on pilings (rather than landfill). New mobile homes are prohibited in V-Zones, and the alterations of certain sand dunes and mangroves are prohibited if likely to lead to increased flood damages. In both A and V zones, if flooding damage of more than 50% of the value of an existing structure occurs, the rebuilding of this structure must be consistent with elevation and floodproofing requirements. (For a good histry of the NFIP see Burby, French and Kaiser, 1979).

It is evident that in many coastal communities the NFIP program and its building requirements have spurred additional mitigative provisions. A number of communities have mandated

building elevation in excess of that required under the 100-year BFE. Referred to as "freeboard" elevation, it can further minimize the impacts of wave and surge forces. The City of East Providence, R.I., for example, has enacted provisions which differentiate a high and low hazard zone. In the high hazard zone (near the beach) residential buildings must be elevated to 15 feet MSL, rather than the 10 feet required under the NFIP requirements (Kusler, 1982, p. 46).

Building codes vary widely in the resistance they provide from hurricane forces, and a detailed discussion of their provisions is not possible here. It should, however, be observed that building codes are probably the most widely employed mitigation strategy. These requirements may be either local option or state-mandated, or some combination. Texas is perhaps most notable for its development of a model set of Hurricane Resistant Building Standards (Texas Coastal and Marine Council, 1981), which among other things specifies relatively stringent wind loading standards. It would have provided provisions to protect against storm winds of 140 mph (as compared with, say, 105 mph in the Southern Standard Code). This model code was, however, not enacted by the Texas legislature.

B. Strengthening Facilities

Inhabited structures located in hazard areas must also be served by certain basic facilities. These facilities, like the structures themselves, can be strengthened to better resist

storm forces. Primary among these are wastewater collection, water distribution, electric and telephone lines, and roads. Sewer and water lines can be floodproofed, while utilities can be placed underground for better protection. Roads are best protected through elevation.

III. MANAGEMENT AND GUIDANCE OF DEVELOPMENT

A. Development Regulation

A primary set of development management tools are those which regulate and control in a direct fashion the location, density and type of development in a coastal community. Regulation can address the reduction of exposure of property to hurricane and storm risks, and reduction of vulnerability of property, and can lead to the enhancement of the protective features of the natural environment. Several alternative regulatory devices are examined below.

1. Conventional zoning. Conventional zoning ordinances control the type of land uses allowed in particular parts of a community (e.g., residential, commercial, recreational) as well as the intensity (e.g., bulk, height, floor area ratio, setback provisions). As a result, zoning provisions can control the amount and type of property exposure to hurricane and storm hazards. For instance, open space and recreational uses may be the most appropriate activities to be permitted in high risk areas (e.g., high wave and erosion areas). Restricting such

areas to commercial or public recreational activities will substantially reduce the amount of property at-risk and in turn the property losses to accrue from future hurricanes and storms.

2. Exclusive undeveloped hazard zone. One zoning option is simply to designate an open space or conservation zone in which all future development is prohibited. Even if this were a politically-feasible option, in coastal areas where agricultural and other non-developed uses do not yield a reasonable economic return, a challenge of a "taking" of private property without just compensation is opened up (see Bosselman et al., 1976). Depending upon specific state statutes and case law, such an approach is not likely to be defensible unless some economic use, such as agricultural, forestal, or commercial recreation can be supported. The community must examine the local viability of these non-developed uses and modify its regulations accordingly.

The legal and political feasibility of a zone where all development is prohibited may depend on the precise design and configuration of this zone, and its relation to land ownership patterns in the community. If, for instance, the zone constituted a "strip" which was long but not wide, the typical landowner could work around such a prohibition, essentially building on other portions of lots. Such a zone then essentially becomes much like an ocean setback. Moreover , even if the zone is not of a "strip" type, but rather encompasses a large amount of land

in one area, if landholdings are quite large, it might be argued that reasonable development potential (economic use) has been preserved.

One reasonable alternative is to limit development in the Coastal High Hazard Area (V-Zone) as designated under the National Flood Insurance Program (e.g., see Platt, 1979). This would serve as a natural delineation of the most hazardous portions of the coastal environment, would simplify mapping problems, and would enhance the legal and scientific supportability of the restrictions. Again, however, the V-zone may encompass large amounts of prime development land, with no other reasonable economic use.

Even where a reasonable economic return cannot be ensured, the legal and political feasibility of development limitation can be maintained by coupling it with other techniques such as the transfer of development rights and the acquisition of less-than-fee simple interests in land. For instance, if the regulated landowner is able to transfer a portion of the pre-regulatory development value of his parcel to another site where it can be used (or sell it to someone who can use it for such a purpose) this will afford the landowner at least some economic return. These techniques are further discussed in subsequent sections of this report.

3. Reducing the quantity of development exposed. In most instances, in the absence of land acquisition or some form of landowner compensation, large scale prohibition of new development is not likely to be feasible. Often a more sensible

approach is one which seeks to reduce the overall quantity of development at-risk. While a residential designation in an oceanfront area may still permit considerable development to occur at high risk to hurricane damages, this quantity may be considerably less than what the unregulated market would support. Moreover, reducing a zoning designation from relatively dense multi-family development to single family may reduce substantially the amount of property at-risk.

This reduction of risk is also contingent to some extent on the quality and type of structures to be built. Multifamily structures, for instance, may be built to withstand much more effectively the forces of hurricanes and storms, in comparison to single family structures. While limiting development to the latter type may reduce the quantity of property at-risk, this property may be more vulnerable to storm damages. This quantity-vulnerability relationship should be considered.

4. Reduction of density/extent of exposure according to magnitude of site risk. Reduction of the amount of property at risk in coastal hazard areas can be commensurate with the extent and nature of the storm and storm-related hazards that exist in various locations. The quantity of development permissible could be a function of the accumulated risks in a particular site. For instance, less development may be permitted in an area subject to both wave velocity action from storms and a potentially-shifting inlet, than a location subject to velocity effects but without the inlet hazard. Different hazard zones can be designated with varying

degrees and combinations of hazards, with the density of development permitted being a direct function of these designations. Proximity to ocean and sound waters may serve as a good proxy for storm risks, with the most extensive amounts of new development permitted on locations farther inland. An important factor here is that in a typical coastal community there will be gradations of hazard and risk, with the primary (mitigation) objective of zoning to orient future development away from high hazard areas to lesser hazard areas.

As with many of the other development management techniques discussed in this paper it is important to utilize zoning provisions to preserve, to the extent possible, the protective features of the natural environment. It may be desirable, for instance, to permit only very low densities of development (where permitted at all) around wetlands. Development in close proximity may threaten the health and vitality of the areas and in turn reduce their utility in absorbing storm forces (e.g., Conservation Foundation, 1980; Benton et al., 1980).

5. Coastal Setback

The concept of development setback has long been part of zoning and land use controls. Setbacks are used in urban settings, for instance, to ensure that sufficient land is available in the future for public improvements (e.g., roads), and to ensure adequate light, access, and separation of structures. Required setbacks from coastal hazard areas is an extension of

this zoning concept, and has become relatively popular as a technique both for minimizing the impact of development on beach and dune areas, and reducing exposure to storm hazards (e.g., see Kusler, 1982; CURS, 1984). Setbacks can be required from the ocean itself (e.g., from mean high tide), the first line of vegetation, or dune ridges. Such setbacks may be either state-mandated or local option. The State of North Carolina requires coastal development to be located landward from the first line of vegetation a distance of 30 times the annual rate of erosion for that particular segment of the coast. Florida operates a similar requirement under its Coastal Construction Control Line (CCCL). Seaward of the control line, a permit must be obtained from the state to develop or excavate land. The line is meant to encompass the 100-year flood area, and varies from jurisdiction to jurisdiction based on local erosion and shoreline changes. While construction seaward of the CCCL is not prohibited it must satisfy certain structural and design requirements, to ensure protection of structures and the beach and dune system. It is at least conceivable that these mitigative requirements can discourage or reduce the amount of development in high risk areas, as it may be easier to obtain development approval in locations outside the CCCL. A number of individual coastal jurisdictions have established setback provisions on their own (e.g., see Kusler, 1982).

6. Subdivision Regulations

Subdivision regulations govern the conversion of raw land into developed uses, and the types and extent of improvements made in this conversion. Subdivision regulations can control the density, configuration and layout of development. It operates in ways similar to zoning in its ability to control the amount and density of development on a particular site. The requirement of a minimum lot size can reduce the amount of new development exposed to storm hazards. Site plan review and other requirements of subdivision approval can provide the opportunity to orient the location of development sites in such a way that storm risks are minimized. For instance, subdivision provisions may require that new single family dwellings on lots in hazard areas be sited in ways which maximize distance from high hazard oceanfront areas. Perhaps some of the most promising requirements from a storm mitigation perspective are clustering provisions (see Whyte, 1968). Such provisions would not affect the overall density permitted on a particular site, but would seek to amalgamate this density in areas of the site which are less-hazardous (e.g., outside of the flood zone, at a distance from velocity zones and active inlets). These provisions may either be required or presented to developers as an option. Clustering could have several advantages from a storm mitigation perspective. By directing density to a particular portion of a site, it can both permit and encourage development to locate on the less-hazardous portions of a site, while preserving hazard-

prone areas in an undeveloped state. These may typically be areas, such as wetlands, and vegetation areas, which in themselves serve to protect against storm forces. Clustering may also encourage the construction of buildings which are more structurally-resistant to storm forces, and may provide a more economical provision of certain storm protection improvements (e.g., sea or floodwalls). Clustering can, as well, economize on the public facilities, such as sewer, water and roads, which must accompany development, in turn reducing the amount of such property at-risk (RERC, 1974). Clustering may also offer advantages in the provision of community storm shelters and evacuation services.

The process of subdivision approval might be made contingent upon certain mitigative actions, such as the protection of dunes, wetlands and natural vegetation. Subdivision approval may be denied, for example, if they do not meet certain evacuation safety or hazard-reduction performance standards, or if certain mitigative actions are not taken to address these issues.

Traditionally, subdivision approval is contingent upon the provision by the developer of certain facilities, or monetary contributions in lieu of such dedications. Referred to as "exactions," they have conventionally taken the form of requirements to construct and dedicate, or to pay for the construction, of such immediate facilities as sewer and water lines, curbs and gutters, and roads. Typically included, as well, are requirements that developers contribute a certain amount of land for open

space, parks and recreation, and future school sites. These are generally needs directly related to the new development. This exactions process offers potential for storm hazard mitigation in several ways. It may require, for instance, that when private developers build and dedicate public facilities, that these facilities be constructed in ways which are hurricane-resistant (e.g., flood proofing sewer and water lines, elevated, etc.). Moreover, in the dedication of lands, or fees in lieu of such dedications, the community can require that lands which are particularly hazardous be dedicated--in turn ensuring that such areas are used for non-developed (non-intensive) uses. An in-lieu land acquisition fund may allow the community to combine resources and to acquire in a more aggressive way large tracts/areas of high-hazard land. Consideration of public reconstruction requirements may also be appropriate. For example, the community may wish to make subdivision approval contingent upon the contribution of the developer to a "reconstruction fund," which would be used to finance both immediate recovery and longer-term reconstruction tasks.

Some communities have attempted to tie subdivision approval to the adequate provision of off-site community facilities and services, such as police and fire. Similar reasoning applies to hurricane hazard reduction. Subdivision approval might be contingent, for instance, on adequate community-wide evacuation capacity, or the provision of community storm shelters.

Clustering provisions are typically associated with the Planned Unit Development (PUD) concept. PUD provisions provide

for flexibility and innovation in project design by relaxing stringent zoning and subdivision requirements, for a more creative design which is the result of negotiation between the developer and public officials. A PUD process may permit the mixing of residential and commercial uses in a way which the conventional zoning in place would not. It is conceivable that storm hazard reduction can be advanced through PUD project design, for instance, by permitting deviation from normal land use and subdivision standards for more innovative developments (and perhaps more profitable from the developer's point of view) when these designs incorporate storm hazard reduction features, such as the provision of protective land and vegetation buffers, and the provision of on-site storm shelters. (For a discussion of PUD provisions see Burchell, 1972).

Two zoning techniques which can increase the ability of local land use restrictions to reduce storm hazards are conditional and contract zoning. Under contract zoning the jurisdiction agrees to allow a land use activity not normally permissable in a particular area (e.g., a rezoning from low-density residential to commercial, or higher-density residential) in exchange for a certain desirable feature provided by the developer (e.g., a deed restriction, certain public improvements). Conditional zoning is similar to contract zoning, but without the community selling or bargaining away its regulatory authority. Here, zoning changes are permitted only if they satisfy the stipulations laid down by the community at the time of

project review. For example, a community may agree to rezone low density residential to commercial uses in a high hazard zone, only if the developer agrees to ensure, for example, that such structures can be used for sheltering the public in the event a hurricane threatens. These are conditions which generally flow from the project review process and are typically not formalized or uniform from project to project.

An additional approach to enhancing the flexibility of land use controls is the use of "conditional" or "special" uses. These are uses which are permitted by right as long as proposed development meets certain standards and criteria. These conditions typically relate to the provision of public facilities and the protection of environmental resources. Such standards could also incorporate storm risk reduction actions, for instance permitting special uses only when adequate evacuation capability exists, or only when such uses do not disrupt the ability of the natural coastal environment to resist and protect against storm forces.

Another possible mechanism for enforcing storm hazard reduction in development management is the use of bonus or incentive zoning. Typically this is a formal mechanism through which developers are granted extra development density (e.g., square footage, dwelling units, etc.) in exchange for certain public amenities. It has been used for some time in New York City and San Francisco. In New York, for example, a developer can obtain a 20% increase in permissable floor area for projects which incorporate a legitimate theatre (i.e., within a

designated theatre district). In the case of coastal hazard areas, developers may be granted additional development units if projects incorporate certain hazard-reduction features. These features may include the purchasing and deeding to the public of high hazard lands, or the provision of certain design features which may increase the ability of structures to withstand storm forces. It may, however, not be wise public policy to encourage or permit additional densities in such areas, even if certain public amenities and hazard-reduction features are provided.

It is important to place storm hazard reduction in the context of our local development goals and objectives. This observation has several implications. The first is that in storm hazard reduction efforts, the presence of opportunities to advance other community goals may increase substantially the feasibility of such hazard reduction measures. While it may not be feasible to purchase high hazard parcels solely to reduce the extent of property at-risk, when the community determines that such lands are also badly needed for open space and recreational uses, together these overlapping objectives may cause such a program to be feasible. Secondly in the local development management process, the reduction or permission of storm risks must be balanced against other legitimate public goals. For instance, a community may permit a certain development in a high hazard area if these risks are counterbalanced by other amenities and features provided by the developer and highly valued by the public.

B. Land and Property Acquisition

The acquisition of land and property, or interests therein, may in many cases be the most effective approach to reducing the extent of exposure to storm forces. Several acquisition approaches are discussed here: 1) fee simple acquisition of undeveloped land; 2) acquisition of less-than-fee-simple interests in undeveloped land; and 3) fee simple acquisition/relocation of existing development.

1. Fee-Simple Acquisition of Undeveloped Land

Fee simple acquisition entails the public's obtaining of the full "bundle of rights" associated with a parcel of land. With respect to the storm hazard, acquisition may have several immediate functions. The first is to secure in public hands high hazard areas, thus in turn preventing the future exposure of property and people to storm hazards. On a larger scale public acquisition of land can serve to influence the direction and timing of growth and development in a community. Urban land ing programs, particularly popular in Europe, have attempted to regulate growth by preventing development in undesirable locations while strategically releasing other land more suitable (see Strong, 1979). Or perhaps, on a much smaller scale, single parcels of land may be purchased to prevent the location of certain growth-shaping private activities, e.g., the construction of a shopping center, boat marina, manufacturing

complex, and so on. Land acquisition can also be used to secure in advance, and typically at lower prices, land that will be needed at some point in the future for public facilities and services, e.g., school sites. The primary focus of the following discussion will be on the acquisition of undeveloped high hazard parcels as an attempt to reduce the extent of property and people at risk.

The use of fee simple acquisition poses a number of practical questions. The most significant perhaps for most coastal communities have to do with its cost and how such acquisitions are to be financed. Fee-simple acquisition in coastal areas experiencing moderate or high levels of market demand will tend to be very expensive--prohibitively expensive for many communities. The purchase of already-improved land (i.e., land with homes and facilities) will be even more expensive, although damaged properties purchased in the aftermath of a storm may reduce these expenses substantially. The community must be prepared, however, to take advantage of "bargain sales" after the storm. (This is discussed at greater length in a later section).

The expenses associated with fee-simple acquisition can be reduced in several ways. First, a community may seek to acquire land a number of years in advance of development, when its market value is relatively low. Reduced acquisition costs may also be obtained through the use of eminent domain. Official mapping is another technique for keeping acquisition costs down. This identifies areas where the public

expects to purchase land in the future, and where inconsistent activities and developments will not be permitted. Such an approach can serve to squelch rising development expectations which can lead to higher land acquisition costs.

The costs of fee-simple acquisition might also be reduced through the use of "preemption" or "right of first refusal." Such a mechanism would essentially permit the local governing body to insert itself in the place of a property-buyer in any local land transation. In other words, it would allow the locality to oversee all land transactions and to spend its limited resources in acquiring only those lands which are truly threatened by development (i.e., are in fact in the process of being sold for development uses). This technique has been used extensively in France under their SAFER program. Here right of preemption is used to purchase farmland, which is in turn reassembled and sold in larger more agriculturally-efficient tracts (Coughlin et al., 1977). The technique has also been used by the State of Oregon in protecting its scenic waterways from damaging development. While this concept has legal precedence in real estate law, enabling legislation will likely be necessary in most states before it can be used.

Acquisition costs can also be kept down through resale of properties, with certain covenant restrictions placed on the use of these lands. This would also address the problem of managing lands and property once they have been acquired. Placing land back into private hands, where possible, may do much to

keep these costs down. This decision, however, will also depend upon other important community objectives which may exist. If there exists a local need for parkland, maintaining these lands in public hands will then make more sense. A locality should in its acquisition decisionmaking be highly cognizant of other community goals and objectives that can be advanced simultaneously with hurricane/storm hazard reduction. The greater the overlap of such objectives the greater will be the social efficiency of these acquisitions.

Where possible a locality should seek to obtain "bargain buys," and land and property donations. Bargain purchases may be particularly attractive in the aftermath of a storm where damages are substantial and some property owners may wish to vacate the hazard area. The locality must, however, be prepared prior to such damages to act upon these bargains when they present themselves.

Acquisition costs may also be reduced by taking advantage of all available federal and state funding sources. Historically, where acquisition has been used most extensively as a mitigation tool, there has been substantial federal and state financial involvement (Kusler, 1979). For instance, Section 1362 of the Federal Disaster Assistance Act provides for federal funds for the purchase of federally-insured properties damaged by a storm (or other disaster). NFIP provisions also provide for what is known as "total constructive loss," or payments to FIA-insured property owners for the complete amount of policy

coverage even where damages are not this extensive, if owners agree not to rebuild. The policy has, however, apparently lost favor with FEMA officials.

A community may also be able to more efficiently use its available acquisition funds by coordinating its acquisition decisions with private organizations, such as the Nature Conservancy and the Trust for Public Land, that are intimately involved in land acquisition. These organizations are ofen in a better position to engage in extensive acquisition than are single jurisdictions. Although their acquisition decisions are typically based on non-hazard objectives, a community may be able to influence these private purchase decisions in several ways. This may occur, for instance, simply by better communicating their perception of which acquisitions will be in the public interest, or by convincing them that by purchasing specific parcels, or parcels in particular areas of the community, multiple social objectives will be furthered. As well, the community may be able to devise a cost-sharing arrangement, in which the community, through some form of financial contribution, is entitled to share in specific decisions concerning acquisition. The community may also be able to facilitate certain private foundation acquisitions which are favorable to local storm hazard mitigation.

Even where acquisition costs can be kept down, the community must address the issue of how it will finance the inevitable local expenses involved in acquisition. One such

approach is simply to finance these expenses through general revenue funds. In turn, local taxes must either be raised to pay for these costs, or funds directed from other local needs. Because acquisition of hazardous lands reduces "general" or "community-wide" damage liability, it can be argued that general revenue financing makes sense from an equity point of view. An alternative approach would be to obtain these funds through special means, which might include the collection of a special acquisition fee from new development, or through special district levies and assessments. Land acquisition as part of the exaction process during development approval has been discussed in a previous section (see p. 15). The use of special assessments or levies would appear contingent, at least from an equity (as well as a legal) standpoint, on the extent to which these acquisitions will benefit existing property owners (i.e., the property-owners to which the tax is applied). To the extent that such acquisitions serve to enhance protection from future storm damages, as well as provide other benefits to nearby landowners (e.g., scenic and recreational benefits) such a mechanism seems a reasonable approach to financing acquisitions.

Relocation to Reduce Exposure

Development management may also involve the relocation of structures and facilities from high storm hazard areas to areas of the community with lesser storm hazards. Relocation can take at least two forms: 1) relocation of the structure and its

contents to another site, and 2) relocation of the contents of a structure while demolishing or putting to a new use the remaining structure. Johnson (1978) has suggested that the first option entails the following steps:

- Locating and purchasing land at a new site.
- Preparing the new site; services, driveway, sidewalk, new foundation.
- Raising the structure off its existing foundation, transporting it to the new site, and placing it on the new foundation.
- Moving contents from the existing to the new location.
- Removing, disposing and backfilling the foundation at the existing site.
- Providing temporary lodging during relocation (p. 47).

Johnson (1978) suggests that the second option entails the following steps:

- Locating an existing structure, or building a new structure, at a flood free site.
- Moving contents from an existing to a new location.
- Either demolishing, and where possible salvaging the existing structure, or reusing it for a less damage susceptible use (p. 47).

Relocation of the structure to a hazard-free or less hazardous site while physically possible, may be economically infeasible. This will depend on the type of structure involved. It is generally not feasible with respect to most commercial or industrial structures and multifamily residential structures. Single family residential structures (one or two stories) and light commercial structures, are most feasible (those with wood frames and with basements or raised foundations). These are

structures which generally weigh less and contain accessible floor joists (Johnson, 1978). Structures with slab-on-grade foundations are difficult to relocate. Reducing the distance a structure must be transported may increase the feasibility of this technique. It may be, for instance, that significant additional protection can be afforded a structure by moving it back from the ocean or high hazard area.

Relocation of families and their belongings to new housing outside the hazard or "high" hazard area will generally be a more feasible approach. This is particularly true following extensive storm damage, where demolition of damaged properties (rather than extensive reconstruction) involves fewer opportunity costs. The recent efforts in the town of BayTown Texas to purchase properties in the Brownwood subdivision--an area devastated by Hurricane Alicia--are illustrative of the technique. Here some 300 destroyed or heavily damaged single family homes have been prevented from being rebuilt (See FEMA, Aug. 1983; Dec., 1983). Federal monies are being used to acquire the land the structures sit on (Section 1362), while SBA loans are being used to make up the difference between federal flood insurance payments and the replacement costs of these homes. This particular subdivision had been flooded at numerous times in the past, and federal officials saw this as an excellent opportunity to reduce future property losses and the federal insurance liabilities that would accompany them. Once these lands are acquired by the federal government they will be deeded to the City of BayTown, which in turn must agree to keep these lands in an undeveloped state.

The question of relocation following the storm will be addressed in greater detail at a later point in this paper.

2. Purchase of Development Rights/Donation of Easements

Where the fee-simple purchase of hazardous lands is, for various reasons, not feasible, a community may consider the purchase of less-than-fee-simple interests in land. One such approach is the acquisition of rights to develop, from owners of high-hazard parcels. Under this arrangement, a jurisdiction would pay the landowner the fair market value of this right in exchange for agreeing to leave the land in an undeveloped state for some specified period of time, typically perpetuity. This is usually accomplished through a restrictive covenant which runs with the property deed. Throughout the section we will refer to this technique as the Purchase of Development Rights (PDR).

As with fee-simple acquisition a number of immediate practical questions arise. First, in what manner are these rights to be acquired? Does the community use its powers of eminent domain, or instead simply bargain for them on the open market, acquiring such rights only from those who wish to sell them? This question may have significant implications for the ability of PDR to protect large blocks of high hazard land. For instance, relying upon voluntary sales may permit substantial development in an otherwise undeveloped high hazard area--it may do little more than shift new development from some parcels to

other parcels (perhaps denser development) within high hazard areas. Through the use of eminent domain, this potential "checkerboard effect" in high hazard areas may be prevented.

There is, as well, the question of what a "development right" is to consist of--i.e., exactly what rights are being purchased by a locality. Clearly, extensive residential development should be precluded; but should this include private recreational uses and developments which do not place substantial amounts of private or public property at risk? The greater the economic use which remains for the property owner, the greater will be the parcel's remaining fair market value, and the less costly will be the development rights purchase. Exactly what uses are permitted after development rights have been purchased may also influence overall property at risk on other parcels/areas. For instance, if private recreational activities are permitted in PDR circumstances, this may in turn induce further residential and other development in adjacent areas (lands where development rights have not been purchased). These types of development influences and side effects should be considered when defining the rights to be purchased (and the types of uses and activities that will be permitted in the future).

While a leading reason for preferring development rights acquisition over fee-simple acquisition is that public expense will be less, PDR may still be a very expensive mitigation approach. In areas where market demand for developed uses is

high, the purchasing of a development right will constitute the major portion of the parcel's fair market value (Coughlin and Plaut, 1978). Because of this fact, PDR may be no more financially feasible than fee-simple acquisition. A community can, however, investigate alternative techniques for keeping down the costs of these rights. For instance, the Maryland Agricultural Land Foundation, a state-funded agency which purchases development rights from farmers, seeks to get the most from its limited funding by giving preference to parcels where the following ratio is highest: development rights (easement) value - asking price/development rights (easement) value (Furuseth and Pierce, 1982; Nielson, 1979). Under this arrangement farmers wishing to sell their development rights submit bids to the state foundation, which in turn gives preference to high value parcels with low sale prices. A similar procedure might be applied in coastal communities. A jurisdiction might designate a general area of high storm hazard from which it will accept bids for development rights sales--in turn maximizing limited local monies by purchasing those rights which consist of the "best deals." A system could also be developed by which to evaluate the extent of relative storm hazard for each parcel (e.g., distance from the ocean) in turn incorporating this information into the evaluation procedure (i.e., getting the largest hazard reduction for the dollar).

The period of time for which the development rights are purchased will also have significance for the cost of such a

program. The Maryland program requires that development be restricted for a minimum of 25 years. A shorter period of time may serve the needs of the locality (e.g., in directing growth in certain areas) and preserve for the landowner a greater portion of the market value of the land, thus reducing the overall costs of development rights to a locality. Instead of purchasing these rights, the locality may find it more economically efficient to "lease" them for shorter periods of time.

As with fee-simple acquisition, there arise important questions of how the securing of these rights will be financed. Again, where possible, outside assistance should be utilized along with attempts to collaborate with the purchasing efforts of private groups. As before, developers of projects in hazardous areas might be required to purchase such rights themselves, or contribute to a local development rights purchasing fund, based on the magnitude of the project (e.g., sq. feet, number of bedrooms). The purchase of development rights may advance other community goals, as already noted, such as the preservation of open space and the protection of natural amenities, and as such funding by the general public may be justified. The general public will also benefit to the extent that future public expenditures for recovery and reconstruction are reduced. It should, however, be remembered that the purchasing of such rights may also reduce the local tax base, as may be the case with fee-simple acquisition. This impact will, of course, depend upon the extent of the local purchase program and characteristics

of the local tax base. Generally the impact on local tax base is not likely to be substantial.

PDR can be used effectively in collaboration with development regulation. On the one hand, restricting development in a particularly hazardous area of the community may prevent the checkerboard effect that sometimes results from a voluntary PDR. In turn, PDR may serve to soften the economic effects of development regulations, and reduce as well the political opposition typically arising around such regulatory programs.

While not widely used, the PDR concept has recently been proposed by North Carolina's Forsyth County (Zaneski, 1984). Under this proposal the county would spend $1 million each year to purchase development rights to prime farmland in the county. These lands could then not be developed for at least 25 years. At the end of this period the landowner would be given the option of buying back the development rights if he so desired, but at their current (new) market value. As currently proposed this program would be completely voluntary.

As an alternative to the purchasing of development rights, a community might investigate encouraging the donation of scenic or conservation easements. Landowners can be encouraged to make such donations in large part because of the income tax deductions permissible under Section 170 of the IRS Code.

For easements to qualify as charitable deductions, the instrument must be for perpetuity, must run with the land, and all

subsequent owners must be subject to the restrictions. Under new provisions (1980), the Treasury Department is now required to make a determination that the easement "will yield a significant public benefit." This does not appear, however, to have been an impediment to receiving the charitable deduction.

The community can take either an active or passive role in soliciting easement donations. It may, for example, actively search out and encourage these donations by landowners in hazard areas. In contrast it may simply assume a passive role as the recipient of easements. In either case, the community must carefully evaluate the significance of each charitable easement for local storm hazard mitigation. Accepting easements located in the wrong places simply because they are donations (or at least inexpensive) may do more harm than good in the long run. Easements in perpetuity may lock the community into land use and development patterns that it may later find undesirable or inappropriate. In the case of extreme coastal hazard areas, this is unlikely to be a significant problem, but in certain situations it may prove to be an important consideration.

If an easement is accepted, the jurisdiction and donating party should seek a clear understanding of the precise restrictions to the use of the land which will be in place. Experience with easements by the U.S. Park Service and others indicates that substantial difficulties can arise where misunderstandings about easement restrictions exist (Coughlin & Plaut, 1978). This highlights the importance of educating landowners

concerning easement restrictions both at initial time of donation and during subsequent sale or transfer of the land. The jurisdiction accepting the easement should also ensure that certain positive rights of entry are included, so as to facilitate public inspection and ensure compliance with easement provisions. Administrative processes need to be devised to detect these violations at an early point.

3. Transfer of Development Rights

One potentially effective approach to reducing the amount of property at-risk is to permit the transfer of development rights from a high storm hazard zone to a non-hazard or "safe" zone in another part of the jurisdiction. Such a system could either be voluntary or mandatory. Under the latter, a locality would simply zone the storm hazard area so that fewer units of development are allowed (or prohibit new development entirely), and the owner of land within this zone would then be permitted to transfer all or some of this unused development density to parcels in designated safe areas, or to sell these on the open market to others who own land in areas designated for development. The locality would then permit increased levels of development in the "safe" zone as a result of possessing extra development rights; thus a natural market for the transfer of these rights is created. A voluntary approach would simply present this transfer as an additional option for the landowner--

a way of maintaining the land in its undeveloped use if the landowner wishes. The landowner in this case would still have the option of developing his land, or selling it for development purposes (e.g., see Rose, 1975).

A number of practical issues must be considered by the community wishing to use a TDR approach. First, there are several alternative institutional approaches to operating such a program. On the one hand, the transfer of development rights can be left entirely to market dynamics, with the community involved only in designating "sending" and "receiving" zones, and determining the number of rights to be allocated. Whether a selling landowner receives a fair price for his rights will depend simply on what the market will provide. While there are decisions which must be made in the initial allocation of rights, the community adopts essentially a "hands-off" stance once the system is created. An alternative institutional structure would have the community play a more direct and active role in the development rights transaction itself, perhaps serving as a broker--buying and selling rights as needed. This in turn helps to ensure that an adequate price is obtained (e.g., overcoming short-term market oscillations). While the latter approach would permit greater control over the price and quantity of rights sold, it would also require greater government expense and oversight. An intermediate position might permit the local government to enter the market at occasional critical points, e.g., to stabilize prices, etc.--

yet leaving transactions, by and large, to the dynamics of the local market.

An initial difficulty is devising a methodology for assigning rights. They might be allocated, for instance, strictly according to acreage (e.g., one right per acre), or according to the market value of the property (i.e., the greater the value of property the more rights assigned). Eventually at some point in the future the question will arise as to whether additional rights should be allocated. If this is considered appropriate a practical and fair procedure for allocating these additional subsequent rights must be devised.

The locality must also decide how rights transferred from hurricant-prone sites can be used. If a developer purchases ten development rights from land in a high hazards area, and seeks to apply these in a non-hazardous (or less-hazardous) receiving zone, what will this entitle him to? Each additional development right, for example, might translate into a certain amount of additional floorspace (e.g., footage) allowed in the receiving zone. In the case of residential development these additions may be measured in terms of additional dwelling units, bedrooms, etc.

The transfer of development rights can also be viewed as a form of compensation when restrictions are placed on development in storm hazard areas. For instance, although an ocean-front landowner may be prevented from developing his land (i.e., it is now zoned for open space or recreational uses), he may

be able to realize a portion of this development potential by transferring (or selling to those who will transfer) his allocated development rights to areas of the community more protected from storm hazards. Viewing TDR primarily as a form of compensation raises several questions: key among them is the extent of compensation deemed to be desirable or equitable. At what point will the market value of a development right be unacceptably low as a form of compensation? If full or substantial compensation is a goal; this may require a more active role for government in the development rights market say by entering the market to buy rights at times when demand is low.

A large-scale TDR program requires extensive information and knowledge about local market conditions and land development trends, and this can represent a major limitation. How large, for example, should the receiving zone be (by how much should the community raise permissable densities?) to ensure an adequate demand for development rights? How readily will landowners in sending zones sell their development rights and when? One reasonable approach to these empirical limitations is to develop a modest TDR program, at least initially, with relatively small receiving and sending zones which can be monitored closely over time.

A number of illustrations of the use of TDR can be cited. One of the better known is that of Buckingham Township, in Bucks County, Pennsylvania, a suburb of Philadelphia. Here

the TDR concept was coupled with performance zoning. The Township was initially divided into two major districts: 1) a development district, designed to accomodate some twenty years of future growth; and 2) a rural district. The development zone was further divided into more specific use and density zones, and the rural district was divided into agricultural and resource protection zones. The TDR program here is entirely voluntary. Owners of land in agricultural protection zones are able, if they wish, to transfer unused development rights to development areas. Each landowner has been awarded one right per acre. If, instead of transferring development rights the landowner wishes to develop his land, he can do so but only under stringent performance standards. Landowners might be required, for example, to preserve as much as 90% of the area of the land in permanent open space, under clustering provisions (see Merriam, 1978).

Collier County, Florida, is another example of effective use of TDR. Here the intent was the protection of the coastal ecosystem. The county has placed more than 80% of its land area in what is called a Special Treatment (ST) zone, where a permit is required for development. The County will issue a permit, however, only in instances where development will not cause "significant environmental damage." If the County finds that such damage will occur and thus prohibits development, or if the landowner simply wishes to leave his land in an undeveloped state, he may transfer unused development rights to areas outside

of the Special Treatment zone. As of 1979, some 40,000 acres of land had been included in ST zones, and 374 residential units had been transferred to less environmentally-sensitive areas (see Spagna, 1979).

Two Maryland communities have also recently initiated TDR programs: Montgomery and Calvert counties. Montgomery operates a development rights bank, while Calvert County operates an "unfettered" program in which development rights are transferred on an open market. Calvert does provide assistance, however, in matching-up prospective buyers and sellers. Both programs are designed primarily to protect local farmland. In the case of Calvert County, development rights transfer is available only for parcels located either in a voluntarily-created "agricultural presentation district," or a "designated agricultural area" identified by the County. Landowners within these areas are generally allotted one development right per acre, although development rights are subtracted for existing residences and additional rights are allocated for existing lots of record. Owners of land within transfer zones can increase their allowable densities by one single family residential building lot for each five development rights purchased. Increased density may not exceed one dwelling unit per acre and in most cases one dwelling unit per two and one-half acres. If a landowner who has already sold his development rights wishes to subdivide a lot for a family member he may do so by purchasing five development rights from other landowners in the district. However, this lot may not be smaller than 25 acres.

C. Taxation and Fiscal Policies

The specific provisions included in this broad mitigative category are designed primarily to affect indirectly the use of hazardous parcels and the quantity and type of development to occur in storm hazard zones. In contrast to the public acquisition of storm-prone lands, a taxation policy might seek to reduce development by decreasing the holding costs of open space and vacant land, in turn reducing the opportunity costs of not developing such lands for more intensive uses. While the broad category of taxation and fiscal policy can entail numerous specific tools and mechanisms, primary attention in this paper is given to the following: preferential tax assessment, public facilities and services pricing policy, and the use of hazard impact taxes or special hazard assessments.

1. Differential Taxation

The use of differential taxation is based on the theory that by reducing the property tax burden on undeveloped parcels of land, this will decrease their holding costs and increase the profitability of their current uses, and in turn their ability to resist pressures to convert to more intensive uses. Almost every state now has a provision for some form of differential assessment (Coughlin and Keene, 1981).

The uses which are typically eligible for such reductions are farm and forestland, open space and recreational uses. These are all uses which could occur in coastal high hazard areas,

and which could in turn reduce the amount of property and people exposed to the storm threat.

Three basic variations of differential assessment are currently in use: 1) pure preferential assessment; 2) deferred taxation; and 3) restrictive agreements (see Keene et al., 1976). Under the first type of program, preferred land uses are assessed for local property tax purposes not at their fair market value (i.e., the potential development value) but rather at their value in their current uses. If the land is in farmland, for instance, it is assessed according to its value in this use (usually based on a state-determined capitalization formula). If the benefitting landowner decides after several years of receiving this lower assessment that he wishes to develop his land, he is still able to do so, without having to repay the property taxes foregone as a result of this lower assessment. In contrast to this pure approach, is that of deferred taxation. The difference here is that the landowner changing the use of his land is required to repay a portion of the tax benefits he received. This recapture period is, however, not typically very long, with five years perhaps average. In addition most states using this approach require the landowner to pay interest on these recaptured funds (although usually at a below market rate). A third approach, the use of restrictive agreements, is best exemplified by California's Williamson Act. Here, in order for qualifying landowners to obtain lower tax assessments they must be willing to enter into written agreements to keep their

land in its current use for a minimum period of ten years. This contract is a "rolling-front" agreement which is self-renewing each year unless the landowner explicitly notifies the locality of his intention to change the use. There are also provisions which permit the landowner to "break" his contract subject to certain penalties.

While differential taxation has been used in most states as a technique to preserve farmland, its effectiveness at retaining land in undeveloped uses is generally found to be low (see, for instance, Keene et al., 1976; Coughlin et al., 1981). Preferential assessment may indeed reduce holding costs somewhat or even substantially, but in the face of high market prices, and thus high opportunity costs of maintaining land in open space, the pressures to develop will generally far outweigh these incentives. Consequently differential assessment is likely to be most successful in circumstances (perhaps specific locations in the community) where development pressures are slight-to-moderate, and where landowners are actively interested in maintaining the present undeveloped use of the land.

Differential assessment will also be a more effective tool at reducing development of hazardous sites when used in collaboration with other approaches, such as the regulation of new development, the fee-simple purchase of land, and the transfer of development rights. For instance, reducing the permissible development density in a hazard location together with preferential assessment may reduce opportunity costs to the landowner

enough to reduce actual conversion of hazard lands to developed uses.

To maximize the effects of these tax benefits, a community should consider establishing mechanisms for funneling these benefits to those lands with the greatest hazard-reduction potential. This might entail, for example, the reduction of local assessments/rates of taxation in excess of what is provided under normal differential assessment provisions. This would provide greater tax benefits for parcels of open space, forestland, etc., which are designated as particularly hurricane-prone. Such additional tax benefits would be directly tied to the zones delineated on hazard boundary maps. Obviously, this approach would reduce local tax revenues, and thus in turn cost a jurisdiction more than the typical differential assessment program would. The extent of this cost would depend, of course, on the degree of property tax reduction deemed necessary to retard the conversion of hazardous parcels. Moreover, providing these additional tax benefits will raise significant questions concerning whether the community has legal authority for such a program. If this is viewed as a desirable policy direction it may be necessary to seek state enabling legislation.

2. Special Assessment and Impact Taxes

Building in, and inhabiting, high hazard areas often involves substantially greater public costs than in similar less-hazardous sites. These costs are seen when a hurricane or

or coastal storm strikes, or even threatens, a community. As we have already mentioned, there are, for instance, public costs of evacuation, search and rescue, temporary housing, the reconstruction of public facilities such as roads, utilities, water and sewer lines, and so on. One public policy approach is to acknowledge that such additional public expenses will exist as a result of permitting this development to occur and to attempt to assess those who will ultimately benefit for these expenditures. This can be accomplished through several means.

One alternative approach is to attempt to tie more closely benefits received and costs incurred through the use of cial benefit assessments. A common example is a special assessment charged to property owners benefiting from the public installation of curbs and gutters, or the improvement of roads, drainage, and sewer and water services. Such assessments are typically tied to a geographically-delineated district in which property owners are generally determined to receive a distinct and substantial benefit in excess of the general benefits received by the public at-large (Hagman and Misczynski, 1978). Applying this concept to storm hazard management, a community would thus be required to delineate an area in which "special storm services" are provided, and in which residents would be subject to the special assessment.

This approach raises a number of issues. The first is how the extent or magnitude of the special assessment is determined

and justified. This may require a number of assumptions, and rather rough estimates, about the public costs associated with an actual or potential hurricane. The magnitude of these costs will, of course, depend on the assumed size and severity of the storm event, among other things. The special assessment required to cover the expenses associated with a Category 5 hurricane (on the Saffir/Simpson Scale) will be substantially greater than those associated with a Category 1 storm. The actual delineation of a special assessment district is dependent on these assumptions as well.

An additional question has to do with the manner in which this assessment will be levied. A traditional approach is the use of an ad valorem property tax, in which the size of the levy for an individual property owner is a function of the market value of land and property. This is sensible from the perspective of ability-to-pay as well as the fact that it seems intuitively fair that those who have the greatest property at-risk ought to be required to contribute the most. An alternative basis is to assess an equal amount for each home or dwelling unit (or other similar units). The community must decide the most equitable approach.

A variation on this theme is the impact tax. Here the tax may be designed to recoup and mitigate the overall "impacts" of a project or development on the community at-large--impacts that may extend beyond the immediate environs and requirements of a project or development. For instance, while a

special assessment may be levied to cover the immediate costs associated with the floodproofing of sewer and water service, an impact tax might assess broader and perhaps more diffuse consequences, less clearly related to services or benefits received directly by a specific site or development. Rather, it is less an issue of direct and visible benefits received, so much as the negative impacts on the community created by the developer or landowner which must be mitigated. For example, the jurisdiction might levy an impact tax according to the extent to which a new project further reduces the overall ability of the community to evacuate in the event of a hurricane. While it may not be designed to cover the costs of a specific improvement or set or improvements by which the particular development will benefit in a unique and special way, it is designed to require the developer (and presumably future residents who purchase these properties) to compensate the public for the costs of these consequences.

Unlike a special tax assessment, and accompanying tax district, there may be greater freedom in how and in which areas of the community the proceeds are used. Under an impact tax scheme, it may be possible for the community to use proceeds to improve hurricane evacuation or to provide additional hurricane shelters in parts of the community quite distant from the development the impact tax is levied upon. The impact tax proceeds might, for example, be used to purchase hazardous land, which would in turn reduce overall community

risk, but which only indirectly benefits the contributing project or developer.

The impact tax may be instituted as a separate instrument, or more typically, attached to the exactions process during development review and approval (Hagman and Misczynski, 1978). The impact tax also usually represents a way of getting around court-imposed and legislative limitations on the extent of exactions permissable (i.e., for the installation of roads, sewers and other facilities, and the donation of open space, school sites, and other land) (Stroud, 1978).

How the impact tax is assessed is an important question. Commonly considered approaches are to assess the tax according to the number of bedrooms, number of dwelling units, or square footage involved. Which of these is closer as a proxy for impact will depend on the types of these community impacts the tax is meant to address, and the primary kinds of new development it will be imposed upon. If new commercial development is considered as substantial and as "impacting" as residential, a tax based on number of bedrooms will be inappropriate. On the other hand, if the primary concern is evacuation-ability, it may be an appropriate gauge. On the other hand, if public emergency services and reconstruction/recovery expenditures are the concern, the total amount or value of property at risk may be the most suitable indicator.

The impact tax in its ability to construct a formal system or procedure for calculating and assessing impacts, may

present a greater level of certainty for the developer than is the case under the exaction process, which may tend to be highly negotiated. Adjusting the expectations of the development community and creating a relatively clear and consistent set of public storm safety obligations on their part may be an important local objective.

D. Capital Facilities Policy

Coastal development--its type, location, density and timing--is highly influenced by capital facilities such as roads, sewer and water services. Such public investments have been aptly called the "growth shapers."

In this section we will briefly review the potential role to be played by the location, type and timing of capital facilities in reducing local storm hazards. Issues relating to the financing and pricing of these facilities have been discussed in a general way in the taxation and financial incentives section of this paper, and will not be repeated here.

Two primary dimensions to capital facilities emerge which have implications for local storm hazard mitigation: one is geographical (where will capital facilities be placed), and the other temporal (when will these be placed there) (see Nugent, 1976). With respect to the first dimension, a locality can develop an explicit set of capital facilities extension policies designed to avoid high hazard areas, thus reducing the amount of development and property which is placed at risk, and

reducing the potential threats to personal safety. This will only become an effective deterrent, however, if development in high hazard areas is dependent upon--or deems as highly attractive--the existence of these public facilities. For instance, if coastal development is able to obtain water through individual site wells, and disposing of wastewater through septic tanks, a reorienting of sewer and water facilities by the locality will do little to impede growth in hazardous zones. It may be necessary for the locality to foreclose other service/facility options available to development by restricting the issuance of septic tank permits, for example. Without valid health reasons, foreclosing such alternative options for development may be legally difficult

It is advisable that the community closely coordinate its environmental protection, health and other community objectives with those of reducing storm hazards. Restricting the depletion of coastal groundwater supplies, for instance, may also serve to advance the effectiveness of capital facilities policy at reducing the number of people and property at risk in high storm hazard areas.

Redirecting capital facilities, and thus the development which accompanies them, into "safer" areas of the community can be facilitated through several means. One is the clear delineation of an urban service area or district, in which the community agrees to provide certain facilities and services. This district would also likely entail a temporal dimension, for example including sufficient land to accomodate ten or

twenty years of future growth, under certain assumptions (e.g., alternative densities). Such a practice has several advantages. It provides a long-term perspective on growth and development, and permits developers, residents and the community generally, to visualize where and when such facilities will become available in the future (and in turn where they cannot be expected). This, in effect, modifies long-term expectations about where future development will and will not be acceptable to the community. Development pressures may tend to shift naturally as a result of this public designation, as developers, landowners and others realize that certain facilities will not become available outside of these designated areas. The provision and availability of facilities may determine the amount of overall development that can take place in a community, and suspicions of "no growth" objectives are often held. Designation of a service area in "safer" parts of the community, and a good faith effort to satisfy growth demands here, will tend to enhance the political and legal acceptability of such an approach.

In perhaps more intermediate terms, the community needs a policy instrument by which to systematically identify, finance and sequence specific capital improvements. This is typically the function of a capital improvements program (CIP). Ideally, the CIP follows closely designated service boundaries, as well as the comprehensive plan, zoning and other regulatory and planning provisions. The CIP provides a specific framework

for making short-term (i.e., each year) decisions about which improvements to make and where. Avoidance of storm hazard areas can be incorporated into this instrument and decision framework, as a specific CIP policy.

A close connection between the designation of service areas and the capital improvement program, and the overall planning process in a community (including the local comprehensive plan) is essential. Such a close link will tend to enhance their effectiveness in advancing overall community objectives, and their legal fortitude. From a practical standpoint, the concept of guiding growth through capital facilities should be closely linked to the objective of reducing the public costs of such facilities and the extent of public investment at risk in high storm hazard areas. The latter is, by itself, a legitimate argument for denying facility extension. This is a facility-related reason which is likely to enhance the legal standing of hazard-sensitive capital facilities extension policy (Nugent, 1976).

Post-Storm Recovery and Reconstruction

While most of the development management techniques described above are equally relevant to post-storm circumstances, there are certain factors which make the post-storm situation unique, and its decisionmaking demands special. The first of these factors is the multiplicity and magnitude of the tasks which must be undertaken in the post-storm context. They range

from such immediate concerns as the clearance of debris, the location of adequate water supplies, and the restoration of public utilities, to less immediate questions about redevelopment and reconstruction. An additional factor is that even those activities which are not immediate, do require relatively rapid actions and decisions, and even more rapid analysis and information-gathering, before such decisions can be made. A locality recovering from a hurricane or severe storm should be prepared to effectively manage this process and should have the appropriate institutions and tools available to bring this rational management about. The following sections examine these institutions and tools in a relatively general way. Again, we are concerned primarily with reconstruction, and will say little about how to go about organizing emergency and short-term recovery activities.

A Post-Storm Reconstruction Plan

A community should, to the extent possible, foresee alternative damage scenarios from hurricanes and severe storms, and have in place a set of policies or planning instruments which will facilitate post-storm decisionmaking. That is, a substantial portion of the reconstruction decisionmaking can in this way be undertaken prior to the actual storm event. This will permit a less pressured, and more deliberative set of decisions concerning reconstruction options. This in turn permits the focusing of the energies and attention of governing officials

after the disaster on questions of a highly "contingent" nature, which could not be completely foreseen prior to the event--or which were simply unexpected. The community should always be prepared to take stock of factors and circumstances that have not been considered (or not considered fully) in pre-storm planning.

Redevelopment Plan v. Reconstruction Policies

The actual output of pre-storm reconstruction planning can take several forms. On the one hand the community may develop very specific and detailed reconstruction/redevelopment plans, indicating sites and locations which should not be developed, areas where changes in uses and activities should occur during redevelopment, where certain capital improvements should take place, and so on. Such a detailed plan would provide a blueprint for reconstruction decisions after the storm. Its primary advantage is that it reduces the deliberation and decision-making pressures on local officials after the storm (assuming that local officials generally concur with the substance and content of such plans. One of the disadvantages of such a detailed redevelopment plan is that for it to be accurate it must be updated frequently (i.e., land use circumstances change). A second limitation is seen in the fact that it must make specific assumptions about the extent, location and nature of damages, as well as the political and economic opportunities which may emerge after the storm (e.g., the nature of demands to rebuild, amount of external

disaster relief). These are factors which undermine any very precise program or design for reconstruction.

In contrast, is the development of a set of general policies concerning reconstruction following the storm. This would provide general guidance to more specific reconstruction decisions following the storm. For instance, a reconstruction policy, may state that rebuilding shall not occur in areas where homes have been destroyed an average of 50% or more. This policy then, would not attach itself to a particular location or site until after the storm occurred. Such policies would simplify public decisions, but would depend heavily upon contingent factors and an analysis of the relationship between reconstruction and other community objectives. Such an approach has the advantage of being more flexible, and sensitive to the numerous contingent factors which will exist in the aftermath of the event. Such a plan or set of policies (whether a detailed redevelopment plan or more general reconstruction policies) should address at least the following issues:

- Identification and mapping of coastal hazards, and identification of high hazard areas (presumably occurring prior to the event), and a process for updating this information following the storm.
- A process for identifying the extent and nature of actual damages from the storm event, by geographical location and zone.
- Identification of instruments and tools that can be applied in the post-storm context to address hazard reduction goals. In the case of a detailed redevelopment plan these mechanisms may be designed to "spring into place" following the event. More general policy plans may simply identify the range of alternatives leaving for post-storm decisionmakers to choose which are most relevant.

- Identification of redevelopment opportunities (in addition to hazard reduction) that may be present should certain locations, types and magnitudes of damage result. Again, the extent of detail and advance precision can vary tremendously.
- Description of a post-storm decisionmaking process by which potential reconstruction decisions are structured and organized in logical fashion, and in which relevant actors and decisionmakers are brought together to solve reconstruction problems.

Institutional Structures and Frameworks

Post storm reconstruction places special decisionmaking pressures and requirements on community officials, which in turn require institutional and decisionmaking arrangements to cope effectively with them. Several of these specific arrangements are briefly described below. This discussion is meant to be exploratory and not intended to be our recommendation for organizing reconstruction--rather, possible approaches which may or may not be relevant in a particular situation.

Post-Storm Damage Assessment

Critical to public decisions concerning redevelopment and reconstruction is a clear understanding of the magnitude, type and causes of damages from the storm. Moreover, the assessment of community damages must occur quickly. A sensible approach is to prepare for the need by constituting in advance of the storm a damage assessment team. Such a team would be organized so as to come into existence immediately following the emergency

phase and should be comprised primarily of individuals with appropriate technical expertise (e.g., engineers, planners, building code specialists). Procedures for estimating and documenting the extent and nature of storm damages should be established in advance of the storm (e.g., damage assessment forms, field guide). Adequate local resources and authority must be invested in this group for an expeditious damage assessment.

Recovery Task Force

The creation of a special task force to deal with the unique issues and problems of reconstruction has occurred in a number of disaster circumstances, and is a result of recognition that normal local decisionmaking capability often needs to be supplemented. Such a task force (or multiple task forces) could have several possible functions. A primary function is to receive and review the damage and other analyses of post-storm circumstances, and to compare these circumstances with mitigation opportunities identified prior to the storm to discern appropriate areas for post-storm change and innovation. Where needed, it can review in a more specific fashion alternative mechanisms for bringing these changes about, and go about harnessing internal and external resources for achieving these ends. Essentially, then, a primary function of this group is comparing contingent factors and circumstances (physical, economic, political) with pre-storm mitigation opportunities, to arrive at and implement a set of post-storm changes. Such a

task force would also ideally undertake a similar process for non-mitigative community objectives and opportunities. Among these other goals which would be considered during reconstruction decisionmaking might be the following:

1) Enhancement of local recreational and open space opportunities; enhancement of public access to beach and ocean.

2) Enhancement and restoration of local natural ecosystems.

3) Reduction of traffic congestion, noise, and other transportation-related problems.

4) Enhancement of the long-term economic vitality of the local commercial and industrial base.

5) Others.

The ease with which opportunities can be capitalized upon in the aftermath of a hurricane will be in large part dependent on the extent and nature of the damages incurred (Ciborowski, 1981). That is, if in an impacted area destruction is both widespread in terms of the number of structures affected and the extent of damage for each structure, substantial changes in land use patterns will be more feasible. The greater the variation and mixture of these damages, the less likely are major land use changes during reconstruction. The existence of undamaged or moderately damaged homes and buildings will tend to increase the political resistance to such changes.

The extent and size of this damage area will in turn determine the magnitude of the mitigative opportunities which are feasible. Substantial redirecting of urban settlement patterns away from high storm hazard areas will simply not be possible in

circumstances where the damage area is relatively small. However, less ambitious mitigative programs may be more appropriate and feasible in these circumstances (e.g., the purchase of smaller damage sites and their use as open space).

It is important to remember as well that hurricane damages may open up the possibility of changes in land uses which are responsive to various community objectives not related to hurricane hazard mitigation. Destruction from a hurricane may provide opportunities to advance these objectives, and the community should be prepared to act quickly to capitalize upon the circumstances. The recovery task force can serve as the body which oversees and advances this "opportunities-pursuing" process. Again, ideally the task force would be guided by (in varying degrees of specificity) the reconstruction policies and redevelopment plans developed before the storm hits.

The composition of this body is an important question. For it to effectively advance mitigation (and other) opportunities it must have sufficient local political clout. This implies the need to have as diverse a committee base as possible represented on the committee, with major community groups and interests having a hand in the deliberative process. This objective, however, must be balanced against the need for such a body to make relatively quick decisions concerning reconstruction.

Reconstruction Moratoria and the "Triage"

One approach to manage redevelopment after a storm is to institute a moratorium. While this approach has already been briefly discussed in a previous section of this paper, a few remarks on its application in the post-storm phase are appropriate. Rogers, Golden and Halpern (1981, see Chapter 5) have developed an elaborate and relatively detailed set of guidelines for the reconstruction of Sanibel Island (Florida), outlining steps, issues and opportunities to be addressed during reconstruction. They suggest the need to establish a moratorium on the construction of new buildings and the reconstruction of damaged buildings in particular locations of the island, and a "triage" process for organizing damage areas and the particular decisions which must be made with respect to them. A "Recovery District Map" would identify the areas subject to this moratorium as well as other affected areas. Based on damage assessment maps and preestablished criteria, land would be classified in one of three zones:

- a "redevelopment district,"
- a "restoration district," or
- an "impacted district."

Redevelopment districts would encompass areas of severe damage, while impacted areas, on the other extreme, would entail properties of little or no damage. Restrictions in each district would be instituted commensurate with the extent of destruction

and the nature of the hazard in that zone. (See Haas et al., 1977, for this original idea.) The idea appears to have a medical analogy in the separation of critical and non-critical patients during an emergency. "Through the process of establishing the Recovery Districts, the areas most heavily damaged are insulated by a reconstruction moratorium from other areas where repair and restoration are allowed to proceed." (Rogers, Golden and Halpern, 1981, p. 4-86).