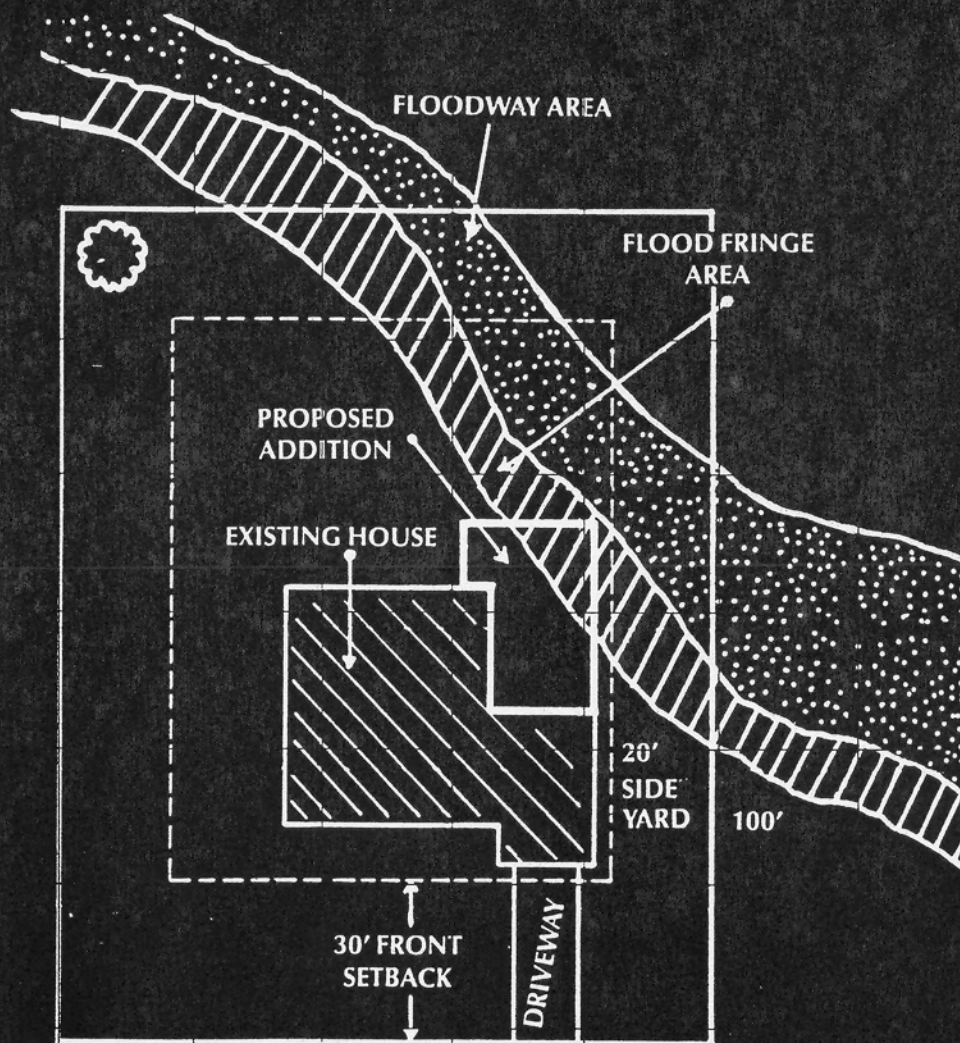


FLOODPLAIN MANAGEMENT INFORMATION SERIES:
A SPECIAL REPORT

PROCEDURES FOR COMPLIANCE WITH FLOODWAY REGULATIONS



U.S. Army Corps of Engineers
Federal Emergency Management Agency
Pennsylvania Department of Community Affairs

MAY 1990

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A SPECIAL REPORT

PROCEDURES FOR COMPLIANCE WITH FLOODWAY REGULATIONS

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For:

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FOREWORD

This document is the second edition of *Procedures for Compliance with Floodway Regulations* developed by the Region 3 office of the Federal Emergency Management Agency and the U.S. Army Corps of Engineers. It provides technical guidance on how to comply with community floodway regulations which have been adopted to comply with the minimum requirements of the National Flood Insurance Program. It is intended for use by designers, builders, developers, engineers, community building officials, and homeowners.

The intent of this manual is not to encourage development in a designated floodway. Rather, when such development cannot be avoided, it is to help ensure that it be accomplished in a manner that minimizes the potential for flood damage and ensures compliance with the community's regulations.

PROCEDURES FOR COMPLIANCE WITH FLOODWAY REGULATIONS

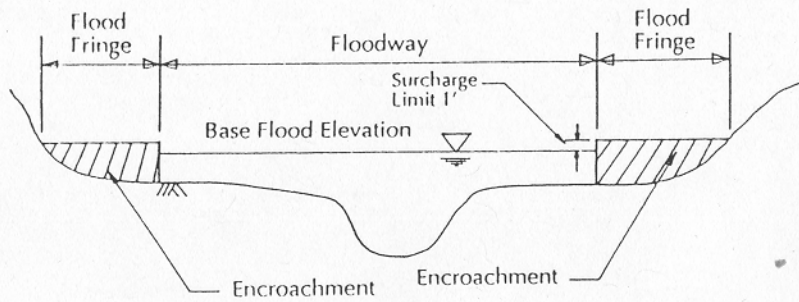
1. Introduction

1-1. **Purpose.** This document is designed to assist municipal officials in administering local regulations based on the requirements of the National Flood Insurance Program (NFIP). More specifically, it provides guidance and procedures for reviewing development proposals to ensure compliance with local floodway regulations. It also contains information concerning the process and procedure for officially revising floodplain and floodway delineations and for modifying base flood elevations.

The document will also serve as a useful reference guide for builders, developers and property owners wishing to develop within designated floodplain and floodway areas. The criteria, requirements and procedures described can be used as the basis for preparing the type information needed for local review and, if necessary, for review by the Federal Emergency Management Agency (FEMA).

1-2. **Report Organization.** The report begins with an overview of the National Flood Insurance Program (NFIP), a description of general development procedures, an explanation of the floodplain maps and basic flood elevation data generated through the NFIP, and a description of the procedures for locating development relative to an identified floodplain. Further on, the report includes a discussion of three possible encroachment impacts resulting from proposed development within identified floodways, a description of six selected types of floodway development and some analytical considerations and submittal requirements for each, and an explanation of the information and analyses which are needed to evaluate and document floodway impacts. The report concludes with an explanation of the requirements and procedures for requesting floodway revisions and a brief discussion of development in unregulated floodways.

Cross Section A



Plan View

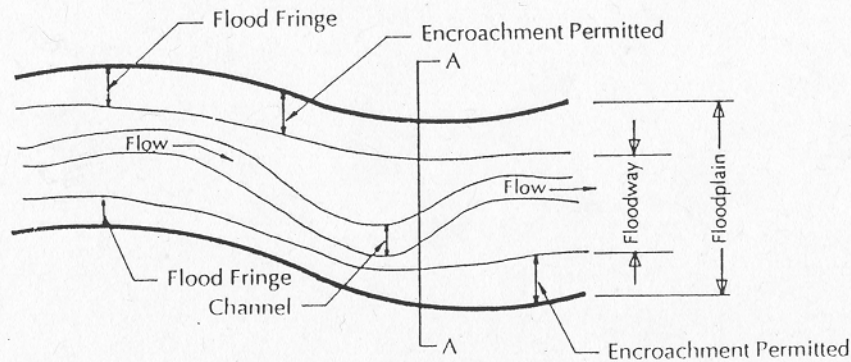


Figure 1: Floodway and Floodway Fringe

2. The National Flood Insurance Program

2-1. Overview. The National Flood Insurance Program (NFIP) was created by Congress through the passage of the National Flood Insurance Act of 1968. The purpose of the NFIP is twofold: 1) to provide the general public the opportunity to obtain insurance coverage to cover flood damages to buildings and their contents and, 2) to reduce future flood damages by requiring the local regulation of new development in floodprone areas. The NFIP is administered by the Federal Insurance Administration (FIA), a division of the Federal Emergency Management Agency (FEMA).

The availability of flood insurance is contingent upon a community's participation in the NFIP. To participate, a community must enact regulations to control development activities within identified floodplain areas. Local

regulations must meet or exceed minimum NFIP requirements. There are over 17,000 municipalities currently participating in the NFIP, nationwide.

Floodprone areas are identified on maps provided to communities by the Federal Insurance Administration. Referred to as Special Flood Hazard Areas, these areas represent the extent of inundation which can be expected from a 100 year flood or base flood. Local regulations must ensure that all new and substantially improved buildings are protected to the level of the base flood, at the very minimum.

For municipalities with Flood Insurance Studies, the identified floodplain is divided into two distinct zones or districts: a floodway and floodway fringe (see figure 1). The floodway is delineated for the purpose of keeping an area clear of obstructions to allow flood waters to freely discharge downstream. When floodways are identified, municipalities must include regulations which restrict any new development within floodways which would cause any increase in flood heights. There is no such restriction to development within the floodway fringe. Development may occur in the floodway fringe provided it complies with applicable elevation or floodproofing requirements.

The Federal Insurance Administration uses special criteria in delineating floodways. In an attempt to allow for some development in floodplains, FIA decided to delineate floodways assuming that development may take place within floodway fringes to an extent that flood heights will be raised a maximum of one foot. Some states have enacted more stringent surcharge limits, but, for the most part, the NFIP floodway criteria and delineation is widely used. The following sections attempt to clarify NFIP floodway regulations and the proper procedures and data needed to evaluate development proposals.

2.2 General Development Procedures. It is the responsibility of the builder, developer, or property owner to obtain a local permit before proceeding with any construction or development within an identified floodplain area. The definition of *development* as defined through the NFIP is as follows:

any man-made change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, drilling operations or storage of equipment or materials.

As one of the conditions for obtaining local approval, an applicant must secure all other necessary federal and state permits which are required for the location and type of development being proposed. Many states have permit requirements and regulations pertaining to development activities in the floodway. The U.S. Army Corps of Engineers and various states have strict regulations concerning the development of wetlands. While it is the responsibility of the applicant to obtain these and other applicable governmental permits, it is incumbent upon communities participating in the NFIP to withhold the issuance of a local permit until such time that the applicant provides evidence that all necessary permits have been secured.

For a developer, the process begins with the location of the proposed development. Is the area floodprone? A good starting point in this determination is the community office. A community participating in the NFIP should have all the maps and related flood data prepared by the FIA (see section 2-2). It should be stressed, however, that not all floodprone areas are shown on NFIP maps. FIA limits their identification of floodprone areas to certain size of drainage areas and floodplain widths. If the area appears to be susceptible to flooding, check other sources of information such as soil surveys.

If the proposed development lies within an identified floodplain area, then the next step is to determine whether the site is within the floodway or floodway fringe, if this information exists (see Section 3). Depending on the outcome, it will be necessary to analyze the applicable local floodplain management requirements in relation to the proposed development and make adjustments, accordingly (see Sections 4, 5, and 6). Once all plans and data are prepared, the package should be submitted to the municipality for review and, if necessary, to the FEMA Regional Office serving your area. An outline of these procedures is shown in Figure 2.

2-3. Flood Hazard Analysis of NFIP Areas. The local community with primary land use jurisdiction, whether it is a municipality, county, or state, has the responsibility for enforcing the National Flood Insurance Program regulations through locally enacted ordinances if that community is participating in the NFIP.

Determination of the status of a community's participation in the NFIP and review of applicable NFIP maps and ordinances are essential first steps in conducting water surface profile analysis of proposed modified or new development. The NFIP maps, where available, are the least restrictive maps allowed to be used in determining if the development alternative will encroach on the base floodplain. Three types of maps are published: (1) a Flood Hazard Boundary Map; (2) a Flood Boundary and Floodway Map; and (3) a Flood Insurance Rate Map. A Flood Hazard Boundary Map is generally not based on a detailed hydraulic study, and, therefore, the floodplain boundaries are approximate.

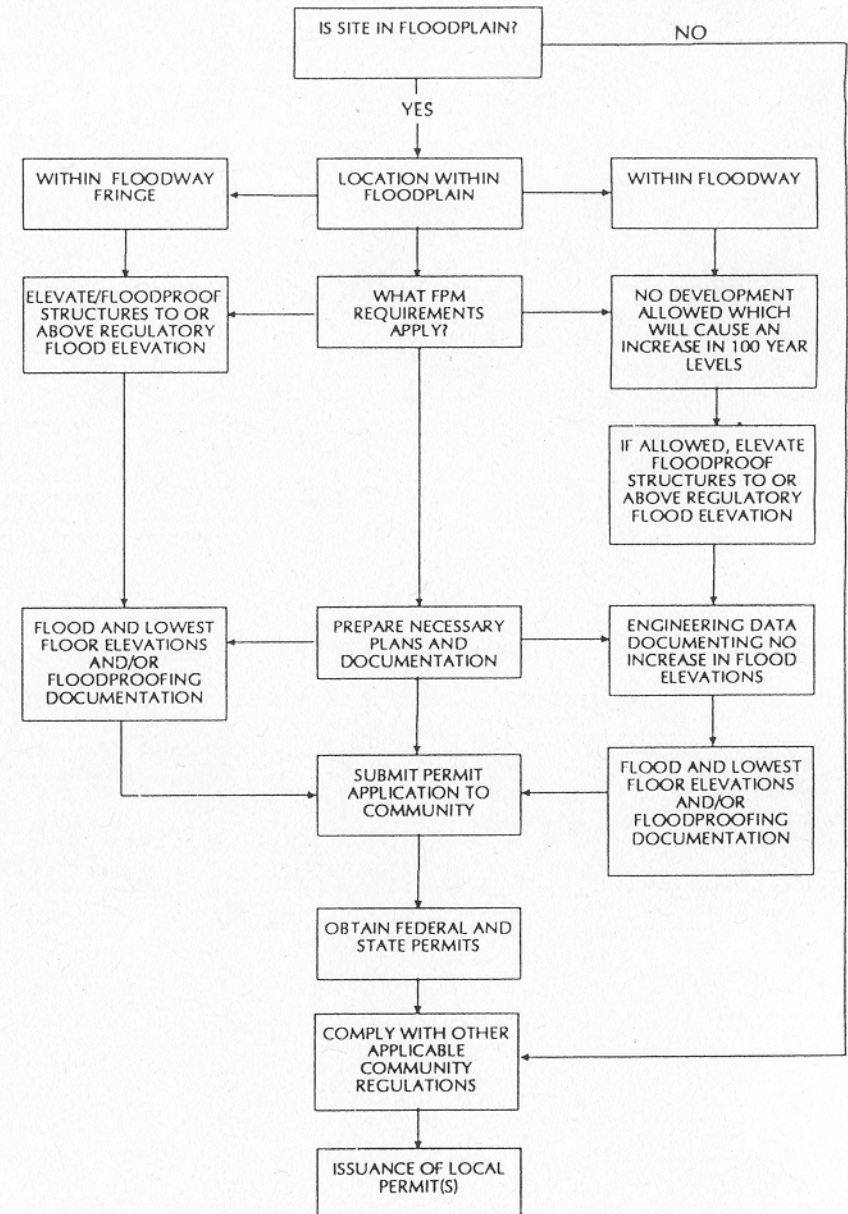


Figure 2: Floodplain Development Procedures

The Flood Boundary and Floodway Map is generally derived from a detailed hydraulic study and should provide reasonably accurate information. The hydraulic data are available through regional offices of the Federal Emergency Management Agency and are normally in the form of computer input data sets for calculating water surface profiles. The Flood Insurance Rate Map is usually developed at the same time as the water surface profile analysis model and has base flood elevations added.

The analysis of proposed development within the floodplain generally falls within four categories of studies with regard to the NFIP regulations. These are: (1) a detailed flood insurance study has been performed and a regulatory floodway is in effect; (2) a community is participating in the regular program and 100 year flood elevations have been determined, but no regulatory floodway has been established; and (3) 100 year flood elevations have not been established, but a one hundred year flood plain has been approximated, or (4) an area has not been identified as floodprone. This document focuses primarily on the development proposals and requirements within floodplain boundaries where regulatory floodways are in effect. Section 8 briefly overviews development conditions for conditions 2 and 3.

3. Preliminary Evaluation of Proposed Development

3-1. General. The location in the floodplain of the proposed development has a significant effect on the development requirements. Development outside the floodway fringe areas, or above the elevation of the base flood is generally not governed by the NFIP floodplain regulations. Within the floodway fringe, new development or substantial improvements to existing structures are allowed, provided that all residential developments be elevated to or above the base flood level and non-residential development be elevated or floodproofed to or above the base flood level. Development within the regulatory floodway is only allowed if there is no resulting increase in flood elevations.

3-2. Locating Floodplain Development. An initial step of the developer is to determine the location of the proposed development with respect to the floodway fringe and floodway delineation for the area. The developer should obtain from the appropriate local officials the base profile and the Flood Boundary and Floodway Map and/or Flood Insurance Rate Map for the stream in the vicinity of the proposed development. Once the floodway fringe and floodways are defined accurately, the proposed development location with respect to them can be established.

The base flood elevation or 100-year flood profile is considered to be the basis for the limits of the floodplain. Once the profile elevations at the cross sections are determined, the floodplain boundaries are delineated using topographic maps to relate to the profile elevations between the cross sections.

Errors in topographic maps, delineation of the base flood, and other factors may produce errors in the floodplain delineation on the Flood Boundary and Floodway Maps. However, these errors do not affect the profile accuracy. The procedure for properly determining the limits of the floodplain and its relationship to the proposed development location are described in the following paragraphs.

1. The 100-year or base flood profile elevation for the corresponding proposed development stream mile should be determined from the flood profiles or floodway data tables provided with the FIS report.

2. A field survey of the proposed development site should be conducted to determine whether the site actually lies outside (above) the floodplain or within the floodway fringe and floodway area. See Figure 3. This procedure is more accurate than a determination from the Flood Boundary and Floodway Map/FIRM.

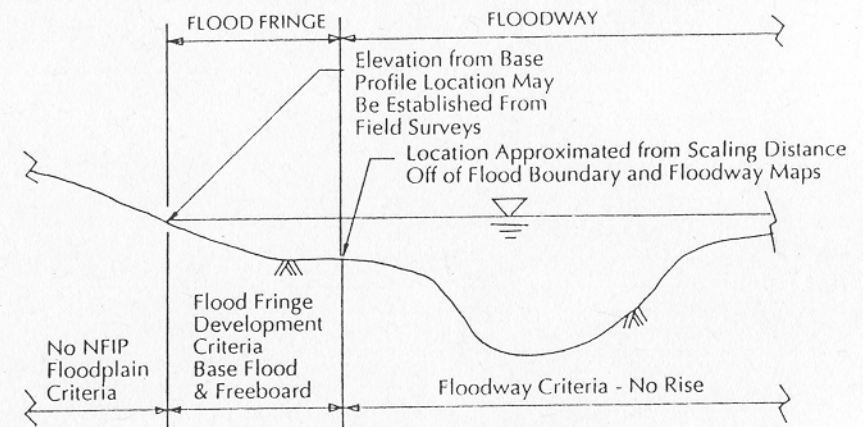


Figure 3: Development Location

3. If the flood maps show the structure or property to be within the floodway fringe, but the field surveys show otherwise the owner may request a Letter of Map Amendment (LOMA) from FEMA to become exempt from flood insurance purchase requirements. The developer, through the community, may also request that FEMA formally revise flood maps through a Letter of Map Revision (LOMr) if it is shown that the original study is in error due to incorrect computations, better analyses, changed conditions, or other factors.

4. Floodway limits are less precise and must be scaled from roads or other physical features reliable from the site and flood boundary and floodway maps. The accuracy of determining whether or not a proposed development site is in the floodway fringe or floodway is affected by the closeness of the site to actual cross sections, physical features, and the

accuracy of the mapping. Normally, the determination as to whether or not a development site is within the floodway limits should be corroborated with the appropriate local officials.

4. Floodway Development Impacts

4-1. **Overview.** The proposed development within the floodway boundaries may result in one of three impacts with regards to the rise in the base water surface profile. They are:

1. Development complies with floodway regulations (no rise)*
2. Development results in profile increase, but within surcharge limits.
3. Development results in profile increase above the surcharge limits.

Note: In some circumstances proposed development may result in no rise in the base water surface profile or in an increase that is within surcharge limits, but will also result in increases in water velocity. Such increases may result in disapproval of the proposed floodway development by the community or a request for a LOMR from FEMA.

The developer must perform the technical studies required to demonstrate the impact of the proposed development. In general, the approval of floodway development is contingent on the development complying with the floodway regulations - no rise in the base water surface profile. However, if the proposed development results in a rise in the base profile, under some circumstances the community and FEMA may revise the floodway boundaries or grant approval if the developer performs remedial actions. *The hydraulic analysis data set used by FEMA in the FIS, modified to reflect the proposed developmental conditions, must be used to document the impacts of the proposed development.*

* no rise = 0.00 ft.

4-2. **Development Complies With Floodway Regulations.** This condition results from the proposed development complying with the NFIP no rise policy for floodway development. No rise means a zero (0.00) increase along the floodway profile when comparing the proposed development floodway profile with the original floodway profile in the FIS.

The project may normally be considered as being consistent with the regulatory standards if the hydraulic conditions can be improved so that no water surface elevation increase results for the proposed design. For functionally dependent components, such as piers, which have a minor effect on the floodway water surface elevations, these modifications often are easily accomplished.

For alternatives where components of the proposed development encroach in the floodway and result in increased floodway profile elevations, more extensive modifications are normally required. Modifications used to alter

the floodway hydraulics to mitigate the increase in the revised conditions profile include:

1. Increase the flow conveyance area upstream and/or downstream of the development or structure;
2. Modify the flow alignment in the vicinity of the development;
3. Reduce the conveyance roughness to increase the efficiency of the base flood flow;
4. Increase the flow gradient in the vicinity of the structure; and
5. Modify design of the piers, abutments, and other floodway components to reduce losses through the structure.

The developer must conduct the water surface profile analysis far enough upstream and downstream of the development location to satisfactorily show that no adverse effects occur if the above hydraulic modifications are performed. Other design considerations besides water surface profiles are energy dissipaters at the downstream end of the modification, upstream and downstream flow transitions into the existing channel, erosion stabilization and sediment transportation, environmental impacts, and other factors relating to possible adverse impacts of hydraulic modifications in the vicinity of the floodway development.

4-3. **Development Results in Profile Rise Within Surcharge Limits.** A community may accept a revised floodway configuration to accommodate a proposed development providing the NFIP limitations on increases in the base flood profile are not exceeded. This is best accomplished when the floodway is first established. However, where the community is willing to amend an established floodway to support this option, the floodway may be revised.

The community has the ultimate responsibility for demonstrating that an alternative floodway configuration meets the NFIP requirements. However, this responsibility is normally borne by the developer, who must also provide all of the data to substantiate the proposal. *Floodway revisions are required even if the floodway width does not change.* The revisions must be based on the water surface profile data sets used to develop the 100-year effective floodway but updated to reflect existing encroachment conditions. This allows determination of the increase in the base flood elevation caused by encroachments since the original floodway was established. For example, if the existing floodway surcharge equals 0.6 00 and the increment of additional surcharge from the proposed development is 0.2 00, the total cumulative surcharge of 0.8 00 is less than the allowable 1.0 00. Under these conditions the community should request a revision to the floodway boundaries, require the developer to implement modifications so that no rise occurs, or require the developer to mitigate the impact with all affected parties.

4-4 **Development Results In Profile Rise Above Surcharge Limits.** Floodway development that will result in a rise in the base profile above the allowable surcharge (normally one foot) should not be approved unless the

conditional approval of the Federal Insurance Administrator is first obtained. The Developer should initially attempt to reduce the surcharge to the base level. This may be accomplished by evaluating alternatives such as widening the floodway or other conveyance modifications described in Section 4-2 to compensate for loss of conveyances caused by the proposed development. If the rise cannot be entirely negated, but the water surface profile elevation is within the surcharge limit, the developer must request a floodway revision as defined in Section 4-3.

If the developer demonstrates that an unavoidable increase in the profile elevation above the surcharge limit results from the development, a request for a conditional map change must be made. Basically this requires the following:

1. A request for conditional approval of the map change and the appropriate initial review fee if applicable.
2. An evaluation of alternatives which would not result in a flood elevation increase above the allowable surcharge limit. This evaluation should demonstrate why these alternatives are not feasible.
3. Documentation of individual legal notice to all impacted property owners within and outside of the community, explaining the impact of the proposed action on their property.
4. Concurrence of the Chief Executive Officer of any other communities impacted by the proposal.
5. Certification that no structures are located in areas which would be impacted by the increased base flood elevation.
6. A request for revision of the base flood elevation and the floodway.

Upon receipt of the Administrator's conditional approval of map change and prior to approving the proposed encroachments, the community must provide evidence to the administrator of the adoption of floodplain management ordinances incorporating the increased base flood elevations and/or revised floodway reflecting the post-project condition. Finally upon completion of the proposed encroachments, the community must provide as-built certifications. A final map revision is then initiated upon receipt of the certification.

5. Examples of Floodway Development

5-1. Overview. This section overviews typical development proposals for floodways and describes basic analysis considerations and requirements for submittal for approval. The actual conditions may necessitate a variation in analysis procedures and requirements. In general, approval for proposed developments in the floodways is contingent on demonstration that the project will not result in a rise in the floodway profile. Specific criteria and actions are described in Section 6.

5-2. Downstream Side of Existing Structure. A small addition to an existing structure may be acceptable if it is constructed on the downstream side of the structure within the flow patterns shown in Figure 4. However, the hydraulics of losses and flow patterns around buildings and other obstructions are complex, especially in urban areas. The developer may be required to show that the assumptions as shown in Figure 4 are applicable to the proposed development location and that no rise in the base flood will occur.

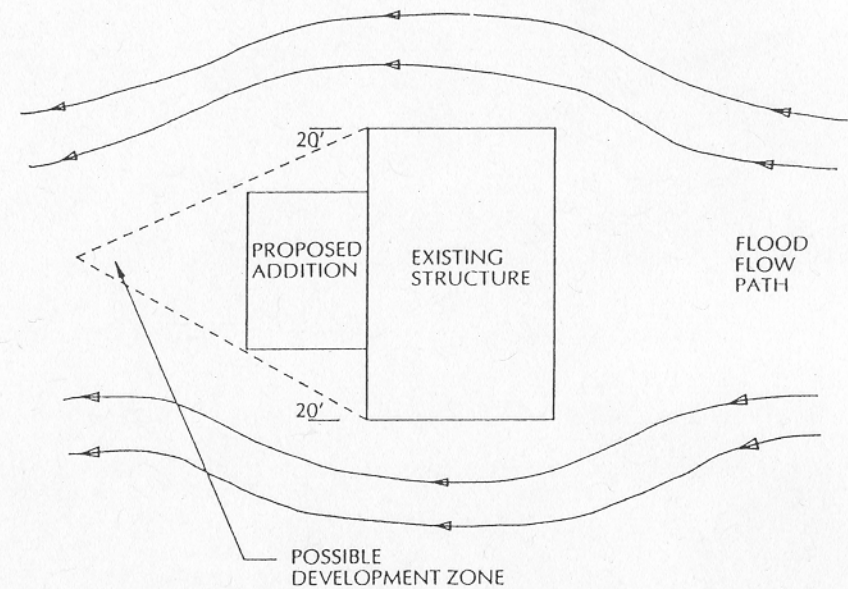


Figure 4: Development Downstream Side of Structure

If it can be shown that the flow patterns are such that the development is on the downstream side, the flow patterns are not significantly interfered with by other obstructions, and that the addition is relatively small, **the proposal may be approved without detailed water surface profile analysis.** Normally for this condition the proposed development must be located within the flowline shadow of the existing building conceptualized by 20 degree angles with the downstream corners of the building.

For complex areas where the flow patterns are affected by several obstructions, more complex hydraulic modeling and analysis may be required to demonstrate that no rise in the base profile will occur.

5-3. Relocation of Channel Alignment. Development within the floodway areas may include realignment of the existing flow conveyance path and floodway delineations. Figure 5 shows an example of a realignment of a

channel and revised floodway delineation. This option is generally limited to relatively small streams. The base flood profile must reflect no increase in elevation unless conditions defined in Section 4 "Floodway Development Impacts" are applied. Adjacent communities and property owners opposite, upstream and downstream of the development must be notified of proposed realignments and of any negative impacts induced by the project.

The community has the option of shifting the floodway to one side of the stream or the other as long as both sides of the stream are within the corporate limits and there are no ownership problems. For example, the designated floodway boundaries may be shifted to a park area on one side of a stream to allow commercial development on the other side.

The development proposal may require hydraulic design documentation of radical bends, bank erosion and sediment control methods, flow transitions to the existing channel and energy dissipation procedures at the lower end of the development as applicable. The hydraulic analysis must encompass the stream from a downstream point unaffected by the proposed development to the upstream point where original conditions and anticipated post-project profiles converge.

Any environmental impacts associated with the realignment of the channel must be described and documented.

5-4. Equal Conveyance Replacement. The concept of equal conveyance replacement as part of a development proposal is similar to that of the channel realignment. The concept is to replace the cross-sectional area of conveyance taken by the development with an equal area below the Base Flood Elevation so that there is no decrease in cross-sectional conveyance area at the development location throughout its range of flow depths. See Figure 6. This may be accomplished by excavation of the conveyance area or by replacing a structure below the Base Flood Elevation by one of equal or less volume and cross-sectional area. The excavated area must be adjacent to the main channel to assure that conveyance is maintained so that there is no increase in the Floodway profile.

Other hydraulic design criteria as described in Section 5-3 are also applicable. As in relocation of channel alignments the hydraulic analysis must encompass the stream from a downstream point unaffected by the proposed development to the upstream point where original conditions and anticipated post-project profiles converge, and it must be demonstrated that a reasonable flow transition is maintained through the altered cross sections.

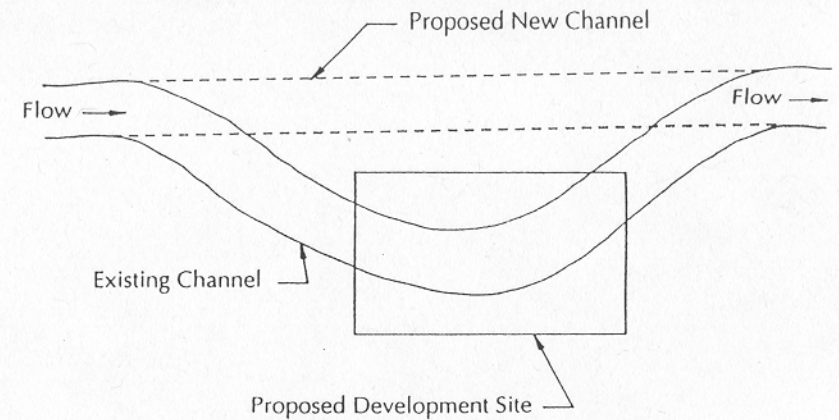


Figure 5: Relocation of Channel

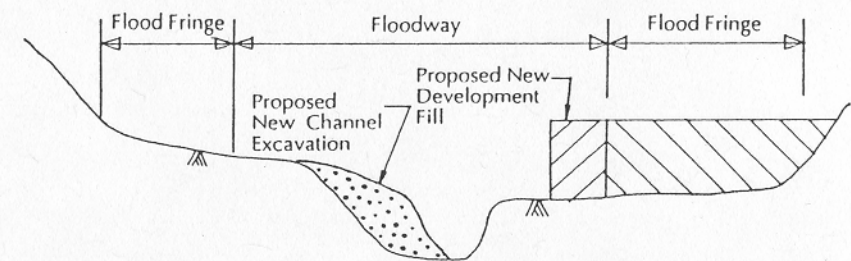


Figure 6: Equal Conveyance Replacement

5-5. Development Elevated on Piers or Columns. Proposed development elevated on piers or columns may result in a negligible increase in the base flood elevations, requiring no compensating actions. However, the developer must demonstrate that this is the case. Small increases in the base profile may be offset by procedures defined in Section 4-2. The developer may also be required to analyze the effect of debris buildup among the piers or columns.

5-6. Fill or Barrier Obstruction. The placement of fill or a barrier such as a levee or floodwall in the floodway requires remedial actions to offset the induced increase in the base flood profiles. These actions are often equal replacement of lost conveyance area through the cross section at the development (see Section 5-4). The developer, if a Federal agency or if using funds from a Federally sponsored program, must also meet applicable floodplain guidelines such as Executive Order 11988.

National Flood Insurance Program regulations (PART 65) include standards for levees or floodwalls. These standards address freeboard requirements, structure and closure maintenance, interior drainage, etc. Developers and

community officials should be aware of specific applicable requirements in order to avoid adverse flood insurance rating.

5-7. Highway Stream Crossing. For communities where the NFIP regulations are in effect and the regulatory floodway defined, the initial alternative analyzed should be a highway stream crossing with all components excluded from the floodway. The design, which essentially spans the floodway, must also limit the rise of the base flood (100-year flood profile) within the regulatory criteria (normally one foot). The alternative must be sufficiently detailed to show the effect on the floodway profile.

When it is clearly shown to be inappropriate to design a highway crossing to avoid encroachment on the floodway and where the floodway cannot be modified such that the structure could be excluded, FEMA will approve an alternate floodway with profile in excess of the 1 foot maximum only when the following conditions have been met:

1. A location hydraulic study has been performed in accordance with Federal-Aid Highway Program Manual (FHPM) 6- 7-3-2 "Location and Hydraulic Design of Encroachments on Floodplains" (23 CFR 650, Subpart A) and FHWA finds the encroachment is the only practicable alternative (Federal Highway Administration 1979).

2. The constructing agency has made appropriate arrangements with affected property owners and the community to obtain flooding easements or otherwise compensate them for future flood losses due to the effects of the structure.

3. The constructing agency has made appropriate arrangements to assure that the National Flood Insurance Program and Flood Insurance Fund do not incur any liability for additional future flood losses to existing structures which are insured under the Program and grandfathered in under the risk status existing prior to the construction of the structure.

4. Prior to initiating construction, the constructing agency provides FEMA with revised flood profiles, floodway and floodplain mapping, and background technical data necessary for FEMA to issue revised Flood Insurance Rate Maps and Flood Boundary and Floodway Maps for the affected area upon completion of the structure.

6. Floodway Impact Analysis

6-1. General. The developer must assemble and provide to the local officials information and analysis results of the effects of the proposed development on future flood elevations. These data will be used to determine whether or not the request for floodway development is approved.

6-2. Data Required. The following data must be provided by the developer

(permit applicant) and submitted to the appropriate local officials to use in determining the effect of the proposed activity on future flood heights.

1. Valley Cross Sections. The valley cross section of the channel and overbank area must be taken perpendicular to the flow of the stream (see Figure 7). The cross section must extend to an elevation above the expected 100-year floodplain.

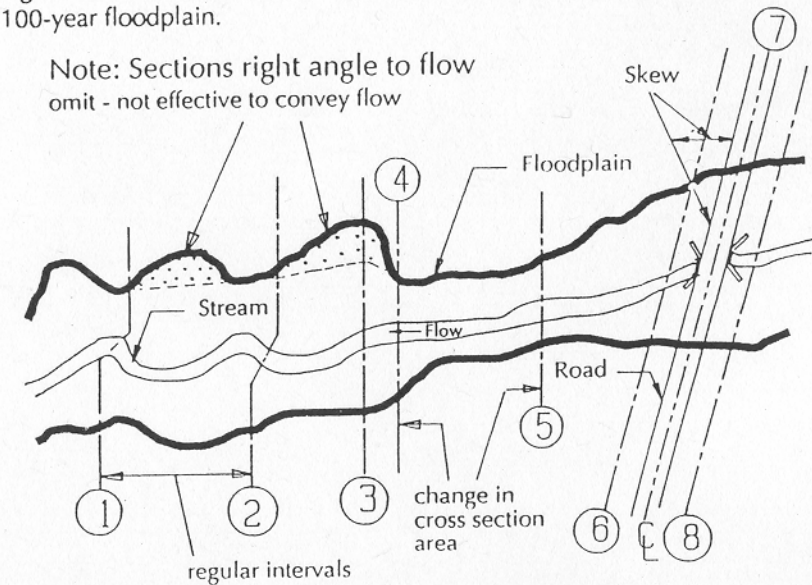


Figure 7: Location of Valley Cross Sections

The collection of field data for use in the calculation of water surface profiles requires many engineering judgments and field considerations. While performing the surveys it is important to note that the cross sections should be typical of the reach between adjacent upstream and downstream cross sections. (If available, the original cross-sections used in the FIS can be obtained from the appropriate FEMA Regional Office.) Local irregularities in the ground surface that are not typical of the reach should be avoided in the surveys. The reach length (distance between cross sections) must be measured in the channel and the right and left overbanks.

Control structures such as bridges, road grades, culverts, levees, dams, and wing dams in the vicinity of the proposed development must be defined by appropriate cross sections and reflected in the water surface profile analysis. Measurements and descriptions of the control structures should be noted in the field survey books.

Starting water surface elevations must be taken from the base profile downstream of the proposed development at the nearest cross section. If the development is near the downstream end of the Flood Insurance Study (FIS),

the downstream distances must be sufficient to mitigate starting conditions profile errors prior to downstream floodway revisions associated with the structure. Upstream distances must be of sufficient distance that the modified conditions profile converges to that of the base condition. The distances will vary depending on the magnitude of the floodway revision and the hydraulic characteristics of the stream.

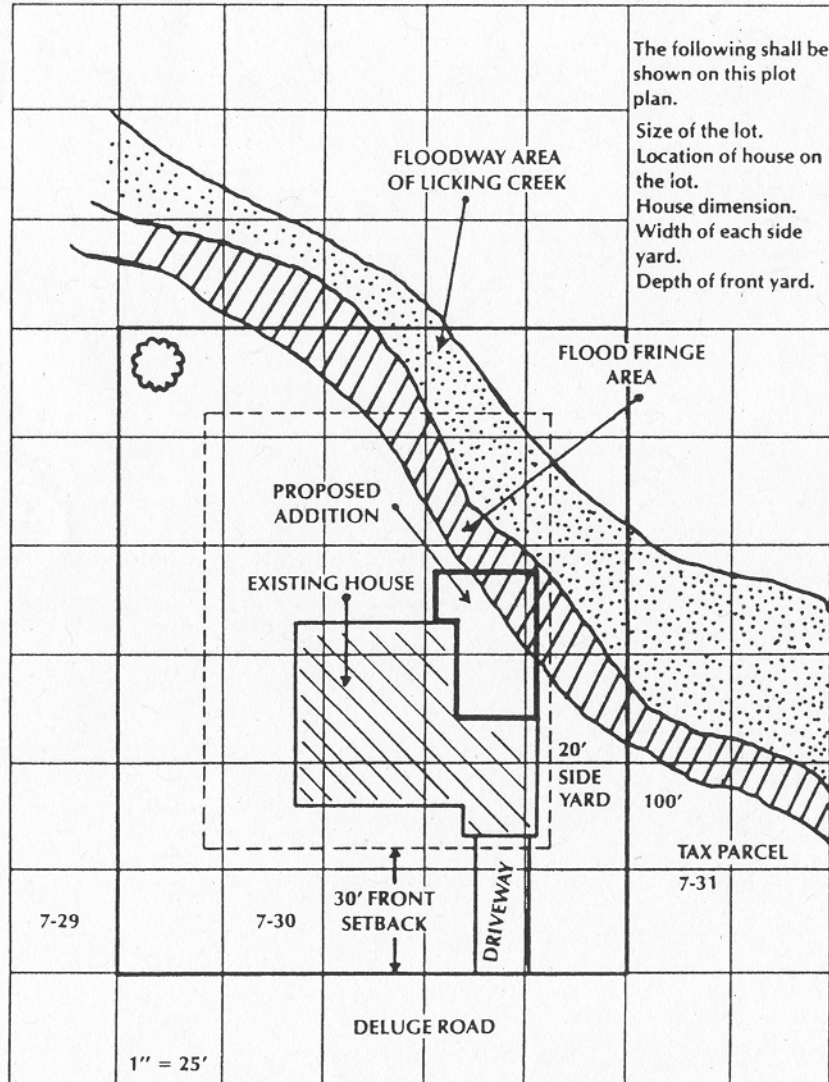


Figure 8: Plan View of Proposed Development

2. **Photographs.** Photographs must be taken along the stream showing the channel and ground cover in the overbank areas. Photographs should also be taken to show the upstream and downstream ends of all control structures in the vicinity of the proposed development.

3. **Plan View.** A plan view of the proposed development must be included with the materials submitted for review. The plan view must show the exact dimensions of the proposed change in the relation to the stream and other physical and geographic features. The geometry of the proposed development should also be shown on the valley cross section so that the hydraulic effects of the encroachment on the opposite side of the stream can be analyzed. (See Figure 8)

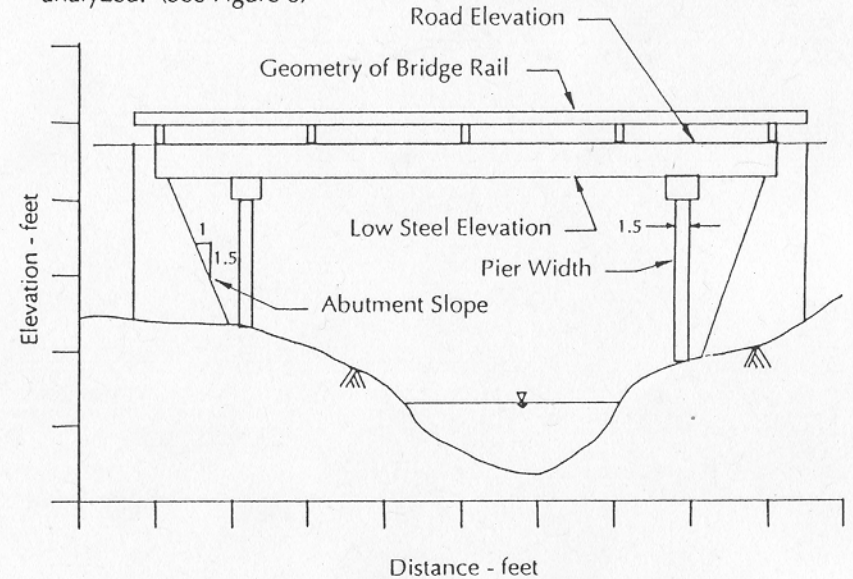


Figure 9: Bridge Cross Section

4. **Bridge Data.** For cases where a bridge is the controlling factor in the analysis of the proposed development, the effect of the bridge on the water surface profile must be determined. The following data are required:

- A representative valley cross section,
- A cross section along the centerline of the bridge to the assumed floodplain limits (See Figure 9),
- The roadway elevation, road width, and type of surface,
- A cross section of the bridge opening showing the low steel elevation, bridge abutments, piers, and channel,
- The number, size, and type of piers,
- The bridge skew (the angle between the centerline of the bridge and a line drawn perpendicular to the channel flow,

- g. Size of bridge opening,
- h. Description of bridge railings, and
- i. Photograph of the bridge opening, channel, overbanks, right and left roadway approaches, and the top of the roadway.

5. **Culvert Data.** For cases where a culvert is the controlling factor in the analysis and the effects of the water surface profile of the culvert must be computed, the following data are required:

- a. A representative cross section,
- b. A cross section along the centerline of the road to the assumed floodplain limits (See Figure 10),
- c. Road width,
- d. Type of surface,
- e. Number, type, size, and length of culverts,
- f. Upstream and downstream invert elevations of the culverts,
- g. Skew of the culvert (the angle between the centerline of the culvert and a line drawn perpendicular to the flow), and
- h. Inlet characteristics (e.g. headwall, projecting, mitered, etc.)

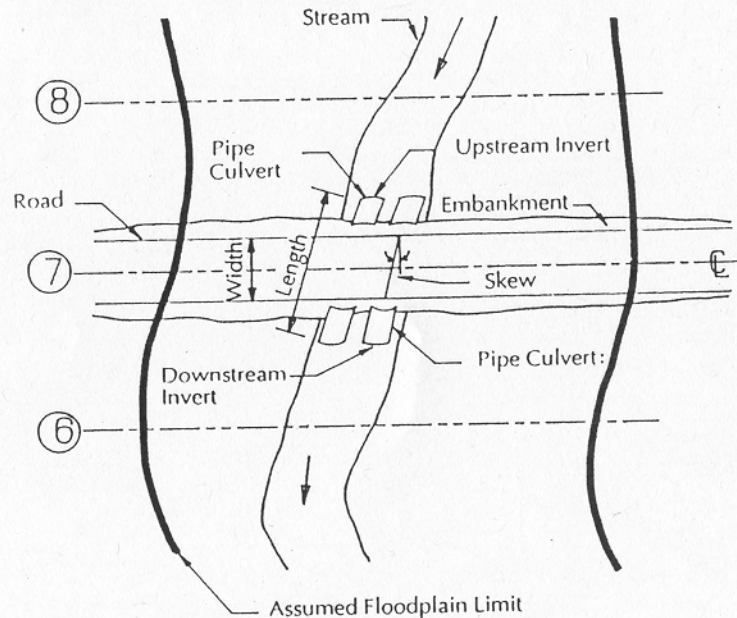


Figure 10: Plan View of Culvert

6. **Dam Data.** For situations where a dam is the controlling factor in the analysis and the effects of the water surface profile from the dam must be computed, the following data are required: (See Figure 11)

- a. Type, size, and number of gates if appropriate,

- b. Elevations and description of the dam,
- c. Elevation, dimensions and description of the spillway and all other outlet works,
- d. Representative downstream cross sections to determine tailwater effects, and
- e. Operating plan for the dam (if available)

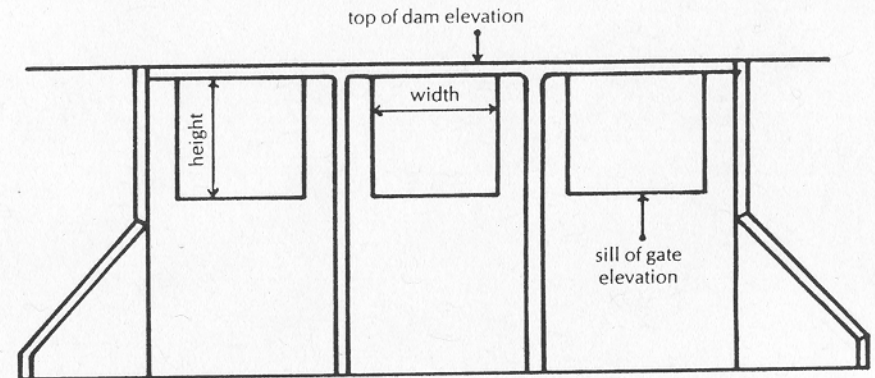


Figure 11: Front View of Dam

6-3. **Analysis Procedures.** The increase to the water surface profile must be referenced to the existing conditions profile developed when the floodway was first established. The base and modified conditions water surface profile analysis must extend far enough upstream and downstream to evaluate the impact of the proposed development.

If the input data of the original regulatory conditions is unavailable, a new data set should be developed using the original cross-sectional topographic information and the discharge values contained in the Flood Insurance Study which establish the original floodway. The profile analysis should then be performed confining the effective flow area to the currently established floodway and calibrated to reproduce the FIS profile. The modified floodway conditions are then evaluated using the above procedures.

7. Floodway Revision Submittal Procedures

7-1. **General.** This section describes the data requirements that must be submitted by the community for review of floodway development proposals and if approved, revisions to the floodway. The potential actions of the FEMA on a request are also described.

7-2 **Data Requirements.** Technical data submitted to FEMA in support of a floodway revision request should include that listed in the following paragraphs:

1. A plan view of the proposed development must be furnished for all proposed floodway development. The plan view must show the dimensions and location of the proposed change in relationship to the stream and other physical features. The geometry of the proposed fill or excavation should be shown on the valley cross section so that compensating conveyance parameters can be reviewed.

2. Before and after cross-sections, plotted on graph paper.

3. Photographs of the site, upstream and downstream conditions, and of unique features that may affect the water surface profile must be provided.

4. Copy of current regulatory Flood Boundary Floodway Map, (FBFM) showing existing conditions, proposed development and revised floodway limits.

5. Copies of the printout for the original computer models representing both the 100-year and subsequent floodway determination runs which were used to develop the present effective floodway. The printouts must include full input and output listings.

6. Copy of the printout from the hydraulic computer model representing the revised 100-year profile. The model should include any channel modifications, fill or encroachments that have occurred in the floodplain since the original floodway was delineated.

7. Copy of the printout from the hydraulic model representing the floodway run for the proposed floodway, including channel modifications and encroachments since the original floodway was established. The equal conveyance reduction method should be used to compute the revised floodway limits unless agreements have been made with affected property owners to utilize a different method. The printout must include full input and output listings with all input changes from the original model highlighted.

8. A copy of the revised Floodway Data Table representing data for the proposed floodway configuration.

9. A copy of the presently effective FBFM showing the existing floodway and one copy showing the proposed floodway configurations.

10. Certification from a professional engineer that the physical parameters used in the proposed floodway delineation represent actual conditions.

11. If the basis for the proposed floodway is a channel modification, the completion of a dam, or any other structural measure, evidence is required to demonstrate the design is adequate and maintenance and operations provision, where applicable, are provided. The submittal must indicate what entity has maintenance responsibility and how it will be performed. If maintenance is to be provided by agencies other than the community, a legal provision for community monitoring and back-up assistance is required.

12. Documentation of approval of the proposed floodway revision from the appropriate state agency for communities where the state regulates the floodway.

7-3 FEMA Response To Floodway Revision Requests. FEMA is required to review all community requests for floodway map revisions. When the revision is considered to be significant, FEMA will revise floodway maps and distribute them to recognized users. FEMA will respond to a request from the community for a floodway revision by one of the following means:

1. Reprinting the affected panels of the Flood Boundary and Floodway Map with the corresponding revised dates. The panels will be accompanied by a revised index panel showing the most up-to-date floodway panels maintained at FEMA. Copies of the revised floodway panels will be sent to previous recipients of the floodway maps. A revised Flood Insurance Study report will accompany the floodway maps. Included in the report will be a description of the revision and revised Floodway Data Tables.

2. Revising the Flood Boundary and Floodway Map, but without immediate reprinting FEMA will send one copy of the Flood Boundary and Floodway Map designating the approved floodway revision to the community and a letter of map revision (LOMR) stating that the review of the submitted material has resulted in the determination that the FEMA minimum requirements have been met but a reprinting of the Flood Boundary and Floodway Map is not warranted at this time. The material will be filed for incorporation at a later time into a floodway map revision. The approved Flood Boundary and Floodway Map revision copies will be dated. Since it is possible that FEMA has previously responded to a floodway revision request in this manner, all Flood Insurance Study users are encouraged to contact the community before proceeding with plans for development within floodway fringe and floodways.

3. Send a letter to the community stating that the submittal material is incomplete and/or that the revised floodway does not meet FEMA minimum criteria.

7-4 Submittal of Material. The material requesting revisions to floodway areas must be submitted by the community to the appropriate FEMA Regional Office. The Regional Office will review the material for completeness, concur with the proposed changes, approve any maintenance ordinances, and forward the necessary material to the FEMA Central Office.

The FEMA Central Office will review the hydrologic and hydraulic materials, engineering design, and any plans of operations and maintenance (where appropriate), request additional revisions or corrections as necessary, then respond to the community by means of the appropriate action defined in Section 7-3.

To obtain further information on the conditions and criteria for floodway revisions, communities are encouraged to contact the FEMA Regional Office. [Region III, 105 So. 7th St., Philadelphia, PA 19106 - (215) 931-5737]

8. Floodplains Without Designated Floodways

8-1. **NFIP - No Regulatory Floodway.** For communities where a detailed flood insurance study has been performed but no regulatory floodway designated, the base condition flood profile is the focus of the analysis. The development should be designed to allow no more than the regulatory criteria (cumulative total of 1-foot of surcharge) increase in the base profile established by the flood insurance study. Where it is not practicable to design the development to meet the regulatory criteria, the procedures outlined under Section 4 should be followed in requesting a revision of the base regulatory profile.

APPENDIX A

REFERENCES

1. Federal Emergency Management Agency 1985a, **National Flood Insurance Program and Related Regulations, Oct. 1, 1988.**
2. Federal Emergency Management Agency 1985b, **Flood Insurance Study, Guidelines and Specifications for Study Contractors**, Federal Insurance Administration.
3. Federal Emergency Management Agency 1984, **Conditions and Criteria for Floodway Revisions.**
4. Federal Emergency Management Agency 1982, *Coordination on Highway Encroachments*, Memorandum to FEMA Regional Directors.
5. Federal Highway Administration 1980, *Assessment of the Impacts of the National Flood Insurance Programs on Highways*, Report No. HGWA/RD-80/015.
6. Federal Highway Administration 1979, *Location and Hydraulic Design of Encroachments on Flood Plains*, Department of Transportation, Federal Register.
7. Pa. Department of Community Affairs, **Regulating Floodplain Development - A Handbook for Local Officials**, December, 1982.
8. State of Wisconsin 1986, **Data Needed for Floodplain Determination**, Wisconsin Department of Natural Resources.
9. U.S. Government 1968, *National Flood Insurance Act of 1968*, Title XIII - National Flood Insurance Program, Federal Register.
10. U.S. Water Resources Council 1982, **Strengthening State Floodplain Management, Appendix A, Regulation of Flood Hazard Areas to Reduce Flood Losses**, Vol. 3.
11. U.S. Water Resources Council 1978, *Floodplain Management Guidelines for Implementing E.O. 11988.*

APPENDIX B

STATE FLOODWAY REGULATIONS

PENNSYLVANIA

The Pennsylvania Department of Environmental Resources, Bureau of Dams and Waterway Management maintains jurisdiction over any obstructions, existing and proposed, within any identified floodway area. Where floodways are not identified, DER's jurisdiction extends 50 feet landward from the top-of-bank of any watercourse.

Anyone wishing to place a structure, fill, or any other obstruction in such areas must obtain a state water obstruction permit. Applicants must complete and submit an application form along with all necessary technical information to the DER. Application fees start at \$50. For a copy of the application form, regulations and any further information contact:

PA Department of Environmental Resources
Bureau of Dams and Waterway Management
P.O. Box 2357
Harrisburg, Pa. 17120
717-787-6826

DER recognizes the NFIP floodway surcharge limit and regulations. Applications are reviewed for measurable impacts on flood heights. Among other things, DER must review water obstruction applications in relation to their consistency with local floodplain management regulations. Applicants are required by law to notify municipalities of their pending application. This is to ensure that municipalities are made aware of proposed floodway activities and to afford the opportunity for communities to address the question of consistency.

The complete set of Water Obstructions and Encroachments Rules and Regulations are contained in Title 25, Chapter 105 of the Pa. Code. In addition to floodway areas, the DER has jurisdiction over selected activities throughout floodplain areas. These regulations are found in Chapter 106 of the Code.