# Chapter 3

NFIP Flood Studies and Maps

# Flood Study Terminology

- BASE FLOOD
- THE 100 YEAR FLOOD
- SPECIAL FLOOD HAZARD AREA
- BASE FLOOD ELEVATION

# BASE FLOOD

- For each river, statistical probabilities are assigned to different size floods.
- Probability is the statistical term for size of flood and likelihood of that size flood occurring in any year
- Base flood is the common standard baseline probability
- Definition: The one-percent chance flood is the flood that has 1 out of 100 chance of occurring in any given year.

# 1 % Chance Flood vs. 100 year flood

- They are the same.
- 100 year flood terminology is confusing

- Therefore:

- 100 year flood=1%chance flood=base flood

# Special Flood Hazard Area

- The land area covered by floodwaters of the base flood is the base floodplain.
- On NFIP maps, the base floodplain is called the SPECIAL FLOOD HAZARD AREA (SFHA)
- NFIP regulations take place in the SFHA, where the community enforces NFIP regulations and where mandatory Flood insurance applies.

# BASE FLOOD ELEVATION

- The BFE is the computed elevation to which floodwater is anticipated to rise during the base flood.

# Identifying Flood prone Areas

- NFIA 1968 directed FIA to

  1) Identify all flood prone areas within the US

  2) Establish Flood Risk zones in flood prone areas

This info is the community's Flood Insurance Study

# Flood hazard boundary maps

- Flood and data information was used to develop maps of the approximate outline of the base flood plain. These were approximate studies.
- Flood Insurance Studies (FIS) were detailed studies.
- Studies lead to FIRMs (Flood Insurance Rate Maps)

# Flood Insurance Studies

- 3 components
- Flood Insurance Study Report (contains purpose, historic floods, area and flooding sources studied, and engineering methods employed, vicinity map, photos of historic floods, summary tables, flood profiles for 10, 50, 100 & 500 year floods).
- FIRM
- Flood Boundary and Floodway Map (FBFM) prior to 1986

# Riverine Studies

- Different types of studies are used for different types of flooding

  Riverine flooding of rivers, streams or other waterways
  Lacustrine flooding of lakes and ponds
  Coastal flooding by hurricanes and storms,
  Shallow flooding, Ponding and sheet flow

- Riverine studies involve the collection, and analysis of the river's watershed, precipitation, topography, river characteristics.

# Hydrology

- A branch of science dealing with the distribution and circulation of water in the atmosphere, on land surfaces, and underground used to determine flood flow frequencies.

- The hydrologic study of a watershed determines the amount of rainfall that will stay with I a watershed , absorbed by soils, trapped in puddles and the rate at which the remaining amount of rainfall will reach the stream.

# Runoff

- The rainfall that reaches the stream is called runoff.
- Increased runoff will, in turn, increase flood discharge
- Discharge is the amount of water flowing down a stream channel.
- Discharges are measured in cubic feet per second (cfs).
- ( a cubic foot is about 7.5 gallons)
- Gauges are used to determine this flow.

# Impervious Cover

- Increases runoff
- Impervious cover includes pave areas and areas of development, where natural lands have been removed.

# Discharge

- Discharges are estimated using rainfall and snowmelt data and historical stream records and plugged in computer modelling equations.
- Discharge rates can increase with an increase in the size of a watershed.
- Discharge rates can be calculated and measured for various rainfall rates at different points along a stream.

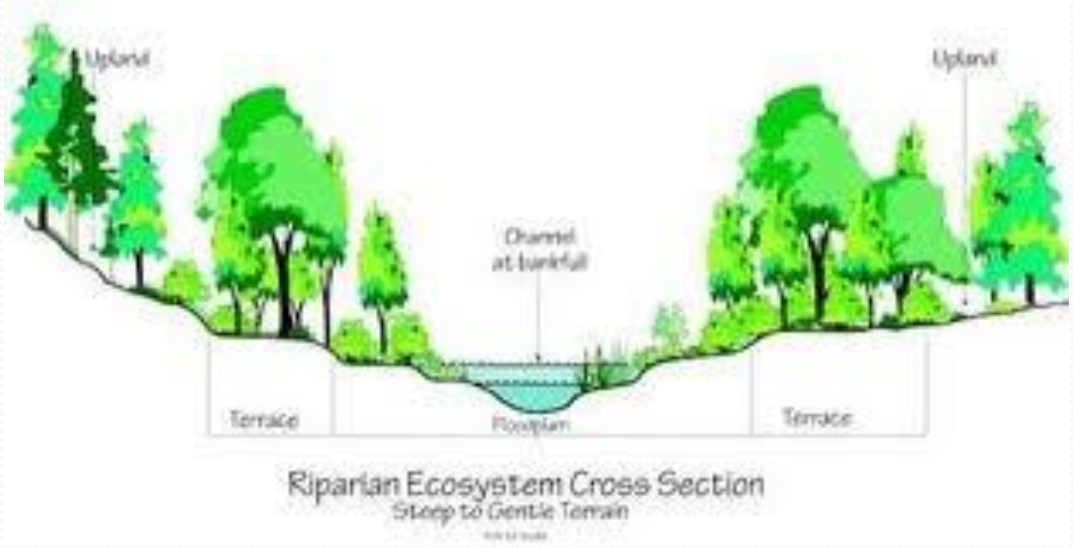
# Cross Sections

- Flood studies examine the areas though which floodwater will flow.  This requires determination of ground elevations and obstructions to flow.

- Accurate data depends upon channel geometry, areal photography, or topographic maps

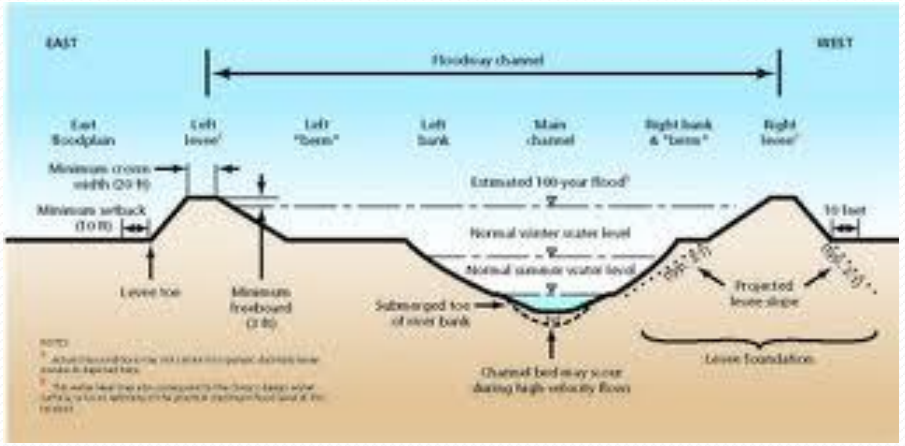
- Elevations are determined by surveyors using an elevation reference mark, or bench marks that reference a common vertical elevation called a datum.

# Cross Section



Riparian Ecosystem Cross Section
Steep to Gentle Terrain

The more changes there are in topography, the more cross sections are needed to adequately define the floodplain



# Datums and Elevations

- Most permanent elevation reference marks  or bench marks are referenced to the National Geodetic Vertical Datum (NGVD)

- NAVD 88 is the most recent datum (600,000 benchmarks nationwide).

# Roughness

- Estimates on how fast floodwater will flow due to ground surface conditions, and changes in velocity due to ground friction.

# Hydraulics

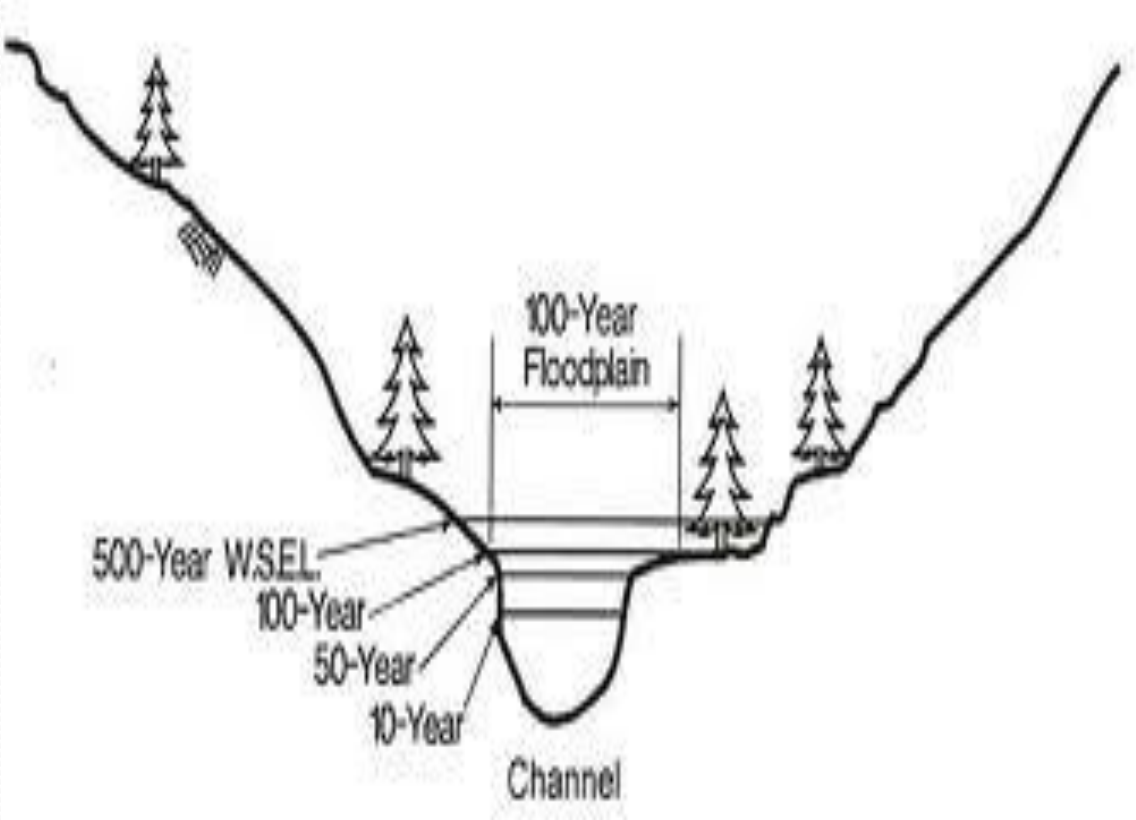
- Hydraulics is the study of floodwaters moving through the stream and floodplain.

- Includes-hydrology or discharges
- Cross section data for area to carry flood
- Stream characteristics—roughness, slope, locations and sizes of stream structures.

- HEC–RAS (USACE model)

- Changes in Hydraulics can be due to bridges, streams, culverts, filling, etc.

# Hydraulics



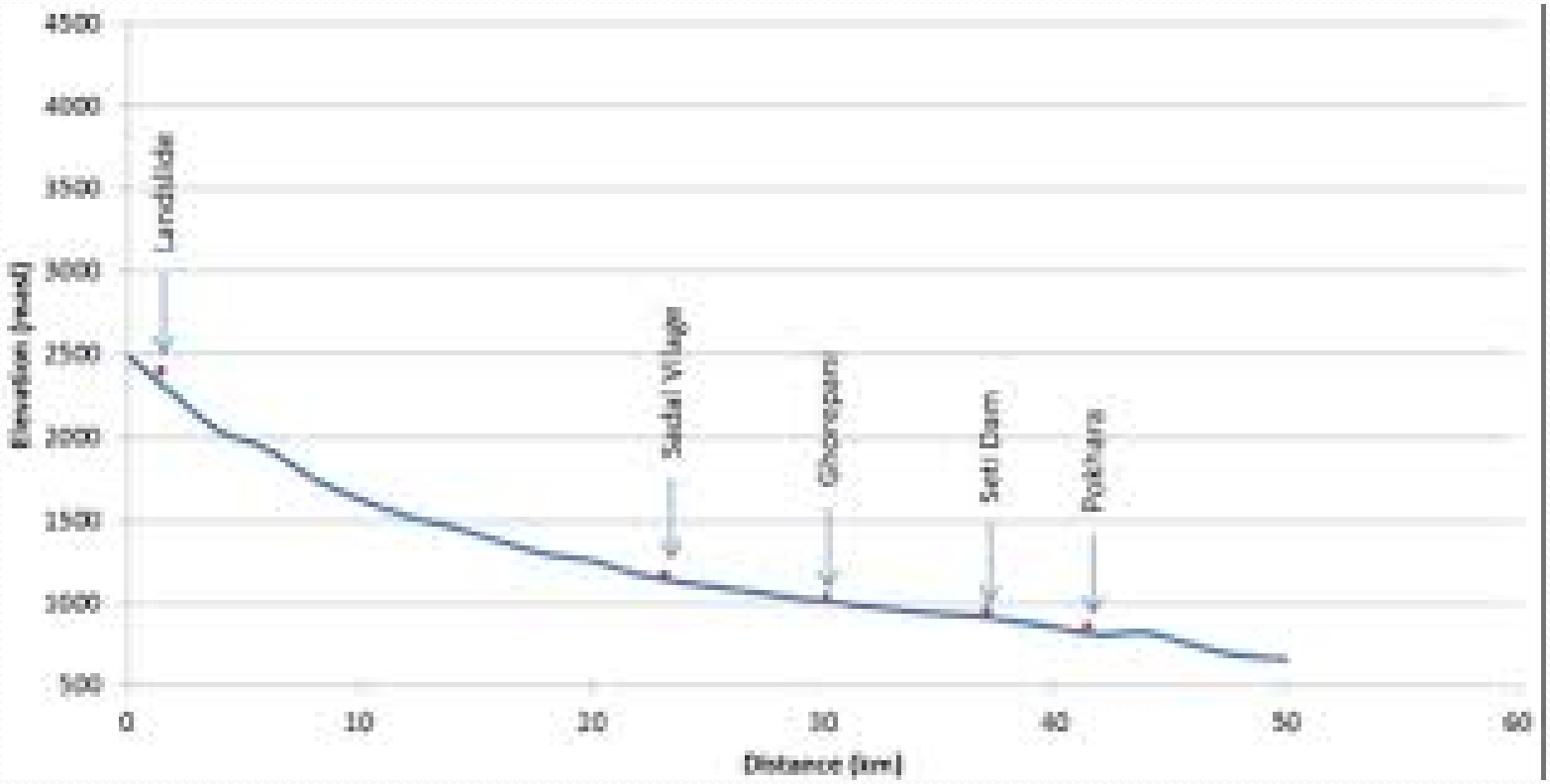

500 year flood is used for siting critical facilities

# Flood Profile

- Flood elevations at locations between cross sections need to be determined.
- This is done by plotting elevations at cross sections and connecting the plotted points,  This graph is a flood profile.

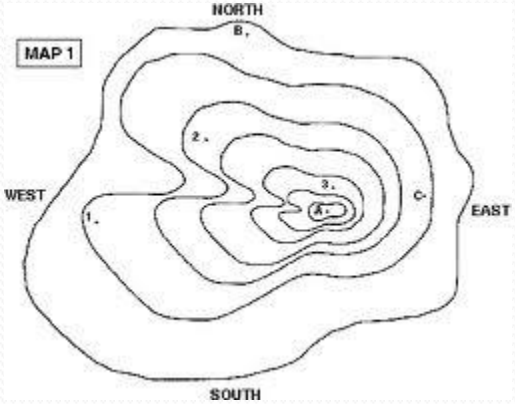
- See flood profiles for Flood County

# FLOOD Profile



# Floodplain Map

- Next step:  Transfer flood elevation data onto a map showing ground elevation data.

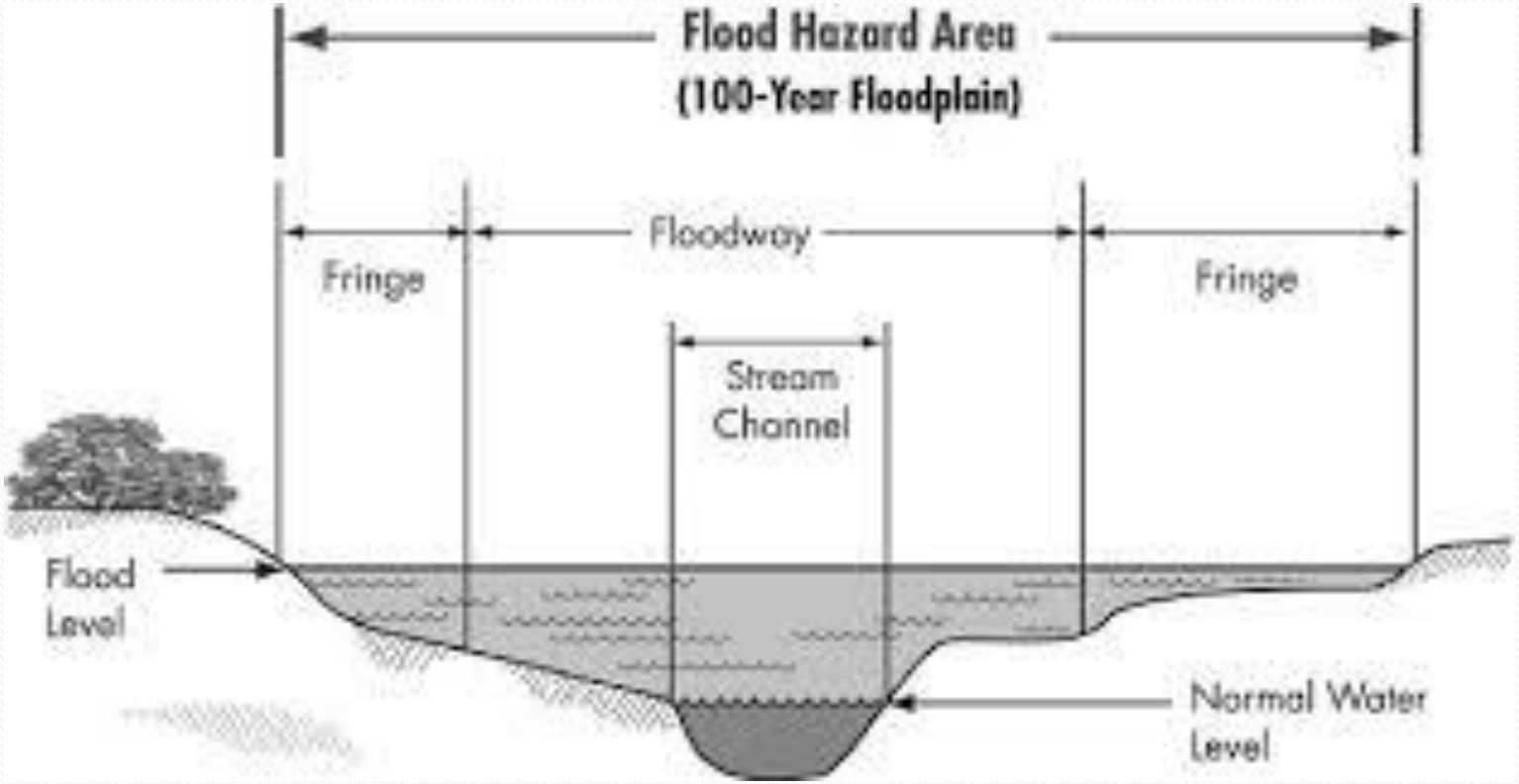



- This is a topographic map or a contour map.
- Points with the same elevations are connected by a contour line.
- This is also called the base map.

# Floodway Analysis

- The final step is to produce a floodway analysis which identifies where encroachment by development will increase flood elevations significantly and worsen flood conditions.
- The **Floodway** is the stream channel and that portion of the adjacent floodplain that must remain open to permit passage of the base flood.
- Floodwaters are deepest and fastest in floodway

# Floodway cross section



# Flood Fringe

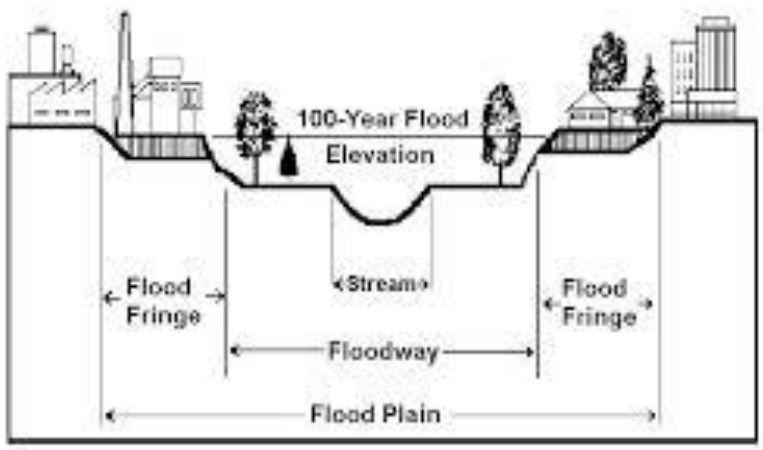
- Remainder of the flood plain
- The floodway + flood fringe= base floodplain or **SFHA**
- Zone A 1-30 or AE

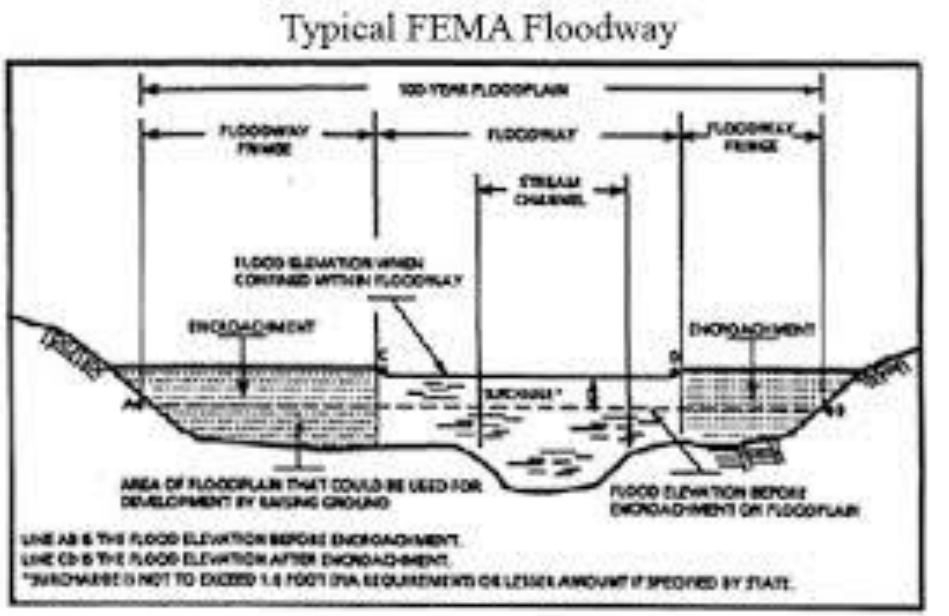
  Development can be permitted in flood fringe if it is elevated or otherwise protected above the base flood level.

Development in the floodway is allowed if it does not increase BFE

However, development in the floodway is generally discouraged or prohibited.

# Computer floodway analysis




Floodway boundaries are drawn where computer model shows a 1 foot rise.

# Floodway Analysis

- Allowing flood heights to rise up to one foot is a compromise standards.

- Some states use a standard of 0.5 foot or 0.1 food rise for a wider floodway and less flood fringe.

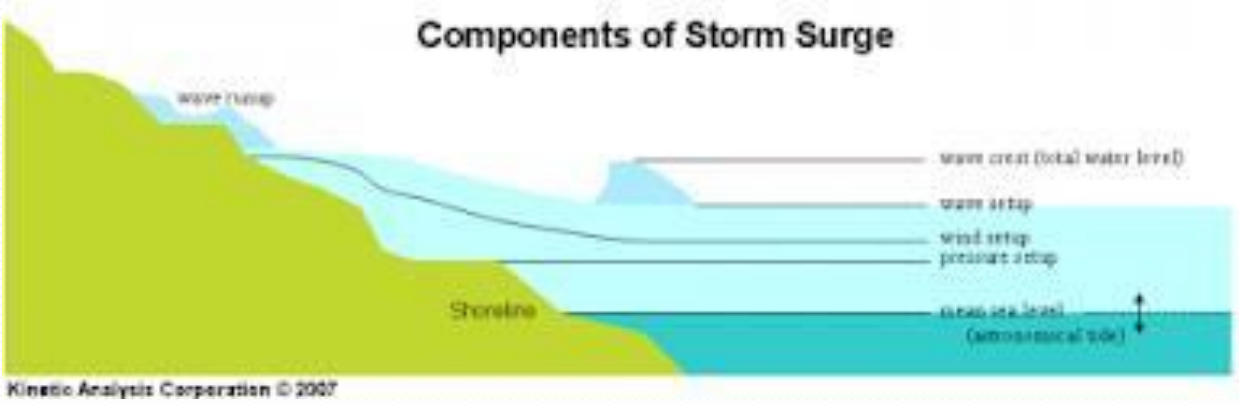
# Coastal Flood Studies

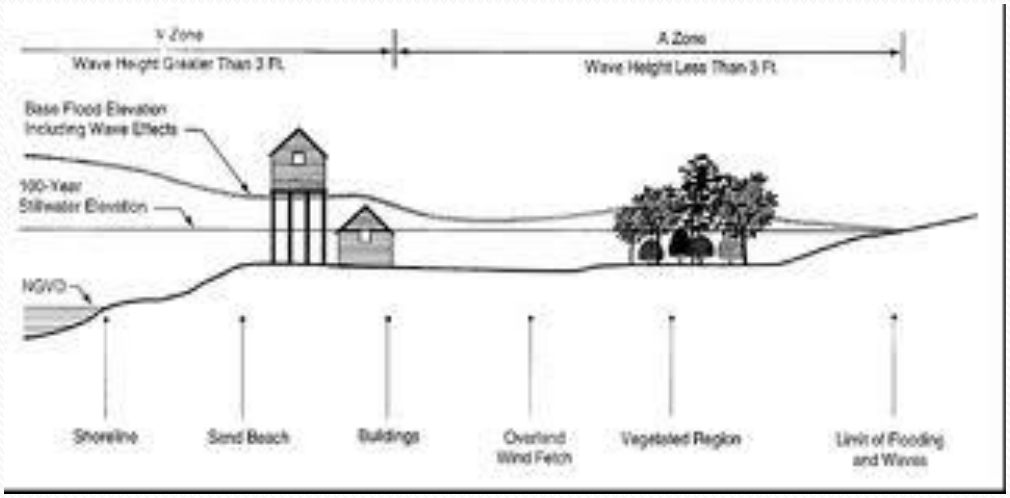
- Coastal studies are for the base flood, and SFHA and the coastal high hazard area (V Zone)
- Storm Surge-occurs when high pressure and strong winds pile up water against the shore
- Coastal storm surge model produces stillwater flood elevation, the elevations of various coastal floods, not including waves.

# Waves

- Wave action is an important component of storms.
- Coastal study analyzes how high the wave crest elevation will be above the stillwater elevation
- Wave runup-when water moves inland when land areas that are higher than the stillwater elevation are flooded.
- Wave Setup-is the additional elevation of the water surface over normal surge elevation caused by inshore mass transport of the water by wave action. It is a function of deep water wave height and duration.

# Wave runup


Components of Storm Surge
wave runup
wave crest (total water level)
wave setup
wind setup
pressure setup
Shoreline
mean sea level
(astronomical tide)
Kinetic Analysis Corporation © 2007

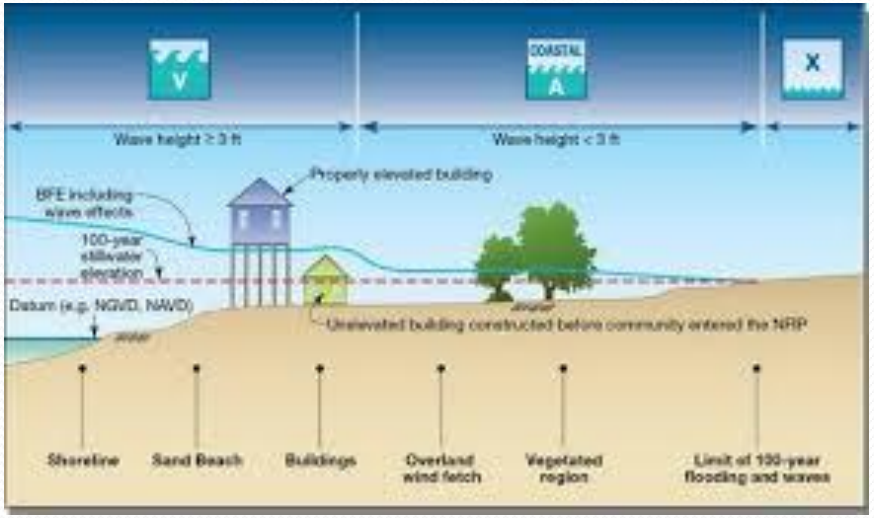

V Zone
Wave Height Greater Than 3 Ft.
A Zone
Wave Height Less Than 3 Ft.
Base Flood Elevation
Including Wave Effects
100-Year
Stillwater Elevation
NGVD
Shoreline
Sand Beach
Buildings
Overland
Wind Fetch
Vegetated Region
Limit of Flooding
and Waves

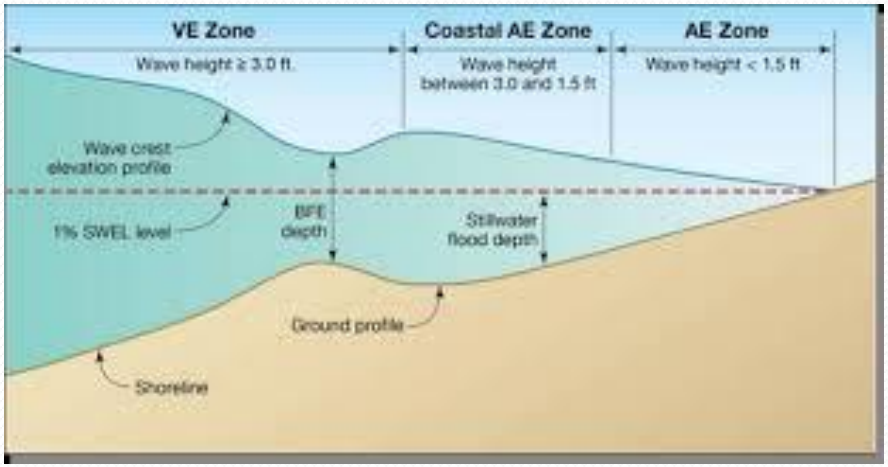
# Hydraulic Analysis

- A coastal hydraulic analysis determines where moving water will go.  Instead of cross-sections, transects are used.

- A transect shows the elevation of the ground both onshore and offshore.  This data is used to determine height of wave  crests and runup,

# Coastal Transect Schematic



# Terms

- Underwater topography is **bathymetry.**
- It includes coastal islands, headlands, estuaries, harbors and other coastal features.

- The official BFE is the stillwater elevation plus the wave runup, or the wave crest elevation, whichever is greater.

# Coastal High Hazard Area-V zone

- It is the area with the greatest hazard due to wave exposure.
- It is defined as the area between the shoreline and the most landward of the following points:
  where the computed wave lengths for the base flood are three feet or more,
- The inland limit of the primary frontal dune, or
- Where the eroded ground profile is three feet below the computed runup elevation.
- These areas are V-zones where or velocity wave action zones. Most stringent regulatory zones and highest insurance rates apply.

# A zones

- A zones are coastal flood areas that are not in the V or high hazard zone.

# Coastal Floodplain Map

- See panel 40

# Shallow Flooding Studies

- Defined as 1-3 foot floods where there is no defined channel
- Ponding-flat areas with water collected in depressions
- Sheet flow:  Steeper areas where there are no defined channels
- Urban drainage:  Water collects in yards or swales or when storm sewers back up
- Coastal flooding:  Wave runup over flat areas or over dunes and collects behind an obstruction that keeps it from draining back to the ocean.
- BFE or base flood depth is an Zone AO sheet flow or AH zone is ponding area

# Approximate Studies

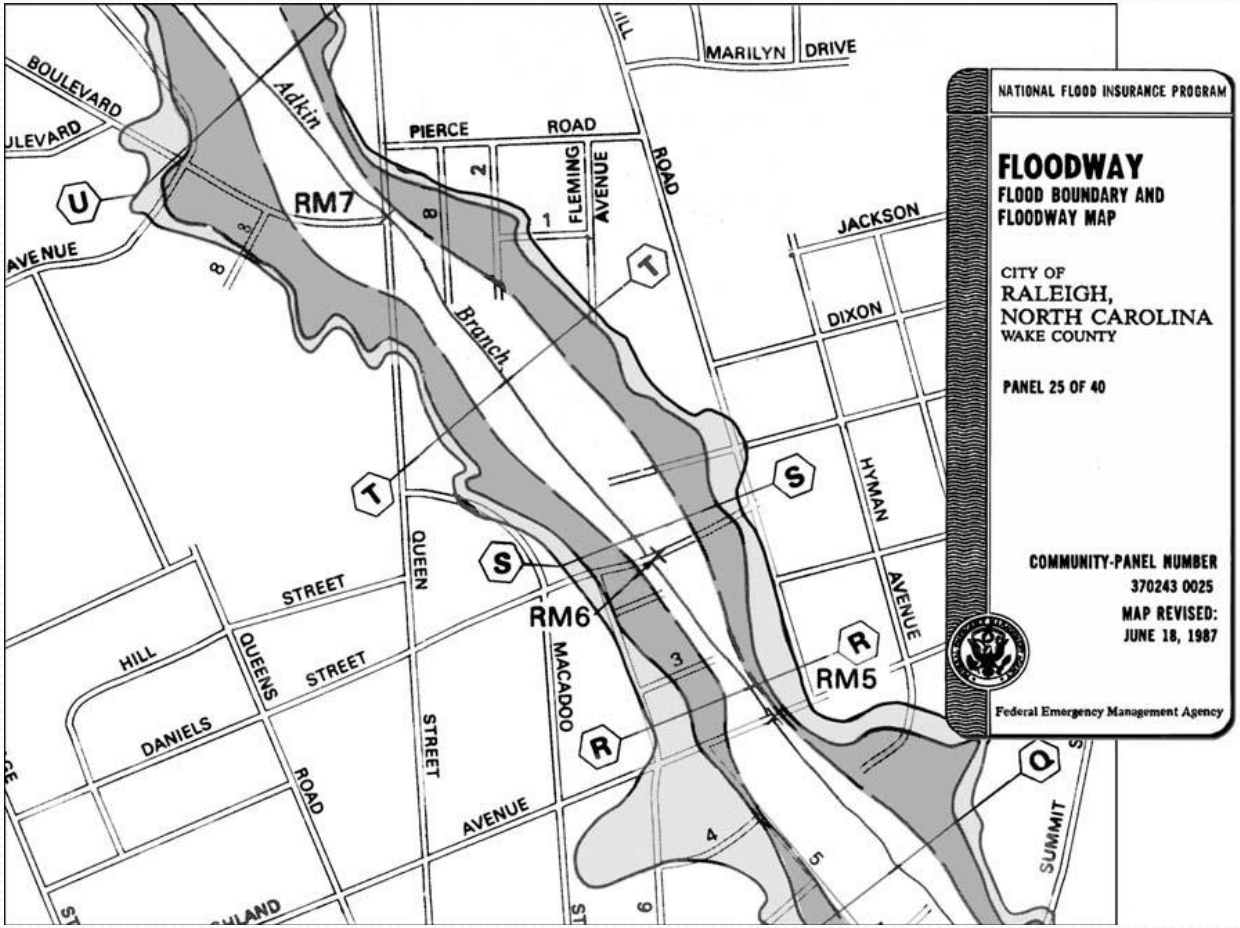
- For coastal areas, Approximate studies are used based on other agency info, such as USGS, USACE, etc.

# NFIP Maps

- FIRMs since 1986 contain both the flood insurance rate zones and floodways
- MAP EXERCISE
  Map Index
  Title Block
  Map Revision Date
  Map scales and north direction
  Elevation Reference Marks (ERM or RM)
  Firm Zones (see Figure 3-10)
  FHBM-Zone A no BFEs
  Zone Break Line: Separates Zones

# More Terms

- Coastal Barrier Resources System: Undeveloped coastal barrier islands are mapped.
- DFIRM : Digital Flood Insurance Rate Map
- Digital Line Graph (DLG) transfer of flood risk data on DFIRMs to GIS


NATIONAL FLOOD INSURANCE PROGRAM
FLOODWAY
FLOOD BOUNDARY AND FLOODWAY MAP
CITY OF
RALEIGH,
NORTH CAROLINA
WAKE COUNTY
PANEL 25 OF 40
COMMUNITY-PANEL NUMBER
370243 0025
MAP REVISED:
JUNE 18, 1987
Federal Emergency Management Agency
BOULEVARD
AVENUE
Adkin
Branch
PIERCE
ROAD
FLEMING
AVENUE
MARILYN
DRIVE
JACKSON
DIXON
HYMAN
AVENUE
RM7
RM6
RM5
QUEEN
STREET
HILL
QUEENS
STREET
DANIELS
ROAD
STREET
AVENUE
MACADOO
SUMMIT
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Q
1
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4
5
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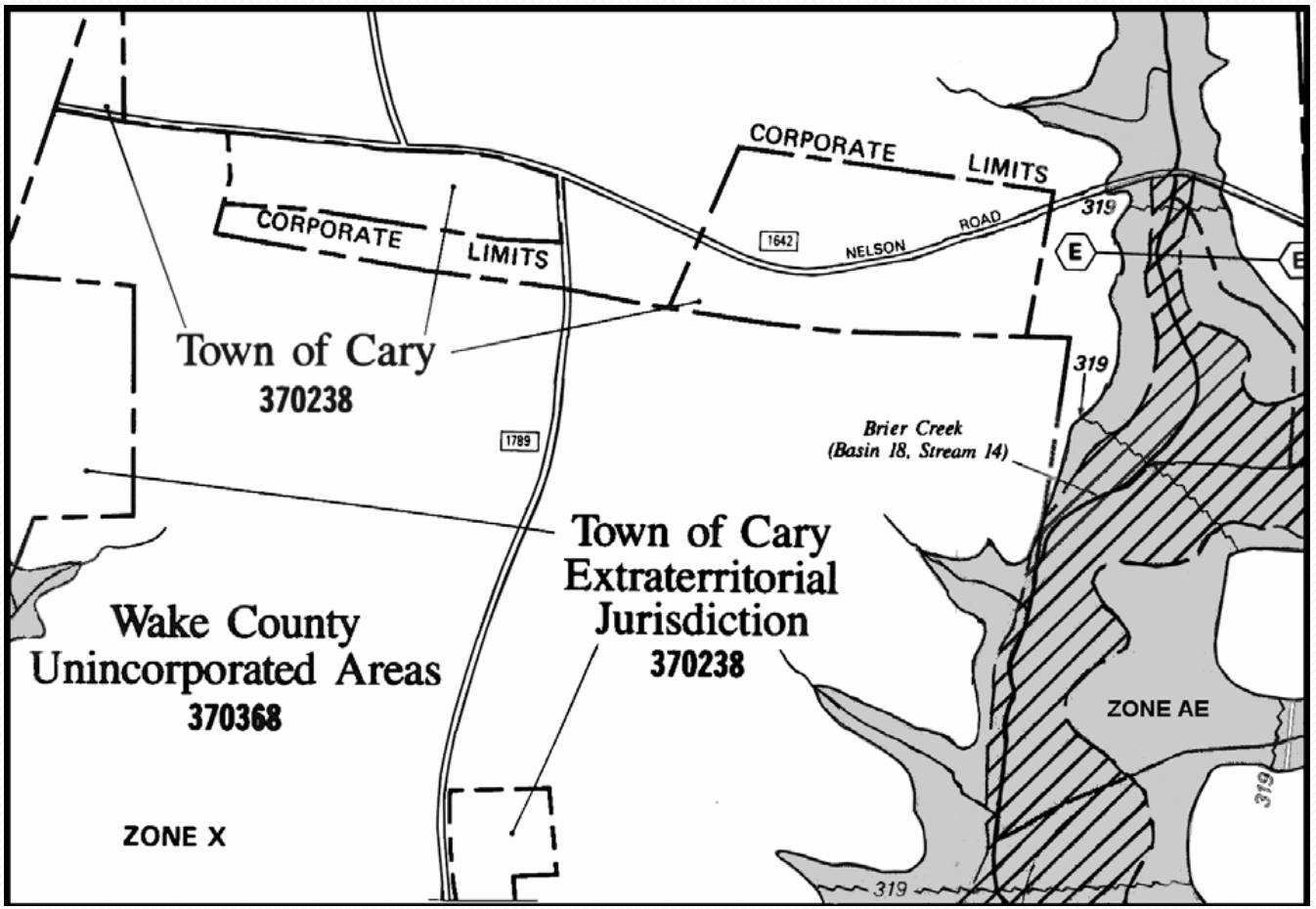
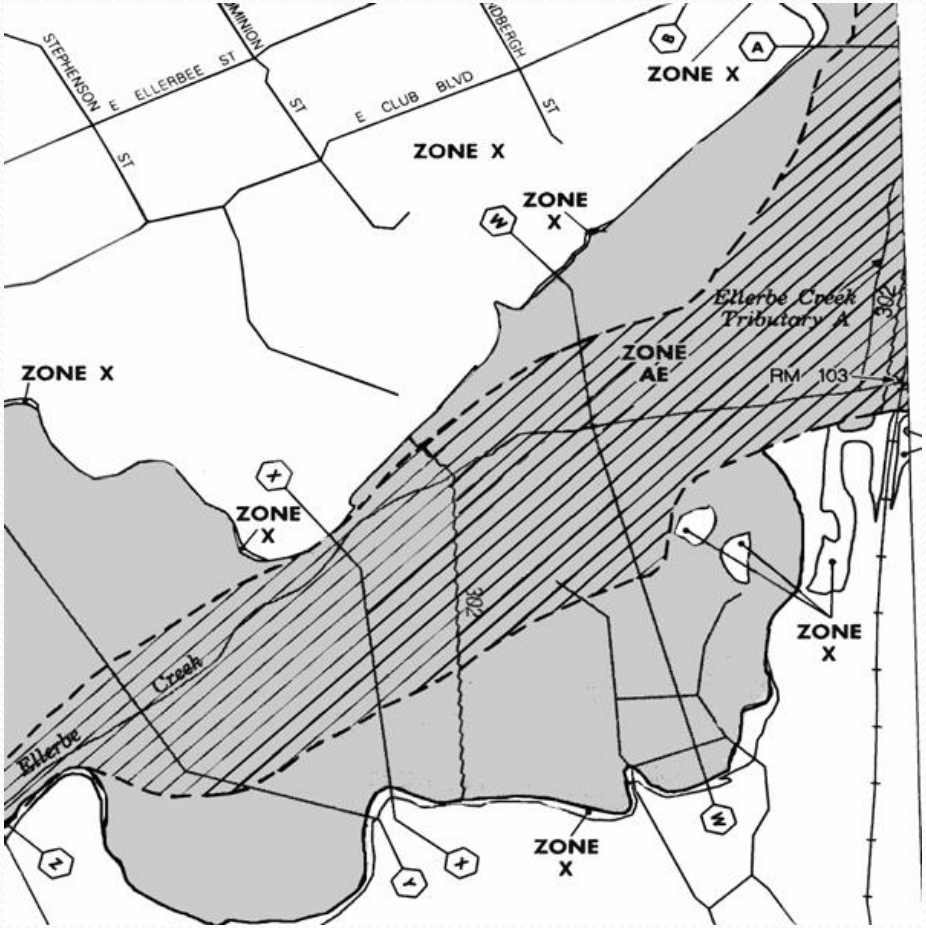
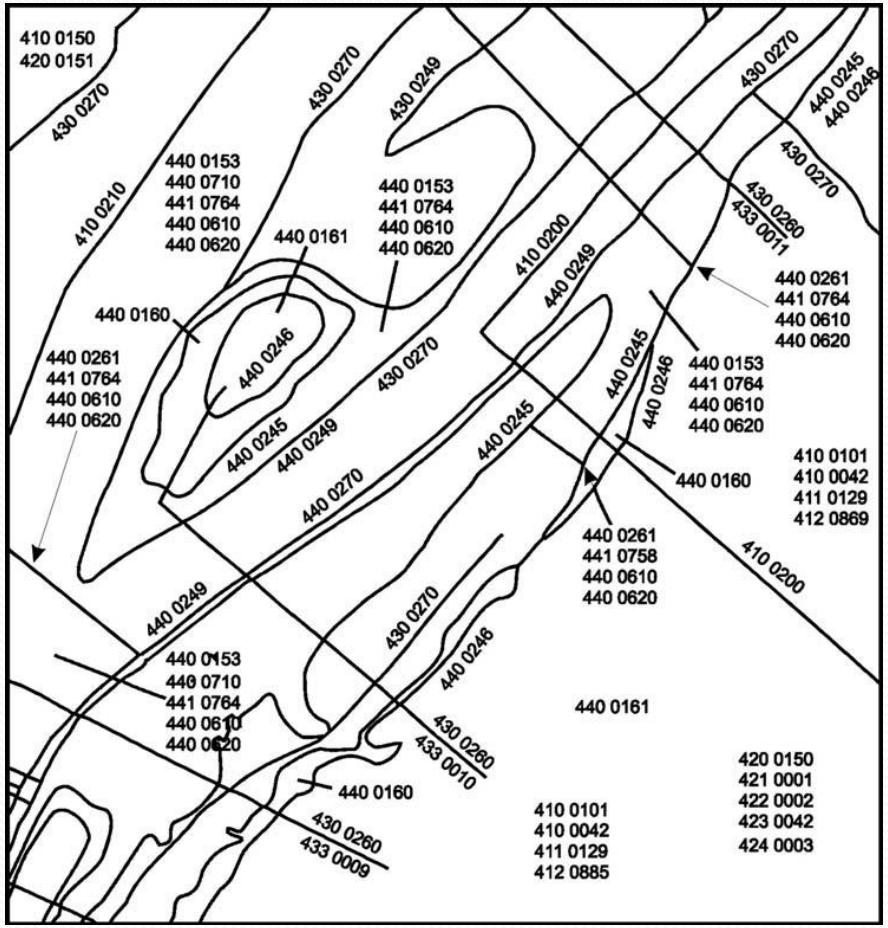
8


CORPORATE LIMITS
CORPORATE LIMITS
1642
NELSON ROAD
319
E
319
Town of Cary
370238
1789
Brier Creek
(Basin 18, Stream 14)
Town of Cary
Extraterritorial
Jurisdiction
370238
Wake County
Unincorporated Areas
370368
ZONE AE
ZONE X
319
319

# DFIRM-DLG


STEPHENSON ST
E ELLERBEE ST
AMNION ST
E CLUB BLVD
ADBERGH ST
ZONE X
ZONE X
ZONE X
ZONE X
ZONE AE
ZONE X
ZONE X
ZONE X
Ellerbe Creek Tributary A
RM 103
302
Ellerbe Creek

# Graphic Image of DFIRM-DLG



# Q3

- The Q3 flood data are created by scanning (raster or grid data files) the FIRM paper maps and vectoring (converting to lines and areas) select data features onto one countywide data layer. The following vectored (lines and areas) data features are included:
  - 1% and 0.2% annual chance flood boundaries (SFHA and 500-year floodplain)
  - Flood insurance zone designations
  - Floodway boundaries (if available)
  - Coastal Barrier Resources System boundaries
  - Political boundaries

http://www.caliper.com/fema.htm

# FIS (Flood Insurance Study)

- To determine whether or not a site is located in an SFHA, a V Zone and/or floodway and to determine the BFE

Contents:
Section 1: Purpose, authority, coordination steps
Section 2: background information
Section 3: engineering methods
Section 4: Flood map preparation
Section 5: Flood insurance zones
Section 6: FIRM
Section 7: Other Studies
Section 8: Location of Data
Section 9: Bibliography and References

# Using Flood Data and Tables

- **Flood Discharges** are included in a summary of peak water discharges for various flood frequencies

- **Floodway Data table**: presents data from the hydraulic analysis