FLOOD DAMAGE MANAGEMENT

Flood hazards are caused by building in flood-prone areas. Floods cannot be prevented, but the damage they wreak on man-made properties can be managed, either by altering the flood potential of an area or by avoiding construction in locations subject to flooding. Historically, flood damage management in the United States has focused on the former management technique, attempting to divert floods with structural flood controls–dams, levees, and channel modifications. However, such flood control measures have proved unsatisfactory over time.

Structural flood control projects have tended to encourage development in high hazard areas, often without appropriate land use planning. When a storm exceeds or violates the design parameters of a flood control structure, the damage that results from a flood can exceed what would have occurred if the structure had not been built. For example, floodplain invasion often occurs where levees have been built with the intention of reducing damage to agriculture. Although in some regions levees have reduced the number of high-frequency floods, in general they cause conditions favorable for their own failure by altering erosion patterns and increasing stages.

Recognition of the cost of development in high-risk areas, the uneven distribution of flood hazards on the landscape, and the natural and beneficial values of floodplains have led to more common adoption of nonstructural flood hazard management techniques. In particular, land use management and modified building practices are finding widespread acceptance.

Information on flood damage management and floodplain and wetland conservation is available from the Federal Emergency Management Agency (FEMA), the Natural Hazards Research Applications and Information Center, the U.S. Army Corps of Engineers, the Environmental Protection Agency, the National Park Service, and state and local agencies.

FLOOD HAZARDS

Most flood damage is caused by weather conditions such as hurricanes, fronts associated with midlatitude cyclones, thunderstorms, and melting snow packs. These conditions interact wtih surface features such as floodplains, coasts, wetlands, and alluvial fans, resulting in floods, mudslides, and erosion. Geologic phenomena such as earthquakes may also trigger floods.

Weather and climate information is available from the National Climate Data Center, regional climate research centers, and state climatology offices. Geologic and hydrologic information is available from the U.S. Geological Survey and state geological and geographical surveys.

FLOOD-PRONE AREAS

FLOODPLAIN: The relatively flat area within which a river moves and upon which it regularly overflows.

Rivers typically meander over their floodplains, eroding the cutbank and redepositing sediments in accretion zones such as point bars, meander belts, and natural levees. Channel shifting may be extreme in alluvial fans. Coastal floodplains, which include barrier islands, shores, and wetlands, have the same relationship to the sea that riverine floodplains have to rivers.

WETLANDS: areas characterized by frequent flooding or soil saturation, hydrophytic vegetation (vegetation adapted to survival in saturated areas), and hydric soils (soil whose chemical composition reflects saturation). Wetlands are often found in floodplains but are more restrictively defined.

FLOOD TYPES

Floods may be classified by their locations or physical characteristics.

RIVERINE FLOOD: great overflows of water from a river channel onto a floodplain caused by precipitation over large areas, melting snow, or both. Over-bank flow is a normal geophysical event that occurs on average every two years for most rivers.

HEADWATER FLOOD: a riverine flood that results from precipitation directly in a basin.

BACKWATER FLOOD: a riverine flood caused by high stages on downstream outlets, which prevent drainage from tributary basins or even reverse the flow.

COASTAL FLOOD: overflows onto coastal lands bordering an ocean, estuary, or lake. Coastal floods are caused by tsunamis (seismic sea waves), hurricanes, and northeasters.

FLASH FLOOD: a local flood of great volume and short duration. Flash floods differ from riverine floods in extent and duration. Flash floods generally result from a torrential rain or "cloudburst" covering a relatively small drainage area. Flash floods may also result from the failure of a dam or sudden breakup of an ice jamb.

FLOOD RISKS

Flood risk is usually expressed as the estimated annual frequency with which a flood equals or exceeds a specified magnitude. The flood risk for a future period of time is the joint probability of the occurrence of the annual flood risk. For example, if a house is situated at the "100-year flood" elevation (1% annual exceedance frequency), then its flood risk for a 30-year period is 26% or approximately a one in four chance it will be flooded to the specified depth or greater.

STANDARD PROJECTED FLOOD (SPF): a flood that may be expected from the most severe combination of meteorological and hydrological conditions characteristic of the geographic area in which the drainage basin is located, excluding extremely rare combinations.

SPFs are used in designing dams and other facilities with high damage potential.

PROBABLE MAXIMUM FLOOD (PMF): the most severe flood that may be expected from a combination of the most critical meteorological and hydrological conditions reasonably possible in a drainage basin. (This term is not a statistical concept.)

PMFs are used in designing high-risk flood protection works and in siting structures and facilities that must be subject to almost no risk of flooding.

LAND USE IN FLOOD ZONES

Land use management is the most effective method of managing flood damage. State control of land use in hazardous areas, authorized by the police-powers clause of the U.S. Constitution, is usually delegated to local planning and zoning boards. Local, state, and federal governments also regulate ecosystems essential for flood damage management, such as wetlands, coastal dunes, and mangrove stands. Land use management often includes setback regulations, which attempt to limit flood-related erosion damage. Regardless of regulations imposed by the government, developers should evaluate building sites for their intrinsic suitability for the intended use.

The National Flood Insurance Program (NFIP) requires that participating local governments adopt minimum floodplain management plans based on data provided by the federal insurance administrator. The NFIP does not require local governments to adopt land use or transportation plans that require preferential development of hazard-free areas or prohibit development of land in high-hazard areas. New construction in coastal zones is required to be located landward of the reach of the mean high tide. Local land use and development or floodplain management plans that are more stringent than NFIP requirements supersede NFIP requirements. The NFIP divides riverine floodplains into floodway and floodway fringes for land use management. Coastal floodplains are divided into coastal high-hazard areas and coastal fringes. Land uses in these areas should always be verified with local agencies.

FLOODWAYS

Floodways include the channel of a watercourse and those portions of the adjoining floodplain required to permit the passage of a flood of specified magnitude at no more than a specified level above natural conditions. The NFIP requires floodways to be large enough to accommodate floods with a 1% annual exceedance frequency (100-year flood) without causing an increase in water levels of more than a specified amount (1 ft in most areas). Some localities object to the acceptability of increased flood levels this NFIP requirement implies. Instead, they define the floodway as the area inundated by floods with a 4% annual exceedance frequency (25-year flood).

Uses permitted in a floodway are those with low flood damage potential that do not obstruct flood flows or require structures, fill, or storage of materials or equipment. Fill is prohibited, and most structures are strongly discouraged. The following uses are generally permitted:

FUNCTIONALLY DEPENDENT USES: facilities and structures that must be located close to water in order to function, such as docking and port facilities and shipbuilding and repair facilities. Water supply and sanitary sewage treatment plants must be floodproofed if they must be located adjacent to bodies of water.

AGRICULTURAL USES: general farming, pasture, outdoor plant nurseries, horticulture, viticulture, truck farming, forestry, sod farming, and wild crop harvesting.

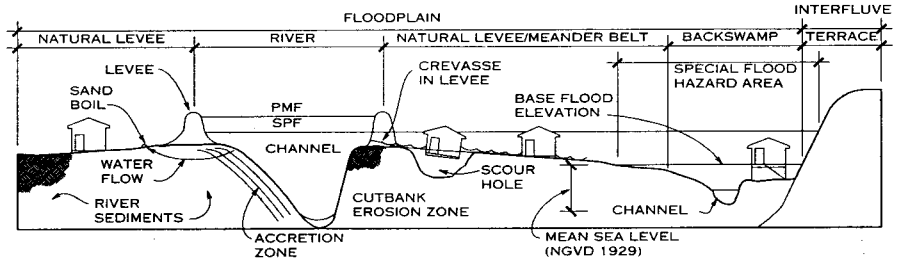
RECREATIONAL USES: golf courses, tennis courts, driving ranges, archery ranges, picnic grounds, boat launching ramps, swimming areas, parks, wildlife and nature preserves, game farms, fish hatcheries, shooting preserves, target ranges, trap and skeet ranges, hunting and fishing areas, and hiking and horseback riding trails.

INCIDENTAL INDUSTRIAL-COMMERCIAL USES: loading areas, parking areas, and airport landing strips (except in flash flood areas).

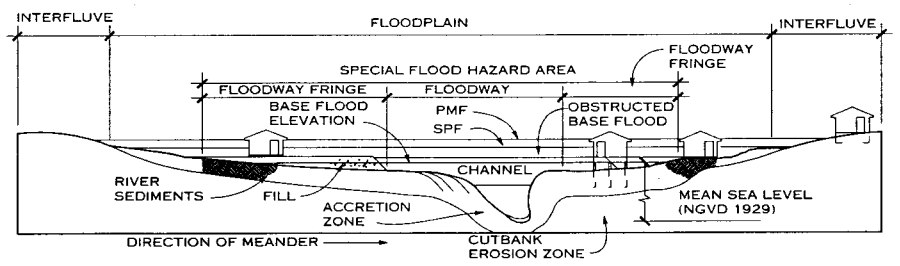
INCIDENTAL RESIDENTIAL USES: lawns, gardens, parking areas, and play areas.

FLOODWAY FRINGES

Floodway fringes are the portion of the regulatory floodplain outside of the floodway. Floodway fringes are treated as storage area for flood waters. Where permitted, property owners on each side of the floodplain may obstruct flood flows equally.



INVERTED RIVER VALLEY



V-SHAPED RIVER VALLEY

Mattie Fincher Coxe; Baton Rouge, Louisiana

Uses permitted in floodway fringes include those permitted in floodways and elevated or otherwise flood-proofed structures. Prohibited or strongly discouraged uses include facilities for storing materials that are toxic or flammable or explosive in water, vital facilities such as hospitals and civil defense or rescue facilities, and facilities that are difficult to evacuate, such as nursing homes and prisons.

FLOOD INSURANCE RATE ZONES

The NFIP is a program intended to reduce federal expenditures for flood disaster relief. It provides flood damage insurance as an incentive for communities to adopt floodplain management regulations, especially those governing floodplain obstructions and building practices in floodplains. NFIP minimum standards require a low level of flood damage management based on historic conditions.

States and localities may establish standards higher than NFIPàs, in which case these supersede NFIP standards. For example, other governments may control land use in hazardous areas, regulate runoff, have freeboard requirements, or base regulatory flood elevations on historic floods that exceeded the base flood or on the projected effects of future development. The NFIP Community Rating System provides insurance rate reductions as an incentive to adopt higher standards.

The NFIP bases Flood Insurance Rate Zones on the frequency of flooding and the presence of storm surge and waves. Local governments are typically required to regulate building practices in A and V zones as a condition of eligibility for flood insurance.

The most important requirement in A and V zones is that the first floor of new buildings be built equal to or higher than the base flood level, which has a 1% chance of being equaled or exceeded in any given year (100-year flood). The base flood is the still water height for riverine floods. For the Atlantic Coast and the Gulf of Mexico, the base flood includes storm surge plus wave crest height because of northeasters and hurricanes. The base flood for the Pacific Coast includes astronomical tides plus wave run-up caused by tropical cyclones and tsunamis. For major lakes, the base flood includes seiche (sloshing because of wind, seismic activity, and storm surge). The base flood elevation (BFE) is the height of the base flood in reference to mean sea level as defined by the National Geodetic Vertical Datum of 1929 (NGVD 1929).

Local communities may adopt regulatory flood datums (RFD) in place of base flood elevations. RFDs are the base flood plus a freeboard, a factor of safety expressed in feet and used to compensate for uncertainties that could contribute to greater flood height than that computed for a base flood. Freeboard allows for hazards excluded from consideration in figuring the base flood and uncertainties in analysis, design, and construction. Severe structural subsidence, increases in floods because of obstructions in the floodplain, urban runoff, or normal climatic variability, as well as long-term increases in sea level and storms, are often excluded from consideration in determining base flood levels. Urban conditions, low accuracy base maps, and unplanned development are other common sources of uncertainty that justify freeboard.

Some communities require up to a 3-ft freeboard to compensate for inaccurate flood insurance rate maps (FIRMs). The margin of error of base maps may be estimated as plus or minus one-half of the contour interval. Most FIRMs are developed from maps with a contour interval of 5 ft, and a margin of error of –2 1/2 ft. Field survey maps with a contour interval of 2 ft or less are used in some communities; the smaller interval reduces the uncertainty of the risk and the need for freeboard.

The NFIP classifies land either as special flood hazard areas (SFHA)—high-frequency flood, flood-related erosion, and mudslide zones—or low-risk and undetermined flood hazard zones. Zone names that include actuarial risk factors, such as A1-A30 and V1-V30, are being replaced by AE and VE designations with flood depths.

A ZONES (A, AE, A1-A30, AO, AH, AR, A99)

Zones A and AE (formerly A1-A30) are high-risk riverine areas susceptible to inundation by the still-water base flood. AO zones are areas of shallow flooding (1 to 3 ft) without defined channels, usually sheet flow on sloping terrain. AH zones indicate shallow flooding, usually with water ponding. AR zones are areas in which structural flood protection is deficient. A99 zones are areas in which structural flood protection systems are near completion.

The finished floor of the lowest habitable level of residences, usually including basements, must be elevated to the base flood elevation in zone A. Flood-resistant residential basements are permitted only in communities that meet special NFIP flood criteria and adopt special local standards for their design and construction. Commercial structures must be elevated or otherwise floodproofed to the BFE.

B ZONES

B zones indicate areas subject to inundation by floods with an annual exceedance frequency greater than the base flood with iess than a 0.2% annual exceedance frequency (500-year flood). B-zone designations are not used on recent FIRMs because of the lack of statistical validity of most estimates of 500-year floods and the false perception that they are generally safe. On some maps B zones are shown as shaded X zones.

C ZONES

C zones, including all areas that are not in zones A, B, or V, are not necessarily flood free. They may include low-risk interfluvial regions (areas of a watershed above the natural floodplain), moderate-risk floodplain between the interfluve and the regulatory floodplain, areas with localized nonriverine flooding, high-risk areas with small contributing drainage areas, and floodplains with structural flood protection that may be subject to low frequency catastrophic floods.

D ZONES

D zones are areas of possible but undetermined flood hazard.

X ZONES

X zones include all areas not in zones A or V, combining B and C zones found on older maps. On some maps, X zones that were formerly B zones and X zones within levee systems are shaded.

V ZONES (V, VE, V1-V30, VO)

Velocity zones V and VE (formerly V1-V30) are coastal high hazard areas identified as susceptible to inundation by the base flood, including storm surges with high velocity waves greater than 3 ft. Generally, zone V indicates the inland extent of a 3-ft breaking wave, where the still-water depth during the 100-year flood decreases to less than 4 ft. VO zones are proposed alluvial fan zones with high velocity shallow flow (1 to 3 ft) and unpredictable flow paths.

Elevation and structural requirements are most stringent in coastal high hazard areas. Fill below buildings is prohibited. If construction is permitted by the local government, the lowest horizontal structural member of the lowest habitable floor must be built above the base flood elevation. Rigid frames or semirigid frames with grade beams can resist the impact of storm surge and waves. Semirigid frames without grade beams should be used only in areas not subject to potential scour. Freestanding pole structures are unsafe; large rotations develop at moment connections, causing deflection of pilings under sustained lateral loads that can lead to collapse.

Destruction of coastal dunes and wetlands dramatically increases the inland reach of storm surge and waves and increases the severity of flood damage. Buildings may be destroyed if dunes and wetlands are inadequately protected, even if they conform to legal building requirements.

E AND M ZONES (E, M)

E zones are areas adjoining the shore of a lake or other body of water that are likely to suffer flood-related erosion. M zones are areas with land surfaces and slopes of unconsolidated material in which the history, geology, and climate indicate a potential for mudflow. Setbacks and special building requirements are used in E and M zones.

SOURCES

Coastal Construction Manual (FEMA-55). Dames & Moore and Bliss & Nyitray, Inc., 1986.

Elevated Residential Structures (FEMA)-54). Washington, D.C.: American Institute of Architects, 1984.

Elevating to the Wave Crest Level: A Benefit: Cost Analysis (FIA-6), Shaeffer & Roland, Inc., 1980.

Federal Emergency Management Agency. *Answers to Questions About the National Flood Insurance Program* (FIA-2)., Washington, D.C.: FEMA.

Federal Emergency Management Agency. *The Floodway: A Guide for Community Permit Officials*. Community Assistance Series No. 4. Washington, D.C.: FEMA.

Flood Loss Reduction Associates. *Floodplain Management Handbook*. U.S. Water Resources Council, 1981.

Floodproofing Nonresidential Structures (FEMA)-102). Booker Associates, Inc., 1986.

Hayes, W. W., ed. *Facing Geologic and Hydrologic Hazards: Earth-Science Considerations*. Washington, D.C.: U.S. Geological Survey, 1981.

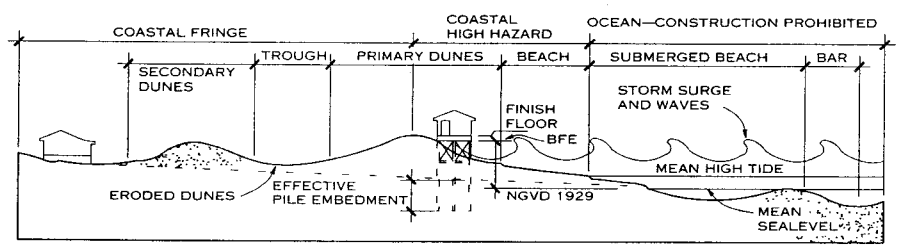
Permit Officials' Handbook for the National Flood Insurance Program. 3rd ed. Baton Rouge Louisiana Department of Transportation and Development, 1993.

GENERAL LIMITS OF FLOODPROOFING

METHOD	DEPTH	VELOCITY	WARNING REQUIREMENTS
Levees	4-7'	< 10'/sec	Advance warning required for installation of floodgates in openings
Floodwalls	4-7'	< 12'/sec	
Closures (24 hr maximum)	4-8'	< 8'/sec	5-8 hr advance warning required for installation of closures
Fill	10'+	< 10'/sec	Evacuation time required unless fill connects to higher ground
Piles, piers, and columns	10-12'	< 8'/sec	Adequate evacuation time required

NOTE

Information presented is general and warrants caution. Time available for warning may be severely limited by a flood's rate of rise.



COASTAL DUNES AND BEACHES

Mattie Ann Fincher; Baton Rouge, Louisiana