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FLOODING

A Staff Working Paper

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Note: This staff working paper is one of a series of Issue and Policy Alternative Papers presenting facts, analyses, and conceptual policy alternatives on coastal resources and coastal land and water uses. The purpose of this draft document is to stimulate discussion and comments that will assist preparation of the management program for the New Jersey coastal zone.

This report was prepared in part with financial assistance from the National Oceanic and Atmospheric Administration under the federal Coastal Zone Management Act, P.L. 92-583.

Comments, criticism, additions, and suggestions are welcome and should be addressed to the New Jersey Office of Coastal Zone Management.

CONTENTS

INTRODUCTION

The ever-increasing growth of flood damages with social, economic and ecological consequences in the State results from man's unwise use of lands susceptible to flooding. Therefore, particularly in view of the rapid population growth and trend toward greater urbanization, there is an urgent need for intelligent planning and regulation of use of lands susceptible to flood hazards.

This paper is intended to further debate on important flooding issues. The first section briefly defines these issues in the coastal area and then presents alternative policies which could be part of the coastal zone management program in New Jersey.

Section III provides physical characteristics and natural functions in New Jersey's coastal area flood plains.

Section IV analyzes natural and man-made problems related to flooding. Two appendices conclude the paper. The first appendix discusses possible management tools which could be used to implement flooding issues. Finally, are the sources used to support the text.

I. ISSUE

Floods have caused extensive damage to property in New Jersey as a result of improper and continued encroachment on river flood plains. Flood damage is the inevitable consequence of flood plain occupance by permanent structures. Streets, housing developments, apartment complexes, and shopping centers are replacing farms and woodlands.

Urbanization outside the flood plains also influences flooding. This urbanization results in loss of important flood plain storage, but it also procuces greatly increased runoff. It has been found that the loss of flood plain storage and increased runoff, particularly on small streams, can double or triple the peak discharge on downstream reaches. The result is in more frequent and intense flood.

Related issues include loss of visual amenity of the streams, alteration of stream channel geometry and alteration of stream biology.

Continued growth is expected and will increase competition for available space. Careful guidance and planning of future development will be required to insure optimum land use. Effects of flooding are necessary consideration in planning land use and development, in designing culverts, bridges, and drainage systems, and in establishing flood insurance rates.

II. POLICY ALTERNATIVES

A comprehensive flood plain management plan could be adapted for each watershed. A wide range of policies would be adopted to reduce flood losses and correct or prevent problems of water sùpply, pollution control, increased runoff from impervious surfaces, fish and wildlife, soil conservation surfaces, fish and wildlife, soil conservation and recreational. Flood plain policies can play a principal role in guiding public and private land uses consistant with such a plan.

Alternative policies include:

1. Flood plain managment techniques such as flood control works could be encouraged for areas that are already intensively developed and subject to major flood damages.

2. Buffer Zones, a land strip on each side of the stream bed, could be maintained to preserve the natural environmental qualities and function of the land to purify water before it reaches the streams. The boundary of the buffer zone may float or be adjusted according to the character of the adjacent lands. The following criteria will be used in determination of the boundary:

   (a) Soil characteristics such as infiltration rate, depth to seasonal high water table.

(b) Types and amount of vegetative cover. Of special interest is the vegetation with water purification capabilities and soil stabilizing characteristics.

(c) Slope

(d) Critical distance from water bodies

Criteria could be established to determine the land uses which would be discouraged from the buffer zone. Criteria would include: impervious surfaces, filling and structures that raise water surface elevation of flood flows, activities that places, deposits or dumps any waste, etc.

Acceptable land uses would include: public parks, forests, nature preserves pasture, recreation areas, etc.

3. Regional surface runoff control and associated planning measures could be adopted. These would apply to many aspects of the development. Criteria to identify permissible types of development include impervious surfaces, soils with high infiltration rates, surface storage areas, vegetation cover, the size of the watershed, etc.

III. PHYSICAL CHARACTERISTICS AND NATURAL FUNCTION

According to Ch. 185 of the Public Laws of 1972 of New

Jersey (N.J.S.A. 58:16A-50 et seq.) a flood plain is "the relatively flat area adjoining the channel of a natural stream which has been or may be hereafter covered by flood water." In fact, a flood plain is a dynamic landform created and maintained by processes of inundation, erosion and deposition, its features and limits may be altered dramatically by floods in only a few hours or days. A typical flood plain is characterized by various features including point bars, meander scrolls, sloughs, natural levees, swamp or marsh deposits, and sand splays. These features are present along the undisturbed reaches of the streams and rivers in New Jersey.

A stream channel is carved naturally to contain the more common low discharge rates of flow. The channel and the flood plain, together, are adapted to contain the high discharge rates which result in overbank flow, the flow which overtops the natural or artificial banks of a reach of river channel. Far from being extraordinary occurence, overbank flow is a natural and frequent response of a stream to increased hydrologic loads. Storm flood-waters are stored in the flood plain during episodes of overbank flow. As flow energy is depleted, floodwaters cannot maintain their sediment load in suspension and deposit much of it on the flood plain. New Jersey supports two major types of flood plains: the flood plains of Northern New Jersey and the flood plains of Southern New Jersey. North Jersey flood plains are formed on rock typical of the ridge and valley, highlands, and piedmont geological regions or on more recent materials deposited by continental ice sheets. South Jersey type flood plains are formed on the unconsolidated sands, silts, gravels, and clays typical to the coastal plain region. North Jersey flood plains are characterized by well developed valley sections, and the sediments contain large amounts of coarse fragments such as gravel, cobbles, and stones. South Jersey flood plains are characterized by poorly developed valley sections, and the sediments are chiefly sands, silts, clay and gravel.

Flood plain soils are classified by SCS are generally poor drained and are affected by flooding and a high water table. The surface layer ranges in texture from silt loam to sand which is about 10 inches thick. The subsurface layers range in texture from sand to clay loam or clay. Other areas are composed of highly organic materials. Recent alluvium and organic soils occur on flood plains where slopes range from 0 to 2 percent. Old alluvium soils, susceptible to occasional flooding, occur on terraces comprised of well drained to poorly drained soils.

Flood plains support vegetation which reflects the dynamic, frequently changing environment. Vegetation found on North Jersey flood plains consists largely of:

a. trees - pin oak, red maple, ash, elm, swamp white oak, black gum, silver maple, yellow birch, basswood, tulip, willow, sycamore, box elder, river birch;

b. shrubs - spice bush, witch hazel, arrow-wood, viburnum, alder;

c. herbs - skunk cabbage, spring herbs, sedges, and mosses.

Vegetation found on South Jersey flood plains consists largely of:

a. Trees - sweet gum, red maple, beech, willow oak, southern red oak, swamp white oak, tulip, sweetbay, black gum, southern white cedar, white oak, pond pine, basket oak;

b. shrubs - spice bush, cranberry, high bush, blueberry, sweet pepper bush, swamp azalea, leather leaf, greenbrier;

c. herbs - arrowhead, skunk cabbage, pitcher plant, chain fern mosses, sedges.

The flood plains provide habitat and food for racoon, otter, mink, beaver, muskrat, rabbit, pheasant, goose, grouse, woodcock, black duck, blue-wink teal, and many other species.

Flood plains and streams, together, provide diverse biological habitats that support numerous fish and game species for which man hunts, fishes and traps.

Intimate relationships exist among the stream, periodic flooding vegetation and wildlife. Leaves debris, logs, etc., found on the floor of the flood plains provide food and cover for invertebrates, amphibians, and reptiles.

Periodic flooding of lowland areas, marshes, and swamps adjacent to stream channels produces a rich physical-chemical environment. As floodwaters subside, silt (minerals and their absorbed chemical load) and organic matter are deposited. The fluctuating water levels not only serve to replenish nutrients and organic matter, but also favor rapid nutrient recycling and subsequent high rates of primary and secondary production. In terms of primary production, such communities are among the most productive of natural systems. Other natural functions of flood plains include: absorbtion and dissipation of the energy of floodwaters, thereby reducing downstream destruction. Also, flood plains store flood waters, thereby reducing inundation of adjacent lands. Flood plains act as sediment traps, removing sediment loads from stream and providing rich soil for agriculture.

IV. ANALYSIS

The extent of the threat to the public health, safety and welfare for any particular flood depends upon other factors including intensity and location of precipation, antecedent moisture conditions, soil, topography and land use.

New Jersey is situated along a major storm track "corridor." Hurricanes originating off the Carolinas, in the Caribbean or in the Gulf of Mexico, continental disturbances forming over western U.S. land areas and polar storm arising in Canada all frequently strike New Jersey. Fortunately, actual flooding during the past 60 years, although often severe, is far below potential. Floods of great magnitude could occur at any time.

Intensity, duration. and frequency or precipitation influence runoff. Runoff occurs when rainfall intensity exceeds soil infiltration. As rainfall duration increases, infiltration rates decrease, as the ground becomes saturated and runoff increases. When rainfall frequency is high, water in the ground does not have time to drain away resulting in increased runoff.

Other factors influencing the rate of runoff after precipitation reaches the ground surface are: antecendent moisture conditions, soils, topography, cover. Antecedent moisture condition is the degree of soil saturation before a rainfall. As the antecedent moistrue condition increases, so does runoff.

Soil is composed of particles and spaces, called pores, between particles. Infiltration, the movement of water into soils, depends on soil texture, the size of soil particles and soil structure, the way they are clumped together. Fine textured soils produce more runoff than coarse textured soils.

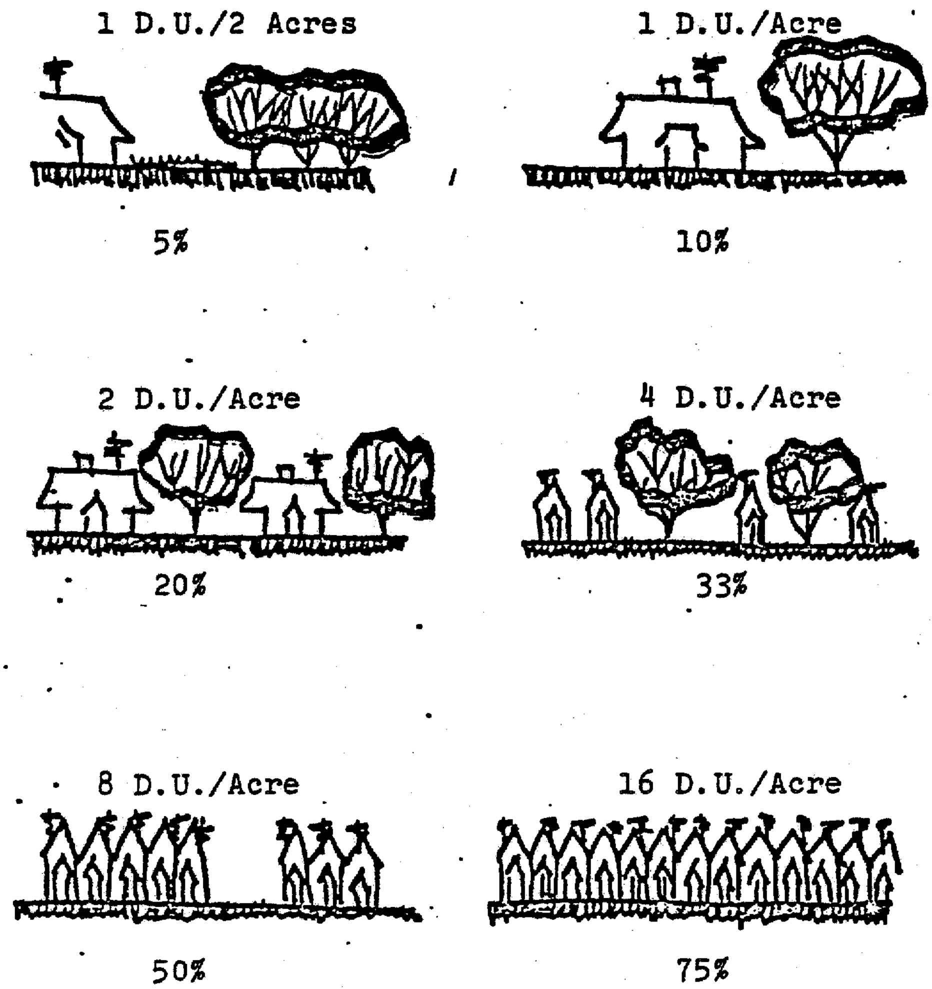
The better the soil structure, the less runoff is produced. Any action affecting the size, shape, and continuity of pores effects surface runoff. Compaction of soil destroys structure. Clogging fills in pores. Both decreases infiltration and increases runoff. Areas with steeper slopes increase the rate of runoff.

The type of cover, natural or man-made, on the ground influences runoff. Forests produce little runoff. A large leaf area intercepts rainfall and a thick litter layer absorbs the remainder. On agricultural land clogging occurs on exposed soils and runoff rates are high.

Pastures and old fields in good condition produce little runoff. The large number of plant stems per unit area slows down and breaks up runoff.

Impervious surfaces as roads, rooftops, driveways and parking lots, increase runoff. Water, not penetrating through these materials runs off. Figure 1 shows various percentages of impervious surfaces associated with development. Figure 2 shows runoff and infiltration rates for various lands uses.

Urbanization affects the flood runoff in at least two ways: (1) the volume of water available for runoff increases because of reduced infiltration of rainfall over man-made impervious areas. Modern suburban development has been found to increase mean annual flood discharges by up to 80 percent,



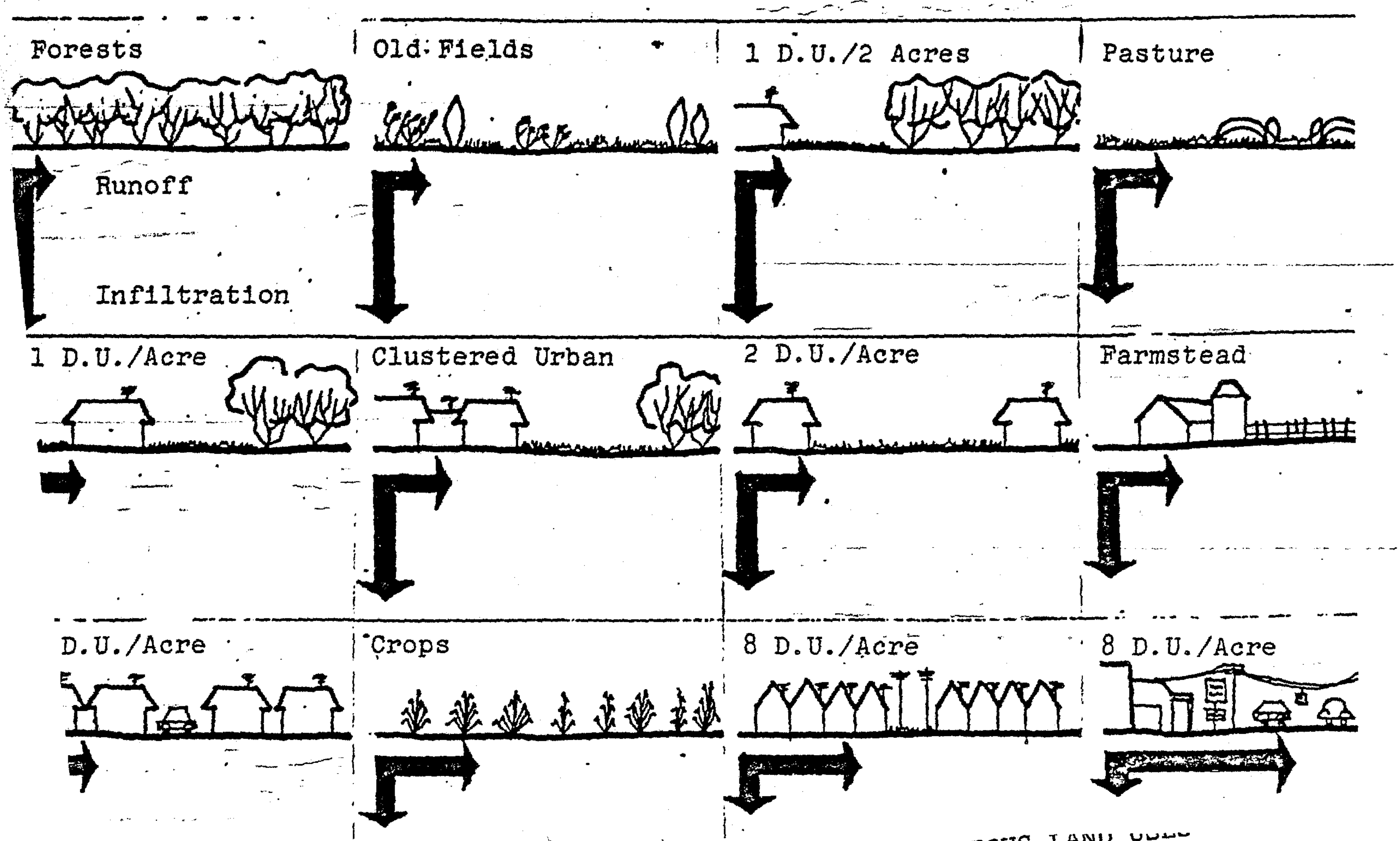
PERCENT IMPERVIOUS SURFACES
FOR VARIOUS LAND USES

Source: "Hydrologic Effects from Urbanization..."
Lull & Sopper, 1969

Figure 1

(2) changes in hydraulic efficiency associated with artificial stream channels, curbing, gutters, drains, and storm sewers increase the magnitudes of flood peaks because runoff time is shorter.

Research by Luna B. Leopold shows a relationship between impervious surfaces, storm sewers and flood frequency and level. Figure 3 shows a 500% increase in the peak flow of the mean annual flood can be expected to occur as an area

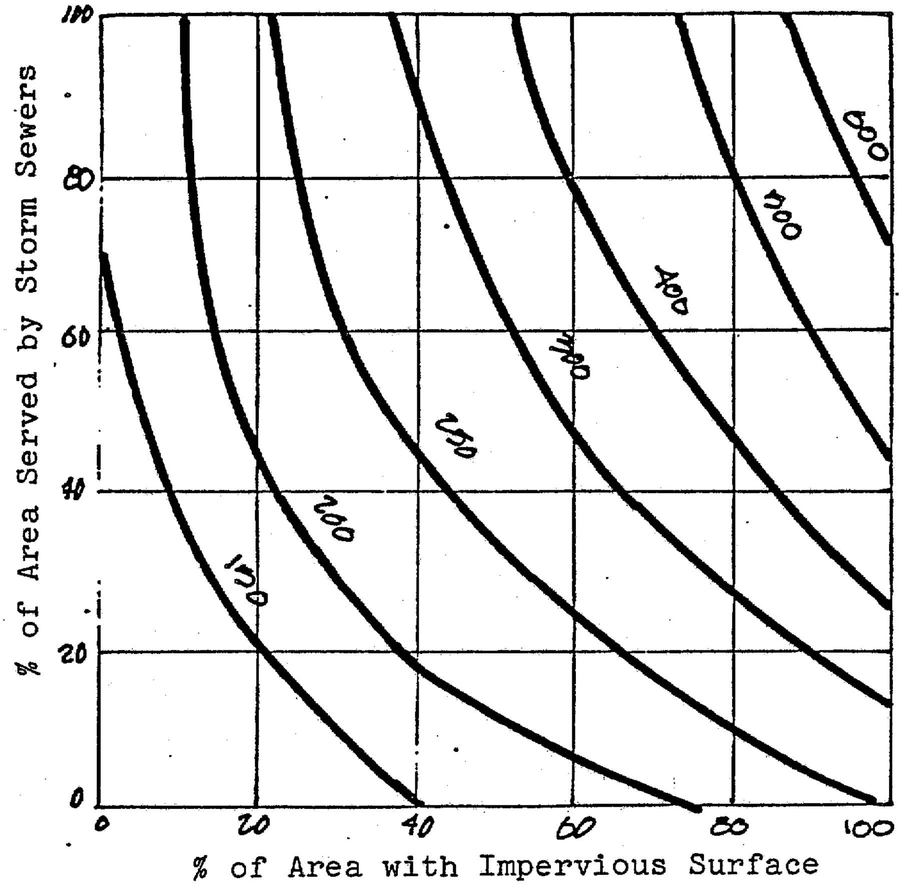


RUNOFF AND INFILTRATION RATES FOR VARIOUS LAND USES

Figure 2

becomes 80% storm sewered and 40% storm sewered and 40% paved, the number of floods per year can be expected to increase by 300%, Figure 4. When flood levels increase the area inundated increases. Development once beyond flood levels now become inundated, Figure 5.

When peak flows increase stream velocities increase eroding stream beds and banks. Leopold reports if a channel capable of carrying 55 CFS at bankfull stage must, due to urbanization, accomodate a bankfull stage of 150 CFS, its depth would increase 50% and its width 100%. If such erosion occurred along at least 1/4 mile of channel length, 2500 tons of sediment would be produced.

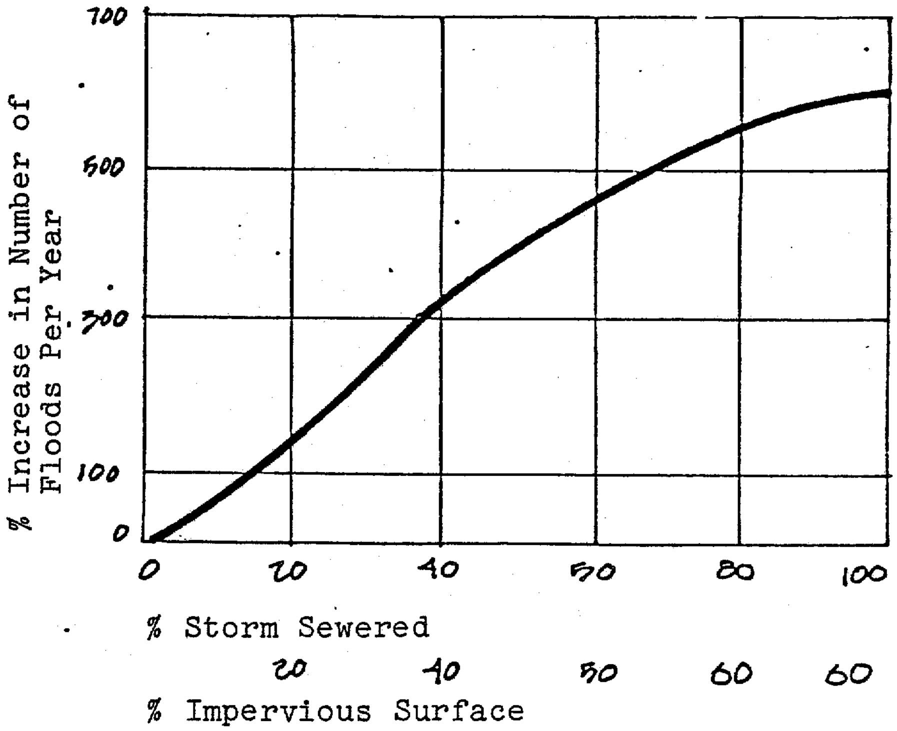


% INCREASE IN PEAK FLOW OF MEAN ANNUAL FLOOD WITH URBANIZATION

Source: Leopold, Luna B., "Hydrology for Urban Land Planning..." Geological Survey Circular 554, 1968

Figure 3

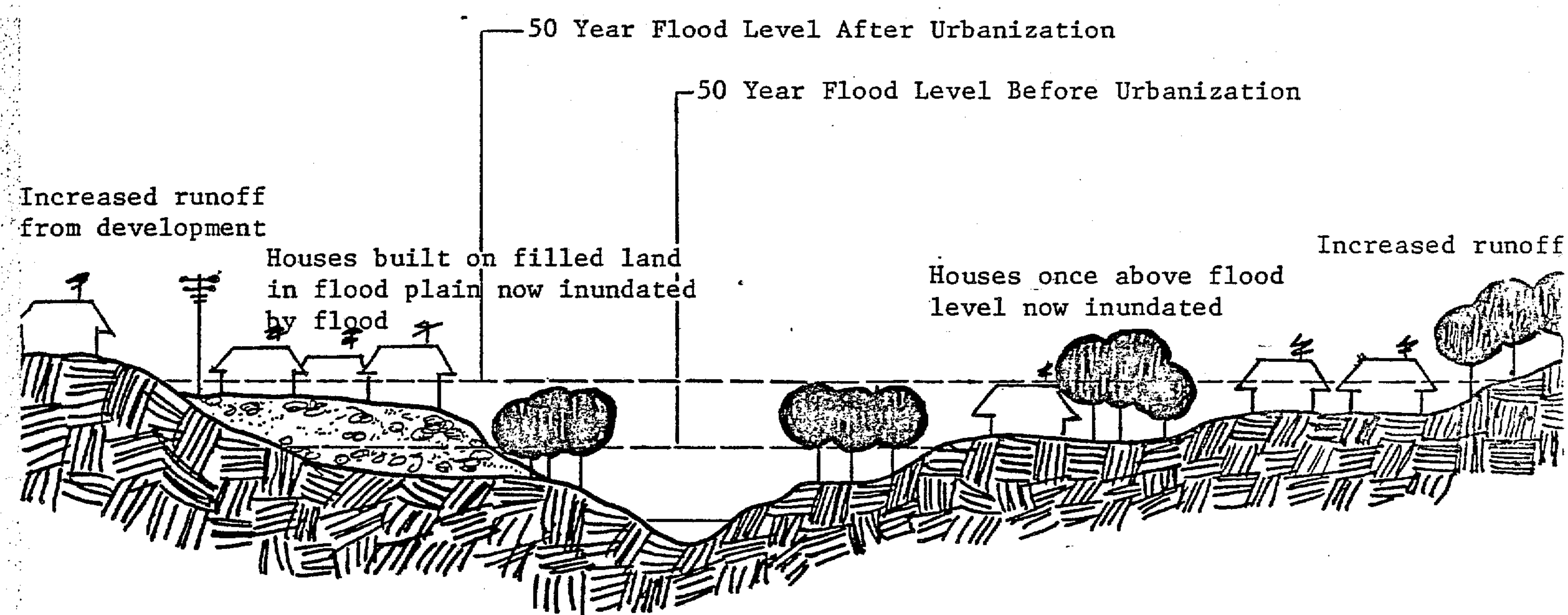
As increase of stream bank erosion as a result of an increase in runoff produces an increase in stream load, suspended soil particles. As a result, light penetration, photosynthesis rates and available oxygen are reduced. Riparian vegetation that once shaded and cooled streams is undermined and lost. Water absorbs heat as it flows over impervious surfaces and upon entering streams raises stream water temperatures. Less oxygen becomes available as water temperatures rise. As a result, animal populations alter and decline. Sedimentation in stream beds fills in depressions and holes, eradicating habitats.



% INCREASE IN NUMBER OF FLOODS AT VARIOUS LEVELS OF URBANIZATION

Source: Leopold, Luna B., "Hydrology for Urban Land Planning..." Geological Survey Circular 554, 1968

Figure 4



INCREASE IN FLOOD LEVELS AS A RESULT OF URBANIZATION

Figure 5

Runoff from agricultural areas carries animal wastes, fertilizers, soil herbicides and insecticides into streams. Plant and animal life is consequently altered and eliminated in polluted waters. An increase in nutrient considerations in streams results in the growth of plankton and algai hastening eutrophication.

Eroded muddy banks, turbid, polluted, foul smelling water, lack of life and accumulation of trash and debris destroys the amenity of a stream.

As flooding increases more tax dollars are spent on flood control. As flooding becomes more severe existing reservoirs offer less protection. Sedimentation decreases reservoir storage capacity. Existing reservoirs must be maintained and dredged. Erosion undermines bridges spanning streams. Existing bridges will have to be maintained, rebuilt or replaced at great expense. Eutrophication and pollution downstream by faster currents may cause damage to structures downstream. To avoid erosion stream banks must be reinforced and maintained. Increased public expenditures, to correct problems initiated by improper development, results.

V. <u>CONTRASTS BETWEEN COASTAL AND RIVER FLOOD HAZARD AREAS</u>

The main damage factor in coastal flooding is wind-driven waters caused by the coincidence of storms and high tides. In contrast, precipitation causes river flooding. Coastal flooding is usually of shorter duration than river flooding. However, waves, winds, erosion and salt water intrusion are often significant problems requiring special treatment. The need to protect beach areas which slow incoming waves is also a special consideration in coastal flood hazard areas (see the Sand Movement and the Shoreline Issue Paper.)

There is no coastal hazard area comparable to the river's "floodway" which must be maintained free of obstructions to convey flood flows. This is perhaps the most important difference between regulation for coastal and river areas. Coastal regulations are not designed to preserve flood flows yet high hazard coastal areas deserve special attention. Beaches and shorelines are buffeted by high waves that destroy all but the strongest structures. At some locations special regulations are needed to protect dunes and other natural protective barriers which blunt the force of wind and waves and minimize property damage. Many coastal communities are constructed at the confluence of a river and the sea, a location subject to both river and coastal flood problems. Here regulations pertaining to both sorts of problems are needed.

APPENDIX A

MANAGEMENT TOOLS

Pollution control and flooding are intimately associated in urban and rural areas. Flooding policies developed for coastal zone management must be attuned to preservation of life and property as well as minimizing non point source pollution resulting from stormwater runoff. Thus, the coastal zone management plan and areawide waste water treatment plans developed under Section 208, FWPCA, should be consistent to the maximum extent or practicable.

Authority to manage flood plains in New Jersey is posited on two statutes and companion regulations. Stream Encroachment permits are required pursuant to N.J.S.A. 58:1-26 et seq. No structure within the natural and highwater mark of any stream may be accomplished without notice to the State Water Policy Commission and obtaining a DEP permit.

The DEP permit program covers the following types of activities.

Stream Encroachment Projects - These projects are minor alterations within the channel and floodplain that do not adversely affect the water carrying capacity of the floodway, do not increase erosion or sedimentation from the site and do not require channel modification or relocation.

Utilities - Any utility to be constructed under or over a channel, or along and within the flood plain requires a permit.

Fills and Excavation - Any fill and excavation project requires a permit.

Permits are also required for any fill, excavation, relocation, or other construction that will change the characteristics of a channel except for walls, bridges, or culverts. Additionally, any structure to be placed within or along the channel or flood plain requires a permit.

Within the coastal area, flood buffer zones may be used as conditions or preconditions of permits issued pursuant to N.J.S.A. 13:19-1 et seq. A major concern of the CAFRA permit decision Tranquility Park CA 75-4-104 was flood plain management. This permit application was denied on several grounds. With regard to flood plains the opinion noted that the applicant had made no attempt to limit development in the flood prone portion of the project site. The Department did, however, encourage the applicant to resubmit a plan which would, among other things, limit the amount of construction in the flood prone area.

Buffer zones, a land strip on each side of the stream, can be developed using several criteria. Two important criteria, slope and soil characteristics, can be developed pursuant to the recently enacted Soil Erosion and Sediment Control Act N.J.S.A. 4:39-1 et seq, jointly administered by the Department of Agriculture and Environmental Protection.

Any development project which disturbs more than 5,000 square feet of the surface area of land for the accommodation of construction must receive the certification of the local soil conservation district which will use the statutory standards in the certification applications. Standards promulgated under this act are divided into vegetative standards and engineering standards. The engineering standards include land grading, diversions, floodwater retarding structures, channel stabilization, slope protection structures and subsurface drainage.

Pursuant to N.J.S.A. 58:16 A-55, the Department of Environmental Protection is authorized to delineate and mark flood hazard areas and adopt rules and regulations concerning the development and use of land in a designated floodway. DEP also has the authority pursuant to N.J.A.C. 7:13-1.2 et seq. to prohibit certain uses of the floodway. Prohibited uses include solid waste disposal, structures of occupancy, storage of any type and construction of individual septic systems for residential, commercial or industrial buildings.

Regional surface runoff controls may be developed under the authority of N.J.A.C. 7:13-1.2 et seq. Additionally, N.J.S.A. 58:16A-1 et seq. authorizes State and Municipal participation on federal flood control projects.

The power of municipalities to control flooding through the zoning mechanisms has been curtailed by the case of

Morris County Land Improvement Co. v. Township of Parsippany-Troy Hills 40 N.J. 539, 139 A2d 232 (1963). The Morris case involved an attempt to protect a 1300 acre swamp through the municipal zoning process. The Morris County Land Improvement Co. operated a sand and gravel plant in a portion of the swamp in an adjacent township and wanted to use 66 acres of swamp in Parsippany-Troy Hills for fill. The swamp had been zoned residential but in 1934, it was placed under a highly restrictive zoning ordinance, the company used some of the land for fill and in 1960 the township reacted by passing a new zoning ordinance creating a "Meadows Development Zone" to protect the swamp. The company sought a variance which was denied and suit was filed challenging the constitutionality of the ordinance. The town's defense was posited on two grounds - that the area acted as a flood water retention basin which helped reduce downstream flooding. The court decided that a municipality could not consider the downstream flooding effects in creating its zoning ordinance, but it could consider local flooding effects. The case, however, represents an anaimoly and is inconsistent with an entire line of cases which requires municipalities to consider the effects of zoning decisions on nearby municipalities. De Simone v. Greater Englewood Housing Corp. No. 1 36 N.J. 428, 267 A2d 31 (1920), Oakwood at Madison Inc. v. Madison Township 117 N.J. Super 11, 283 A2d 353 (1970), Southern Burlington County NAACP Township of Mt. Laurel 67 N.J. 151 (1975).

APPENDIX B

SOURCES

SOURCES

1. Thurow, Chrles, William Toner and Duncan Erley. "Performance Controls for Sensitive Lands: A Practical Guide for Local Administrators," U.S. Environmental Protection Agency.

2. Caputo, Darryl, Michael Hochman, and Stewart Hougen. Ecological Planning: Water Resources Study on the Assunpink Water," Master Thesis, University of Pennsylvania (1973).

3. Stankowski, Stephen. "Magnitude and Frequency of Floods in New Jersey with Effects of Urbanization." U. S. Geological Survey in cooperation with NJ DEP (1974).

4. Anderson-Nichols Co. Inc. "Basin-Wide Program for Flood Plain Delineation" Delaware River Basin Commission (1973).

5. State of New Jersey, Department of Environmental Protection, "Basis and Background for Proposed Land Use Regulations in Flood Hazard Areas" DEP (1974).

6. United States Water Resources Council, "Regulation of Flood Hazard Areas to Reduce Flood Losses" Volume #2, Parts V-VI. WRC (1972).