



**US Army Corps
of Engineers**

Hydrologic Engineering Center

Flood Emergency Plans

Guidelines for Corps Dams

June 1980

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Flood Emergency Plans

Guidelines for Corps Dams

June 1980

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RD-13



REPLY TO
ATTENTION OF:

**DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF ENGINEERS
WASHINGTON, D.C. 20314**

DAEN-CWE-H

30 Jun 1980

SUBJECT: Flood Emergency Plans Guidelines for Corps Dams

SEE DISTRIBUTION

1. References:

a. Director of Civil Works multiple letter dated 20 March 1978, subject: Evacuation Plans for Areas Downstream of Corps Dams and Corps/State Cooperation on Safety Review of Corps Dams.

b. ER 1130-2-419, "Dam Operations Management Policy", dated 18 May 1978.

c. Federal Guidelines for Dam Safety, 25 June 1979.

d. Executive Director of Civil Works multiple letter dated 30 November 1979, subject: Policy Issue No. 79-13, Corps Role in Emergency Planning for Areas Downstream of Corps of Engineers Dams.

2. Inclosed is a copy of supplemental guidelines to augment previous information provided in the above references.

3. The attached guidelines, prepared by the Hydrologic Engineering Center at the direction of OCE, should be used in the future development of Flood Emergency Plans for Corps dams and reservoirs. Updating of existing plans should also be in accordance with the guidelines, insofar as practical.

4. In accordance with instructions in paragraph 8 of reference 1b, the responsibility for preparation of the emergency plans is shared by Operations and Engineering personnel. The water control management and emergency operations staffs should play a major role in the plan preparation. However, other elements of field organizations with special expertise, such as flood plain information personnel, should provide assistance as appropriate.

5. Appendices on case studies and background information are being developed and will be provided when available. However, preparation of emergency plans should proceed as expeditiously as practical because the additional information is not essential to completion of the plans.

6. The critical period regarding dam safety is generally during construction and initial storage of water in the reservoir. Therefore an emergency plan is particularly important during this

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period. Future dam and reservoir projects should have an emergency plan, approved by the Division Engineer, prior to significant storage of water in the reservoir.

7. Additional copies of the attached guidelines are available from the Hydrologic Engineering Center, 609 2nd Street, Davis, CA 95616.

FOR THE CHIEF OF ENGINEERS:

1 Incl
as

E. R. HEIBERG III
Major General, USA
Director of Civil Works

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PREFACE TO THE SECOND EDITION

Recent emphasis on dam safety and flood emergency evacuation plans resulted in new requirements for Federal dam safety. This document provides guidance for the Corps effort to implement President Carter's directive to Federal agencies to develop flood emergency action plans for Federal dams. The procedure described is based upon the Federal Guidelines for Dam Safety but provides added detail.

It was planned during preparation of the first edition of these guidelines to include a "Background Appendix" summarizing some of the more important literature relevant to emergency planning for dams. This material has since been published as Emergency Planning for Dams -- Bibliography and Abstracts of Selected Publications by the Hydrologic Engineering Center (January 1982).

The first edition of the guidelines also anticipated two appendices consisting of case studies illustrating application of the guidelines. Only one case study is now planned and the results are to be published as two independent documents, consisting respectively of: 1) a hypothetical example of a Corps flood emergency plan package, and 2) a hypothetical example of a community-level flood emergency evacuation plan.

The content of this edition is the same as that of the first edition. This edition only serves to update the document with respect to the preparation and inclusion of appendices.

Mr. H. James Owen, Consulting Engineer, prepared this document pursuant to Contract DACW05-79-P-1962 with the Hydrologic Engineering Center (HEC). Portions of the document describing hydraulic and dambreak analyses were based on information provided by Dr. D. Michael Gee of the HEC. Funding was provided by the Corps Water Resources Planning, Analytical Techniques research work units entitled "Hydrologic Methods of Dam Safety Studies" (No. 31638) and "Emergency Planning Manual for Flood Evacuation" (No. 31705). Mr. Bill S. Eichert was the Director of the Hydrologic Engineering Center during the preparation of this document, and Mr. Arlen D. Feldman of the HEC was the principal-in-charge. Valuable comments and support were received from the Office, Chief of Engineers, and especially from Mr. Vernon K. Hagen, Chief of the Hydraulic and Hydrology Branch.

July 1982

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FLOOD EMERGENCY PLANS

GUIDELINES FOR CORPS DAMS

1. Background

Much of the land constituting the reservoir area that would be inundated by spillway design flows is not in Federal ownership. The possibility therefore exists at many dams that large flows could cause a hazard to life and property in reservoir areas. In addition, flows from reservoirs during design floods could be hazardous to life and property in downstream areas.

Extensive care is taken by the Corps in design, construction and operation of dams. As a result, the Corps record for dam safety is considered excellent. Nevertheless, dam failures in the United States in recent years have focused much attention on dam safety, resulting in a requirement for all Federal agencies to review practices affecting the safety and integrity of Federal dams.

The Corps Dam Safety Assurance Program addresses the problems relating to both larger than normal flows and potential dam failure. It requires the preparation of emergency plans¹ for all Corps dams.

a. Flood Emergency Plans

The Director of Civil Works sent a letter to all division offices on 20 March 1978 regarding "Evacuation Plans for Areas Downstream of Corps Dams and Corps/State Cooperation on Safety Review of Corps Dams." The letter directed the Corps field offices to proceed with the development of evacuation plans (inundated area maps), and suggested the techniques to be used in routing hypothetical flows. It also provided guidance for cooperating with states in regard to their concern for the safety of Corps dams. The letter was followed on 18 May 1978 by issuance of ER 1130-2-419, entitled Dam Operations Management Policy. The ER specified the respective responsibilities of districts, divisions and the Office of the Chief of Engineers for management of dam operations. It also directed that a program be undertaken to train staff in emergency operations and detection of problems at dam sites. Preparation of dam safety plans were required by the ER. Plans were to include:

- (1) Emergency notification procedures;
- (2) List of conditions leading to emergencies and ways of dealing with them;

¹The term "emergency plans" includes both the portion of a dam safety plan prepared by the Corps and the complementary evacuation plan prepared by non-Federal interests. More precise definition of the Federal and non-Federal portions of emergency plans are provided in subsequent sections.

- (3) Reservoir de-watering procedure;
- (4) Dam failure inundation maps;
- (5) Listing of emergency repair materials and equipment;
- (6) Outline of responsibilities for inspection and emergency repairs; and
- (7) List of nearby contractors.

With respect to evacuation plans, ER 1130-2-419 specified that their development was the responsibility of non-Federal officials. Corps districts were to suggest the development of such plans and provide pertinent project information, including inundation maps, to assist in their development. Other technical assistance for development of evacuation plans was permitted if requested.

b. Federal Guidelines for Dam Safety

The Federal Guidelines for Dam Safety was issued on 25 June 1979. This document represented the response to President Carter's request in April 1977 for safety guidelines. The guidelines treated organizational management and management of site investigation and design, construction, and operation and maintenance. A portion of the guidelines for management of operation and maintenance dealt with emergency action plans and addressed the following points:

- (1) Evaluation of emergency potential:
 - (a) determination of mode of dam failure;
 - (b) inundation maps;
 - (c) classification of inundation areas; and
 - (d) time available for response;
- (2) Actions to prevent failure or minimize effects of failure:
 - (a) development of emergency action plan;
 - (b) notification plans;
 - (c) evacuation plans;
 - (d) stockpiling repair materials;
 - (e) locating local repair forces;

- (f) training operating personnel; and
 - (g) increasing inspection frequency;
- (3) Actions upon discovery of a potentially unsafe condition:
- (a) notification of supervisory personnel;
 - (b) initiation of predetermined remedial action; and
 - (c) determination of need for public notification.

The Executive Director of Civil Works transmitted a policy summary to OCE elements and division offices on 30 November 1979 dealing with the Corps role in emergency planning for areas downstream of Corps dams. The policy summary expanded consideration of potential emergencies to include significant flooding without dam failure and provided for assistance by Corps offices to non-Federal interests upon request in order to foster development of effective non-Federal emergency plans. The policy summary also assigned the Hydrologic Engineering Center responsibility for preparation of this technical manual on dam emergency planning for use by Corps personnel and as a source of information for non-Federal interests and other Federal agencies.

2. References

- a. Federal Guidelines for Dam Safety. Prepared by the Ad Hoc Interagency Committee on Dam Safety of the Federal Coordinating Council for Science, Engineering and Technology. Washington, DC June 25, 1979.
- b. DAEN-CWR-P letter dated 30 November 1979, Subject: Policy Issue No. 79-13, Corps Role in Emergency Planning for Areas Downstream of Corps of Engineers Dams
- c. ER 1130-2-417
- d. ER 1130-2-419
- e. ER 1110-2-101
- f. ER 1105-2-40
- g. DAEN-CWE letter dated 20 March 1978. Subject: Evacuation Plans for Areas Downstream of Corps Dams and Corps/State Cooperation on Safety Review of Corps Dams.

3. Purpose

This document provides basic technical guidance for the development of dam emergency plans. The information is intended to be of assistance in the evaluation and improvement of existing emergency plans and evacuation plans and in the development of new plans where none exist at present.

4. Scope

This document provides guidance for preparation of dam emergency plans to deal with potential emergencies caused by:

- a. Spillway discharges sufficiently large to cause flooding in downstream areas;
- b. Flooding upstream of dams due to backwater effects or high pool levels; and
- c. Dam failure.

Guidance presented is oriented specifically toward emergency planning for Corps dams. Many aspects of emergency planning are treated in existing Engineering Regulations and other instructions and are therefore not repeated here. Persons using the guidelines are cautioned to review the cited references.

The guidance presented is pertinent to dams located in riverine situations. It may not be entirely relevant for other types of protective works or dams for offstream storage. Use of the guidelines should be supplemented in every case by analysis of the individual requirements of the structure under consideration.

There is little experience available on which to base preparation of guidelines for dam emergency planning. Guidelines presented are therefore based largely on analysis of the problem and, by analogy, on guidance already developed for planning and, implementation of flood warning and preparedness alternatives. Improvement of the guidance can be expected as experience is gained. Preparation of a case study example of emergency preparedness planning is presently underway.

5. Components of Emergency Plans

The principal components of dam emergency plans are:

- a. Emergency Identification Subplan. (Federal)

The object of this subplan is to describe procedures and means for assuring reliable identification and evaluation of existing or potential emergencies. The major elements of the subplan are:

- (1) Listing of the conditions which could indicate an existing or potential emergency;
- (2) Description of the data and information collection system, monitoring arrangements, inspection procedures and other provisions for early detection of conditions indicating an existing or potential emergency; and
- (3) Procedures, aids, instructions and other provisions for interpreting information and data to assess the severity and magnitude of any existing or potential emergency.

b. Emergency Operations and Repair Subplan. (Federal)

The objectives of this subplan are to guide immediate operational decisions in the event of various types of emergencies; identify the need for equipment, material, labor and other necessities for carrying out emergency repairs; and describe the procedures for securing and employing needed equipment, material, labor and other necessities. The major elements of the subplan are:

- (1) Identification of the appropriate response to the type and severity of existing or potential emergency;
- (2) Reservoir de-watering plan;
- (3) Description of equipment and materials to be stockpiled for use in carrying out emergency operations and repairs;
- (4) Assignments of responsibilities for carrying out emergency operations and repairs;
- (5) Description of needs for equipment, material and labor not available at the site which are needed to carry out each type of emergency operation or repair; and
- (6) Listing of nearby contractors and other sources of needed equipment, material and labor, and description of procedures for securing their assistance on an emergency basis.

c. Notification Subplan. (Federal and Non-Federal)

The objective of this subplan is to describe the procedures and means for prompt notification of appropriate parties concerning existing or potential emergencies. The major elements of the subplan are:

- (1) Inundation maps which show the area likely to be inundated and time of onset of dangerously high flows for each emergency condition for which plans are made (Federal);
- (2) Listing of vital services and facilities outside the area of inundation which will or may be disrupted by the level of inundation associated with each emergency condition for which plans are made (non-Federal);

- (3) Listing of major secondary problems resulting from the level of inundation associated with each emergency condition for which plans are made (non-Federal);
- (4) Evacuation maps which show (non-Federal):
 - (a) all areas which should be evacuated because of inundation, secondary problems, loss of services, isolation or other reasons which are associated with each emergency condition for which plans are made;
 - (b) major evacuation routes;
 - (c) areas requiring priority in evacuation; and
 - (d) potential obstacles to timely evacuation;
- (5) Listing of persons to be notified about each emergency condition for which plans are made and procedures for notification including description of primary and secondary means of communication to be used, listing of telephone numbers, and addresses, and other information needed for reliable and prompt contact for (Federal):
 - (a) notifications internal to the Corps;
 - (b) notifications from the Corps to principal local officials;
 - (c) notifications from the Corps to other Federal officials;
 - (d) distribution of warnings from the Corps to officials responsible for dissemination to the general public; and
 - (e) dissemination of warnings by the Corps directly to the general public in the immediate vicinity of the dam and reservoir;
- (6) Example press releases for each emergency condition for which a plan is prepared and instructions for adaptation before their use to the specifics of an emergency situation including but not limited to (Federal):
 - (a) exact nature of emergency and degree of danger;
 - (b) remedial action underway;
 - (c) expected course of events and timing; and
 - (d) appropriate action for public to take.
- (7) Description of the procedure and means for dissemination of warnings directly to the general public in the immediate vicinity of the dam and reservoir (Federal).

d. Evacuation Subplan (Non-Federal)

Non-Federal officials are to be encouraged to develop evacuation subplans as a complement to the portion of dam emergency plans prepared by the Corps. The objectives of the evacuation subplan are to provide for the timely and safe evacuation of threatened areas and the minimization of property damage. The major elements of the subplan are:

- (1) Description of traffic control arrangements to expedite evacuation and passage of emergency vehicles and prevent accidental travel into dangerous areas;
- (2) Provisions for any necessary assistance to evacuees such as transportation and aid to invalids;
- (3) Arrangements for sheltering, feeding and other care of evacuees;
- (4) Description of actions to be taken to reduce damages and other losses;
- (5) Arrangements for security of evacuated areas; and
- (6) Arrangements addressing other aspects as required for the case at hand.

6. Number of Plans Required

A large number of hypothetical emergencies could be conceived by combining various causes for and assumptions about emergencies of one type or another. It is obviously impractical to prepare completely separate plans to address each potential emergency condition which might be postulated. Instead, each major portion of the emergency plan must be considered individually with respect to how many separate versions are necessary.

a. Emergency Identification Subplan

Only one Emergency Identification Subplan is required.

b. Emergency Operations and Repair Subplan

The Emergency Operations and Repair Subplan consist of guidance and procedures for dealing with a variety of emergencies. One subplan is sufficient. The portion of its contents dealing with emergency responses should be divided according to the type of emergency addressed or action to be taken as, for example, the following:

- (1) Wave erosion;
- (2) Excess seepage;
- (3) Piping;
- (4) High pool conditions;

- (5) Malfunction of control gates;
- (6) Failure of discharge facilities;
- (7) Upstream dam failure; and
- (8) Downstream dam failure.

c. Notification Subplan

Notification Subplans are to be prepared for three basic emergency conditions including: spillway design discharge without failure, spillway design discharge with failure, and failure at normal high pool level (top of flood control pool). The separate notification subplans are required for each emergency condition because:

- (1) Identification of the local officials to be notified of an existing or potential emergency depends on the area requiring evacuation which is associated with each emergency condition;
- (2) The need to notify other Federal agencies, the public in the immediate vicinity of the dam and reservoir, and other parties varies according to the nature of the existing or potential emergency; and
- (3) The appropriate text of news releases depends on the emergency condition for which they are prepared.

d. Evacuation Subplan

Evacuation Subplans should be prepared for conditions of:

- (1) Spillway design flood;
- (2) Spillway design flood with dam failure; and
- (3) Dam Failure with normal high pool level.

7. Plan Development

The most important aspects in describing the plan development are identification of the major steps, description of the sequence, and definition of the level of detail.

a. Major Steps

Development of an emergency plan requires identification of the types of emergencies to be encompassed, accumulation of needed data and information, performance of various

analyses, conceptualization of solutions, design of measures and subplans, preparation of appropriate documents and implementation of the plan. The key steps in the process are:

- (1) Selection of the emergency conditions for which plans are to be prepared;
- (2) Computation of pool levels and outflow hydrographs for assumed emergency conditions;
- (3) Routing of flows predicted by outflow hydrographs;
- (4) Preparation of inundation maps;
- (5) Delineation of areas requiring evacuation;
- (6) Identification of needed evacuation strategy;
- (7) Preparation of the several subplans (components) making up the emergency plan;
- (8) Posting of subplans; and
- (9) Provisions for maintenance of the plan.

b. Sequence

Figure 1 shows schematically the major steps of the process, and their principal interrelationships. It also shows the general responsibilities of Federal and non-Federal interests for development of the major steps. The specific mix of Federal and non-Federal activities must be negotiated for each project.

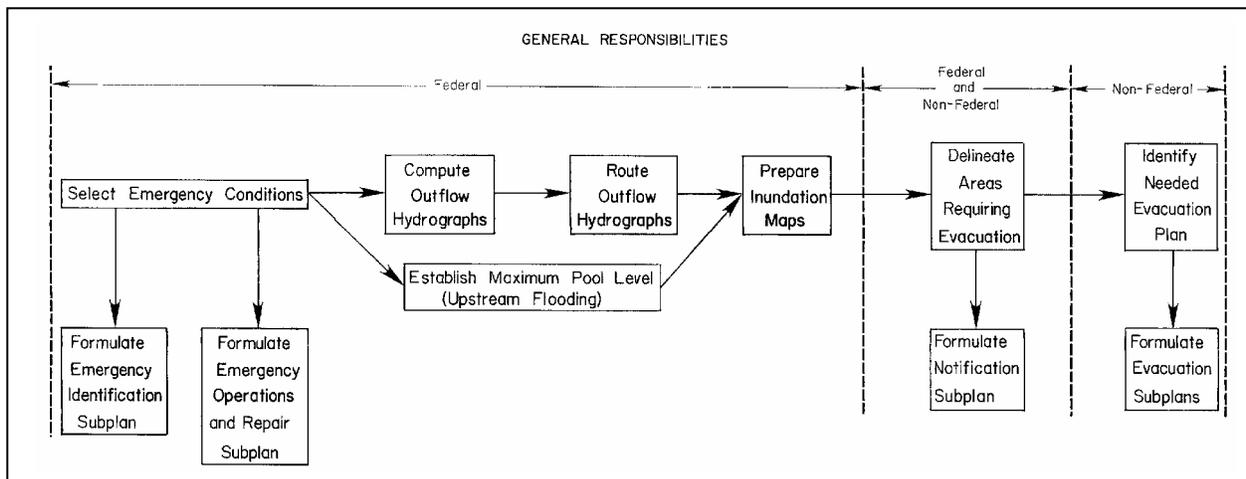


Figure 1 Plan Development

Some interrelationships between the steps and needs for successive iterations of the process are not shown on Figure 1 in order to avoid obscuring the major linkages. However other relationships and a need for iterative process do exist. For example:

- (1) The means and procedures selected for identifying emergencies may be influenced by:
 - (a) assumptions about the effect of potential emergencies' causative agents at the dam site and in downstream areas, such as disruption of communications; and
 - (b) analysis of the time likely to be available between recognition of an impending emergency and the onset of dangerous water levels at vulnerable locations.
- (2) Overall timing or staging of the emergency plan may need adjustment to assure sufficient time exists for successful execution of evacuation plans by non-Federal interests after identification and warning of an emergency.
- (3) The identification of non-Federal officials to be included in the notification plan is dependent on assignments of responsibility made in the non-Federal evacuation plans.

The foregoing are cited only as examples and do not necessarily constitute all of the needs for iteration or supplementation in the plan development.

c. Level of Detail

Dam emergency plans must be prepared in considerable detail for the following reasons:

- (1) Emergency plans and evacuation plans are not subject to testing, at least not under any conditions approaching those likely to prevail in the event they must be put to actual use. The only way to assure their workability is through careful consideration of every important detail.
- (2) Emergency plans are expected to be employed only under hurried and stressful conditions. Plans which are vague or which require significant interpretation to decide appropriate action may lead to serious errors.
- (3) Emergency plans contain some portions which are made up largely of intraorganizational arrangements subject to a number of complex legal, institutional, sociological and other influences.
- (4) Emergency plans of the type described in this document, which have been proven through use to be effective, are not available as prototypes.

Objective oriented plans which only identify what is to be done in various circumstances are inadequate. Plans must be specific in identifying who is responsible for taking prescribed actions, the resources to be used in accomplishing the prescribed actions and other similar details.

8. Implementation Aspects

Emergency plans require implementation to be effective. Attention must therefore be given during the plan development to: identification of items requiring specific implementation; identification of who, or what organization, should carry out the various actions required to implement and execute each subplan; and the commitments required to assure participants' performance in accord with the plan in the event an emergency threatens or occurs. Because emergency plans are expected to be used only on rare occasions, particular care must be taken to ensure that personnel are familiar with the plan and equipment is operable. Periodic testing of equipment and training of personnel should be done to ensure readiness to carry out the plan.

Plans must be posted in locations known to participants. Subplans should be posted in locations appropriate to the participants in the subplan (e.g., at the headquarters, project, etc.).

a. Items Requiring Implementation

The major items associated with each subplan which require implementation consideration are:

(1) Emergency Identification Subplan:

- (a) acquisition, installation, calibration, operation, servicing and maintenance of monitoring equipment;
- (b) establishment of any volunteer or other network of observers to monitor conditions;
- (c) arrangements for collection and/or provision by others of data and information on conditions with potential for creation of emergencies;
- (d) acquisition, installation, and testing of communications equipment for receiving off-site data and information on conditions with potential for creation of emergency conditions and for on-site communications; and
- (e) development or acquisition and installation of procedures and equipment for processing and analyzing data and information and identifying the nature and magnitude of existing or potential emergencies.

(2) Emergency Operations and Repair Subplan:

- (a) acquisition and storage of equipment and materials to be stockpiled for use in making emergency repairs;
- (b) arrangements with private contractors and/or others for the prompt provision of needed amounts and types of equipment, materials and labor for use in making emergency repairs; and

- (c) acquisition and storage or arrangement for prompt availability of equipment, material and labor required for de-watering of the reservoir or other emergency operations.

(3) Notification Subplan

- (a) acquisition, installation and testing of communications equipment for communications with Corps personnel at other locations, other Federal agencies and non-Federal parties;
- (b) arrangements with other parties for 24 hour availability of some person or organization to receive notifications of emergencies; and
- (c) acquisition, installation, testing and servicing of any mass warning devices for use in the immediate vicinity of the dam and reservoir to signal existing or potential emergencies, including acquisition of necessary lands, rights-of-way and easements and provision of necessary power supplies.

(4) Evacuation Subplan

- (a) acquisition and storage of equipment and materials to be stockpiled for use in carrying out the subplan;
- (b) inter-organizational arrangements (contracts and memoranda of agreement) for provision of assistance in carrying out the subplan.

b. Commitments to Participate

Implementation of emergency plan requirements relating to acquisition of equipment and materials can be accomplished with regular procedures and pose no particular problem. However, requirements relating to the provision of services or equipment from others require special attention. There are several techniques of binding participants to execution of the plan. Among others, these include adoption of appropriate portions of the plan by a non-Federal government, contracts, and memoranda of understanding. Adoption of portions of the emergency plan by a non-Federal government is particularly well suited for:

- (1) Assuring an adequate legal basis exists for their participation;
- (2) Cases in which multiple agencies of the governmental unit are intended to participate in a coordinated fashion; and
- (3) Cases in which the desired participation is ongoing rather than intermittent and/or has a significant cost which is to remain uncompensated by the Corps.

Contracts and memoranda of understanding are much alike. Their major distinction lies in the intended means of their enforcement. Contracts are designed for enforcement through the courts while memoranda of understanding usually depend on administrative or political action for enforcement. In general, contracts should be used in implementing arrangements with

private parties and memoranda of understanding for fixing responsibilities of other Federal agencies. The technique appropriate for use in the case of non-Federal governmental units depends on what is to be achieved. Matters of general cooperation are probably best spelled out in memoranda of understanding while contracts should be used when specific services are to be provided, when identified resources are to be maintained in readiness, or when compensation is involved.

c. Institutional Considerations

It should be recognized in drafting implementation arrangements that enforcement of some types of obligations to participate in an emergency plan poses special problems. Whereas enforcement of agreements such as one to provide routine servicing of a gage may be useful in reminding participants of their responsibilities, enforcement actions brought after a critical lapse in performance during an emergency are only likely to be useful in assigning blame. Care should therefore be taken to assign responsibilities and prepare implementation arrangements so as to maximize the prospects for success and minimize dependence on enforcement provisions. Means of doing this include:

- (1) Assignment of responsibilities to organizations already in being which are successfully carrying out vital programs;
- (2) Assignment of responsibilities to organizations with closely allied missions, emergency responsibilities, or with another inherent reason to be interested in the success of the emergency plan;
- (3) Provision of ample opportunity for participation in development of appropriate portions of the emergency plan by agencies expected to be assigned responsibilities; and
- (4) Inclusion of provisions for periodic review and confirmation of the plan and implementing arrangements.

9. Maintenance Arrangements

Arrangements required to assure the continued viability of the emergency plan should be spelled out in specific and detailed terms. Analysis of the type and schedule of maintenance activities which are needed can be best determined by subdividing the overall topic of maintenance into separate sets of activities for updating, testing, and training.

a. Updating

Updating is primarily aimed at identifying and making modifications needed in the emergency plan because of particular events which have taken place or because of the accumulation of minor changes which have occurred over time. The portions of an emergency plan most likely to require updating are things such as names and telephone numbers and those items of an expressly limited life such as contracts or memoranda of understanding. However, other needs for updating may also arise which are more complex and which require that some

revisions be made. For example, changes in land use in areas subject to inundation or installation of upstream water control structures may change the area which should be considered by the plan. Likewise, community growth or new development in the vicinity may require expanding the aerial coverage of the emergency plan. The appropriate frequency of updating depends upon the importance of the portion of the emergency plan being considered, the potential penalty of relying on outdated information of various types and the resources required for updating.

b. Readiness Testing - Equipment

Testing refers primarily to equipment, supplies, and other material items. Examples of testing activities include checking stockpiles of material and equipment for emergency operations and repairs, testing monitoring equipment and communication links, periodic trial of sirens or other mass warning devices, and occasional operation of auxiliary generators. The desirable frequency of testing depends on how often an item is used during the regular course of activities, its vulnerability to failure, the item's importance to the success of the emergency plan, and the resources required for testing.

c. Readiness Training - Personnel

Training refers to those maintenance activities required to assure people assigned responsibility for conduct of the emergency plan are able to fulfill their responsibilities competently. Several types of activities may be necessary including individual study of emergency plans, instruction, learning of special skills through "hands on" experience, and practice of the plan under simulated emergency conditions to maintain skills and discover plan deficiencies. As with other categories of maintenance activities, the frequency and extent of each type of training must be adjusted based on relevant factors. In the case of training, the most important factors are likely to relate to turnover in personnel and complexity of skills or information to be mastered.

10. Select Emergency Conditions

Emergency plans are to be prepared for three conditions including spillway design discharge without dam failure, spillway design discharge with dam failure, and dam failure at normal high pool level. Normal high pool level is defined as the top of the flood control pool. The two principal steps in selecting and describing the emergency conditions for which plans will be prepared are evaluation of potential emergencies and establishment of assumptions.

a. Evaluation of Potential Emergencies

Various degrees of emergency may occur and any malfunction or abnormality outside the design assumptions and approved water control rules which adversely affect a dam's primary function of impounding water is properly considered an emergency. Lesser emergencies can progressively lead to or heighten the risk of catastrophic type emergencies. They are, however, normally amenable to corrective action. The hypothetical emergencies to be considered are those which:

- (1) Stem from the more probable causes;
- (2) Could result in the release of significant amounts of water within a period of minutes or a few hours;
- (3) May not be capable of control even by prompt remedial action; and
- (4) Have the potential for resulting in uncontrolled levels of water sufficiently large to pose a hazard to life and/or property.

b. Causal Agents of Emergencies

Causal agents of emergencies which are not appropriate for the specific project should not be considered. Neither should combinations of causes excepting those which might be expected to occur simultaneously or as a result of one another such as a landslide induced by an earthquake. The most prominent causes of emergencies to be considered are:

- (1) Earthquake;
- (2) Landslide;
- (3) Extreme storm;
- (4) Piping;
- (5) Equipment malfunction;
- (6) Structural damage;
- (7) Foundation failure; and
- (8) Sabotage.

Not all causes of emergencies may be pertinent to a given structure. The type of dam and its appurtenant facilities, topography, geology, foundation conditions, design features, condition of the structure and other factors need to be evaluated in order to identify which of the potential causal agents for an emergency should be considered. In some cases, it may be necessary to consider causes of emergencies in addition to those on the foregoing list because of a dam's peculiar vulnerability to one or another type of event. The type of dam failure selected to be the basis of the emergency plan for failure at maximum and high normal pool levels should be selected from a list of potential causes. Failure at normal pool level should generally be based on reservoir inflow conditions appropriate to achieve a full flood control pool.

c. Establishment of Assumptions

The three emergency conditions for which plans are to be prepared are intended to establish the maximum range of outflows on which inundation maps, notification subplans and non-Federal evacuation plans will ultimately be based. It is also necessary to describe the

circumstances which identify the assumed events and associated conditions, the conduct of emergency operations and repairs, and the issuance of warnings. Development of assumptions about these circumstances cannot be limited to consideration of only the potential cause of the emergency used for arriving at estimates of outflows. For example, dam failure of high normal pool level might reasonably be free of assumptions about complications at the dam site such as loss of power and communications or closing of roads. However, if an earthquake was assumed as the potential cause of failure for the dam and the emergency condition is to represent that type of failure, assumptions about earthquakes must necessarily be included as a basis for development of workable plans. In order to assure that the assumed emergency conditions provide an adequate basis for plan development, it is necessary that their descriptions encompass the relevant circumstances which could be associated with the emergency. The following are examples of the assumptions concerning conditions at the dam site which ought to be considered in connection with an emergency:

- (1) Earthquake:
 - (a) loss of electric power from outside sources;
 - (b) disruption of telephone service and gas lines;
 - (c) collapse of bridges and blocking of roads; and
 - (d) unavailability of immediate outside assistance;
- (2) Extreme hydrologic event:
 - (a) disruption of microwave transmissions of data by extensive and heavy rainfall;
 - (b) severe local flooding causing road closings and disruptions of telephone service;
- (3) Operator error:
 - (a) absence, disablement or death of operator.

The assumptions of circumstances surrounding each emergency condition should also postulate adverse conditions of a general nature such as occurrence of the emergency during late night or early morning hours on a weekend or holiday.

11. Compute Outflow Hydrographs

The spillway design flood discharge represents the outflow hydrograph for one emergency condition. This discharge includes all releases considered in routing the spillway design flood such as spillway, flood control outlets, turbines, etc. Computations are required to determine the outflow hydrographs corresponding to the emergency conditions of spillway design flow with failure and failure at normal high pool levels. Selection of the causes and types of failure to be

considered in determining these conditions is addressed in paragraph 10a. In general, the computation of the outflow hydrograph for these emergency conditions requires acquisition of pertinent data for the structure, establishment of the parameters of failure, selection of the computational technique to be used, and performance of the computation.

a. Establishment of Parameters of Failure

The parameters of failure which are important in computation of the outflow hydrograph depend on the mode of failure. For purposes of preparing inundation maps, no assumption as to a specific failure cause need be made. However, assumptions relative to breach timing and size are important. Most serious failures of the type to be considered result in a situation resembling weir conditions. Table 1 presents suggested breach parameters for use with various types of structures. Other modes of failure may be selected where appropriate. Further discussion of selection of failure parameters may found in McMahon (1979).*

**TABLE 1
SUGGESTED BREACH PARAMETERS
WEIR TYPE MODE OF FAILURE**

FOR EARTH FILL DAM	
Parameter	Value
Breach Width	½ to 3 dam heights
Side slope of Breach	0:1 to 1:1
Failure Time (hrs)	0.5 to 4
FOR CONCRETE GRAVITY DAM	
Parameter	Value
Breach Width	A multiple of monolith widths
Side slope of Breach	0:1
Failure Time (hrs)	0.1 to 0.5
FOR CONCRETE ARCH DAMS	
Parameter	Value
Breach Width	Entire dam width
Side slope of Breach	Valley wall slope
Failure Time (hrs)	Nearly instantaneous

b. Selection of Computational Technique

A variety of techniques are available for computation of the outflow hydrograph associated with a particular failure mode. The principal ones which are available for various circumstances are:

- (1) Triangular hydrograph for instantaneous or almost instantaneous development of a rectangular breach;

*References are given on page 38.

$$Q = \frac{8}{27} \sqrt{g} Y_o^{3/2} B$$

Where:

Y_o = initial depth upstream of the dam; and
 B = width of the dam;

- (2) HEC-1-DB* for cases of overflow or weir type breaches with or without progressive enlargement;
- (3) HEC STREAM HYDRAULICS PACKAGE* for cases of overflow or weir-type breaches with or without progressive enlargement; and,
- (4) NATIONAL WEATHER SERVICE DAM-BREAK MODEL* for cases of overflow and both weir and orifice type breaches with or without progressive enlargement.

At present, the model developed by the National Weather Service is judged to be generally preferable.

c. Performance of Computations

Computations using triangular hydrographs can be easily done by hand. A computer is required for use of HEC-1-DB, HEC STREAM HYDRAULICS PACKAGE and NATIONAL WEATHER SERVICE DAM BREAK MODEL. Adequate documentation is available for all programs which must be performed on a computer.

The computed peak outflow should be compared to the historical observations shown on Figure 2 to test their reasonableness. The curve shown on Figure 2 represents an upper bound of peak discharges from known dam failures. Computed results that fall below this curve should not be used unless they can be explained by reference to site-specific conditions such as a narrow canyon at the dam.

12. Route Outflow Hydrographs

The movement through downstream channels of outflows corresponding to each emergency condition must be simulated as a basis for inundation mapping. The general steps in preparing the simulation are selection of the computational techniques to be used, establishment of assumptions, acquisition of necessary data, and performance of the computations.

*References are given on page 38.

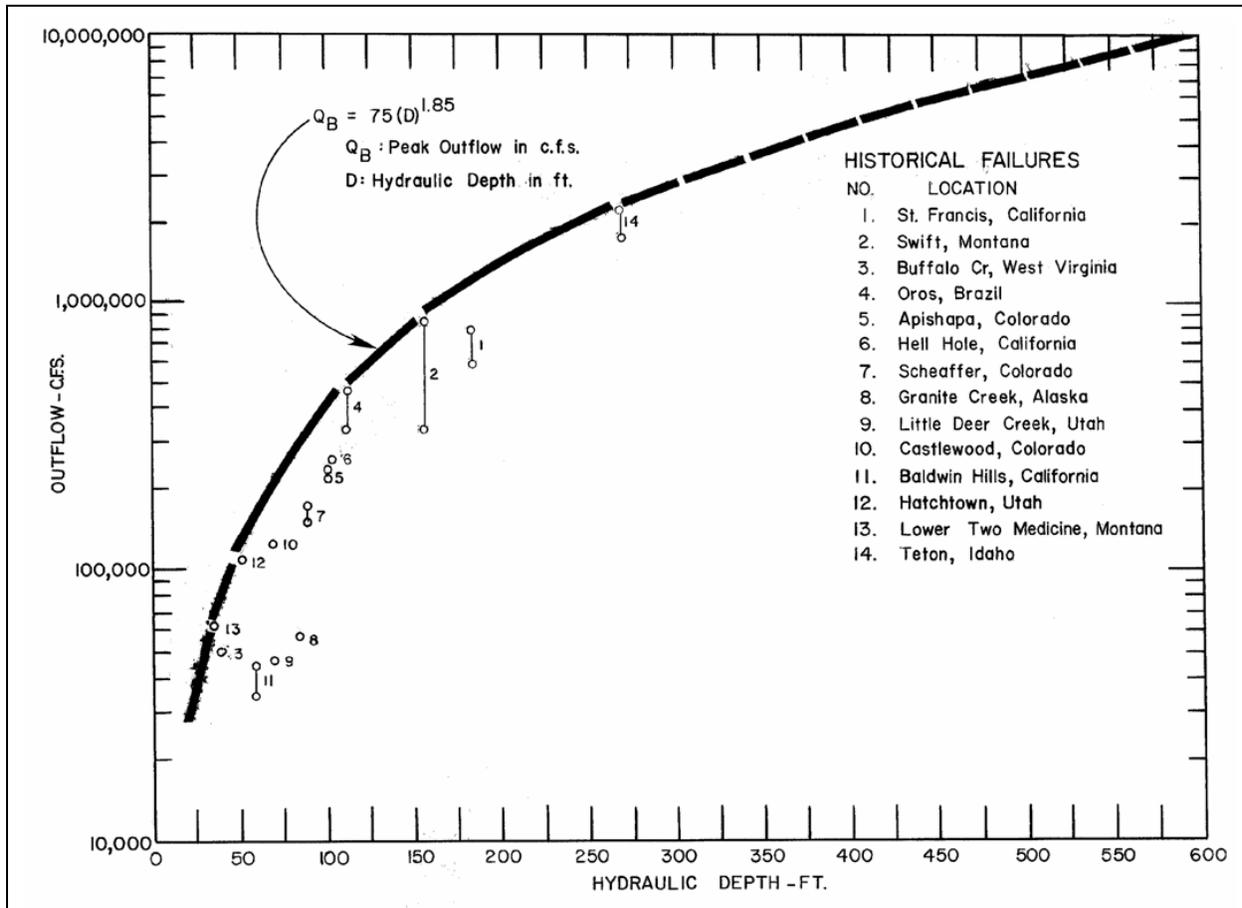


Figure 2 Envelope of Experienced Outflow Rates from Breached Dams

a. Selection of Computational Techniques

Simplified methods are available for dams upstream of essentially rural flood plains where the more expensive computational techniques may not be warranted. A complete solution of the unsteady flow equations should generally be used for dams upstream of urban areas.

Simplified techniques which are available and suitable for use in appropriate cases include "Dimensionless Graphs" (Sakkas, 1974)* and "Modified Puls". Highly empirical routing techniques such as, "Tatum" and "Straddle-stagger" are not recommended for use. Computational techniques which provide the approximate solution of the full unsteady flow equations include the computer models "NATIONAL WEATHER SERVICE DAM-BREAK MODEL," "GRADUALLY VARIED UNSTEADY FLOW PROFILES", and HEC STREAM HYDRAULICS PACKAGE. Table 2 lists salient features of each of the simplified and more complex computational techniques. Within the guidance provided by the Director of Civil Works, selection of the particular technique to be used should be based on considerations of cost and ease of use and accuracy. Accuracy depends on both the completeness of the program and the degree to which assumptions underlying the particular technique fit the case at hand. Major

*References are given on page 38.

assumptions pertinent to each computational technique are listed in Table 2. The cost and ease of using a particular model depends in part on the information required as input. Some models require less topographic information on valley shape than do others and may appear for that reason 'to be preferable for use. However, it must be borne in mind that the subsequent step is the preparation of inundation maps. Savings in time and cost through using approximations in

**TABLE 2
CHARACTERISTICS OF COMPUTATIONAL TECHNIQUES**

Techniques	Routing Technique	Major Assumptions	Requires Computer	Advantages	Disadvantages
Dimensionless graphs	Complete unsteady flow equations	Prismatic valley, total instantaneous failure	No	Quick, can be done by hand	Prismatic valley assumptions
HEC-1DB	Modified Puls	Unique stage-discharge relationship at all points in valley	Yes	Does basic hydrology, computationally inexpensive	Hydrologic routing technique - requires extrapolation of empirical coefficients
NWS-DB	Complete unsteady flow equations	Rigid boundary hydraulics	Yes	Uses full equations, supported by HEC and NWS, inexpensive	No user manual
Gradually varied flow profiles	Complete unsteady flow equations	Rigid boundary hydraulics	Yes	Uses full equations, supported by HEC	No internal computations for breach hydrographs
HEC Stream Hydraulics Package	Muskingum, Modified Puls, Kinematic wave, or complete unsteady flow equations	Rigid boundary hydraulics	Yes	Can use full equation, supported by HEC	New, not thoroughly tested

the routing computations may be lost due to the greater difficulty in translating the resulting information onto maps showing the boundaries and the time of arrival of dangerously high flows at various downstream points.

b. Establishment of Assumptions

The major assumptions likely to be required in routing of outflow hydrographs concern:

- (1) Amount of flow in channels through which routing is to be done at the time an emergency occurs;
- (2) Friction factors in channels;
- (3) Method for treating tributaries and other off-channel storage areas;
- (4) Method of treating highway and other embankments and bridges; and
- (5) Distance to carry routing downstream.

The amount of flow in downstream channels at the time an emergency occurs is generally of concern for avoiding computer program aborts when using the complete unsteady flow equations. The NWS suggests use of a downstream flow of approximately 1/2 of one percent of the anticipated peak flow. This flow may seem unrealistically large. However, the sensitivity of routed peak discharges and stages to this parameter is usually small. Friction factors are also usually higher than would normally be used for smaller flows. This is attributed to the large amount of debris carried by a dam break flood wave. Flood wave travel times can be quite sensitive to roughness coefficients. Tributaries, off-stream impoundments and other features of the downstream area may provide sufficient storage to attenuate flows significantly. If such storage is significant, the true channel geometry may be artificially modified to provide the additional storage at appropriate locations. Flows in tributaries and available space in off-channel impoundments should be selected to be consistent with the emergency condition being analyzed. Small embankments and bridges in the downstream valley may be assumed to wash out without influence on the flood wave. Large embankments may act as dams, however, and should be analyzed as such. The NWS model is capable of analyzing multiple dams in series. Routing computations should be carried downstream to the point where the predicted flows no longer pose a significant threat to life or property.

c. Performance of Computations

Use of the dimensionless graphs technique is relatively straight-forward and can be accomplished quickly with the aid of a hand calculator. Use of the other techniques (mathematical models) requires access to a high speed digital computer. The data preparation, output interpretation, calibration and performance analysis of HEC-1-DB should be routine to Corps hydrologic/hydraulic engineers. Use of unsteady flow models, however, is much less familiar to field office engineers. The NWS model is considered the most reliable (robust) and generally applicable model for use in these analysis which is available at this time. Training in use of these techniques is available at the HEC.

d. Establish Maximum Pool Level

The maximum pool level is obtained from the routing of the spillway design flood hydrograph. This information is readily available from project design studies.

13. Preparation of Inundation Maps

The results of flood routings are to be used to plot the inundated areas for emergency conditions associated with the spillway design flood. Downstream limits will be established by the actual routings. To avoid cluttering, inundation areas will be plotted on the maps for only two conditions; spillway design discharge without dam failure and spillway design discharge with dam failure. The maps should be of sufficient scale and detail to identify clearly the area which would be flooded if the hypothesized emergencies occurred.

The maps should be prepared in two phases; preliminary and final. The preliminary maps basically will be a work map and used for review purposes. Two sets of final maps are to be prepared. One set with approximate dimensions of 22" x 34" is intended for use by local governments to augment their evacuation planning efforts. The second set of final maps is to be

at half-scale and bound into the Emergency Plan Report discussed in these "Guidelines". A separate map index sheet should also be provided with each map set in order to provide general location and orientation of individual maps sheets.

Detailed information on the preparation and publication of the inundation and index maps is provided in the appendix.

14. Delineate Areas Requiring Evacuation

The area requiring evacuation in response to a particular emergency condition may be larger than the related inundation area due to the effect of secondary problems. Among others, important types of secondary problems to be considered are those which result in isolation of areas, disruption of vital services and facilities, or creation of some type of hazard. Operational interdependencies between utilities and between utilities and the availability of vital services should not be overlooked in assessing the impact of potential flooding. For example, inundation of an electrical substation causing loss of power over a wide area could affect the continuation of water service for fire fighting, curtail operation of medical facilities or have other effects bearing on safety. The area requiring evacuation should be identified on maps. Information which should be shown on maps includes:

- a. Boundaries of inundated area;
- b. Principal streets and roads;
- c. Land use or other appropriate classification of evacuation area;
- d. Location of vital facilities in the area;
- e. Points at which secondary problems could occur;
- f. Identification of the reason(s) for evacuation of each subportion of the delineated area.

Maps should be supplemented with a brief text explaining the nature of potential secondary problems.

15. Identification of Needed Evacuation Planning

Most non-Federal units of government have available some type of emergency plan which provides for evacuation under specified conditions. However, such plans vary widely with respect to their detail, completeness, realism, and other aspects affecting their quality as well as the extent to which they have been implemented

Evacuation planning encouraged by district offices should be viewed as supplementation of any existing non-Federal emergency plans. Identification of the nature and extent of supplementation required depends on evaluation of the existing plans. The following points should be considered in the evaluation:

- a. Is the plan written?
- b. Is the plan current?
- c. Does the plan have formal legal status through appropriate adoption or recognition by non-Federal authorities?
- d. Does the plan specify actions to be taken in sufficient detail to avoid indecision on whether or not to execute the plan and how it should be executed?
- e. Does the plan make specific assignments of responsibility for its initiation and execution?
- f. Does the plan cover all of the affected areas?
- g. Is successful execution of the plan in potential emergency situations reasonable in view of the warning time likely to be available for an emergency and the conditions which could occur concurrent with or as a result of the agent causing an emergency?
- h. Is the plan realistic and based on adequate background analysis concerning means of warning and transporting evacuees, lane capacities of escape routes and other pertinent matters?
- i. Are adequate equipment, personnel and materials readily available for execution of the plan?
- j. Does the plan contain adequate provisions for updating, testing, practice and other maintenance activities to assure its continued viability?

Plans which meet all of the foregoing criteria are likely to need only minor supplementation to deal with evacuation on the scale appropriate to the postulated dam-related emergencies. Lack of an affirmative answer to any of the questions indicates the need for more effort. However, use of the questions as a checklist should not substitute for thorough and detailed evaluation of evacuation plans.

16. Formulate Emergency Identification Subplan

The Emergency Identification Subplan is based on selection of the emergency conditions to be addressed (paragraph 10). That step required identification of the types of emergencies and potential causes of emergencies to be considered. Formulation of the subplan requires designing the system needed for their detection.

a. Procedure

The general procedure to be followed in formulation of the Emergency Identification Subplan is:

- (1) Identification of the possible means of detecting each type of emergency and potential cause of an emergency;
- (2) Selection of the means to be used in detecting each type of emergency and potential cause of an emergency;
- (3) Design of the monitoring arrangements, communications and other components of the system for collecting the data and information necessary for the detection function;
- (4) Design of operating procedures for collection and analysis of data and information;
- (5) Design of maintenance arrangements for the data and information collection system and for the operating procedures; and
- (6) Design of arrangements for implementation of the data and information collection system, operating procedures and maintenance arrangements.

The sequence and interrelationship of these several steps are shown in Figure 3.

b. Considerations

Conduct of the procedure summarized in paragraph 16a is relatively straightforward. The principal matter to be taken into account is the effectiveness of the resulting subplan. The chief criteria for its effectiveness relate to timeliness, accuracy, reliability, and thoroughness.

- (1) What constitutes timeliness in identifying a particular type of existing or potential emergency depends

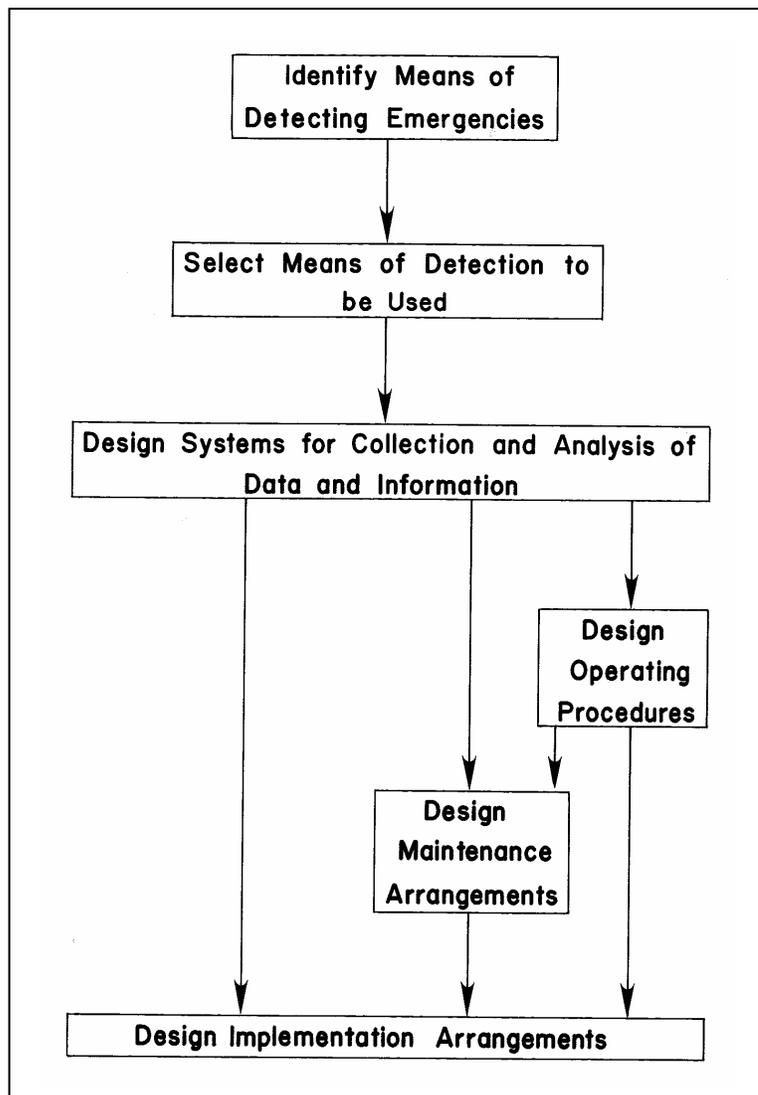


Figure 3 Formulation of Emergency Identification Subplan

on the severity of the emergency, time required for response, distance to downstream areas which could be affected and other factors. Several iterations of the overall emergency subplan process may be required to adjust the means of identifying emergencies to the timeliness required.

- (2) Consideration of timeliness and accuracy may require different approaches to identification of potential emergencies. For example, an early estimation of high inflows resulting from a storm in upstream areas can be made based on precipitation data while a more accurate but less timely estimation can be made based on stream levels. Selection of the approach taken to recognition of an existing or potential emergency should be based on evaluation of all of the means of detection which might be employed.
- (3) Means of identifying emergencies should be designed so as to be consistent with assumptions concerning the conditions which could exist at the time, particularly with regard to the possibility that the causal agent could interfere with the collection or transmission of information or data needed for its recognition. Reliability in identification of existing or potential emergencies can be improved through:
 - (a) redundancy in equipment to reduce the probability of simultaneous failure to an acceptably low level;
 - (b) separation of systems with respect to their basis of operation to assure one type of failure, such as telephone or electrical service, does not disrupt all of the means to detect a particular type of emergency; and
 - (c) fail safe arrangements so any disruption of systems for detection of emergencies results in positive action.
- (4) Thoroughness in design of the arrangements for detection and analysis of existing or potential emergencies requires:
 - (a) provision of adequate means of detection for every potential cause of emergency warranting coverage;
 - (b) detailed attention to how the system will function under all foreseeable conditions; and
 - (c) provision of all of the aids, examples, instructions and other things necessary for operation of the system.

c. Format of Subplan Documents

Two versions of the Emergency Identification Subplan should be prepared including one intended to serve primarily as a reference document, and one intended to serve as an action document for the dam manager.

- (1) The version of the subplan intended to serve as a reference document should contain all of the materials pertinent to the subplan including appropriate introductory and explanatory materials and listings or descriptions of:
 - (a) potential types of emergencies addressed by the subplan;
 - (b) type(s) of data and information collection systems employed to detect each type of existing or potential emergency including salient features of their design;
 - (c) procedures for operation of each data and information collection system;
 - (d) techniques and aids for analysis of collected information and data;
 - (e) maintenance arrangements for equipment and procedures; and
 - (f) implementation arrangements including cost estimates, schedules, assignments of responsibility, and agreements with other parties.

- (2) The version of the subplan intended to serve as an action document for dam managers should be an abridgement of the full subplan and exclude all portions not necessary for guiding day-to-day operation and maintenance of the data and information collection system and analysis of existing or potential emergencies. For example, the abridged version of the subplan should be limited to such things as:
 - (a) listing of responsibilities assigned to each on-site personnel position;
 - (b) schedule for routine activities in operating and maintaining the data and information collection system;
 - (c) description of normal and abnormal ranges of parameters which are to be monitored;
 - (d) instructions as to increased levels of monitoring and/or other actions to be taken when abnormal conditions are noted;
 - (e) aids for interpretation of data and information and instructions for their use; and

17. Formulate Emergency Operations and Repair Subplan

The Emergency Operations and Repair Subplan are also based on the selection of the emergency conditions to be considered (paragraph 10). That step provides in part for identification of all of the types of emergencies to which the emergency plan would be addressed. Formulation of the subplan requires designing the response to be made to each type of emergency selected for consideration.

a. Procedure

The general procedure to be followed in formulation of the Emergency Operations and Repair Subplan is:

- (1) Description of the appropriate response to each type and severity of emergency;
- (2) Development of scenarios for potential emergencies and corresponding operational and repair responses to identify equipment, material and labor required for each;
- (3) Summarization of the maximum likely requirements for equipment, materials, and labor to conduct emergency operations and repairs;
- (4) Determination of which needed equipment, materials and labor can be readily obtained from off-site sources;
- (5) Identification of what needed equipment, materials and labor will be obtained from off-site sources in an emergency and the particular source(s) to be used for each item;
- (6) Identification of what equipment and materials are to be acquired and stockpiled on-site for use during an emergency;
- (7) Development of instructions and procedures to be followed in carrying out emergency operations and repairs, including de-watering of the reservoir;
- (8) Development of arrangements for updating inventories of off-site resources, updating and practicing operational procedures and inspecting stockpiles of equipment and material; and
- (9) Description of arrangements for implementing necessary on-site stockpiling and agreements with off-site sources of assistance.

Figure 4 shows the sequence and principal relationships between the various steps.

b. Considerations

Relevant considerations described in paragraph 17a and shown in Figure 4 which ought to be explicitly recognized involve the effect of factors other than the type of emergency in deciding appropriate responses, and decision of which resources to stockpile. These include:

- (1) The response which is appropriate to an existing potential emergency depends on a variety of factors including the type of emergency or nature of the potential cause of emergency; magnitude or severity of the emergency; cost and difficulty of mounting one or another type of response; and other conditions such as reservoir level, existing flows downstream, weather conditions and time of day. The

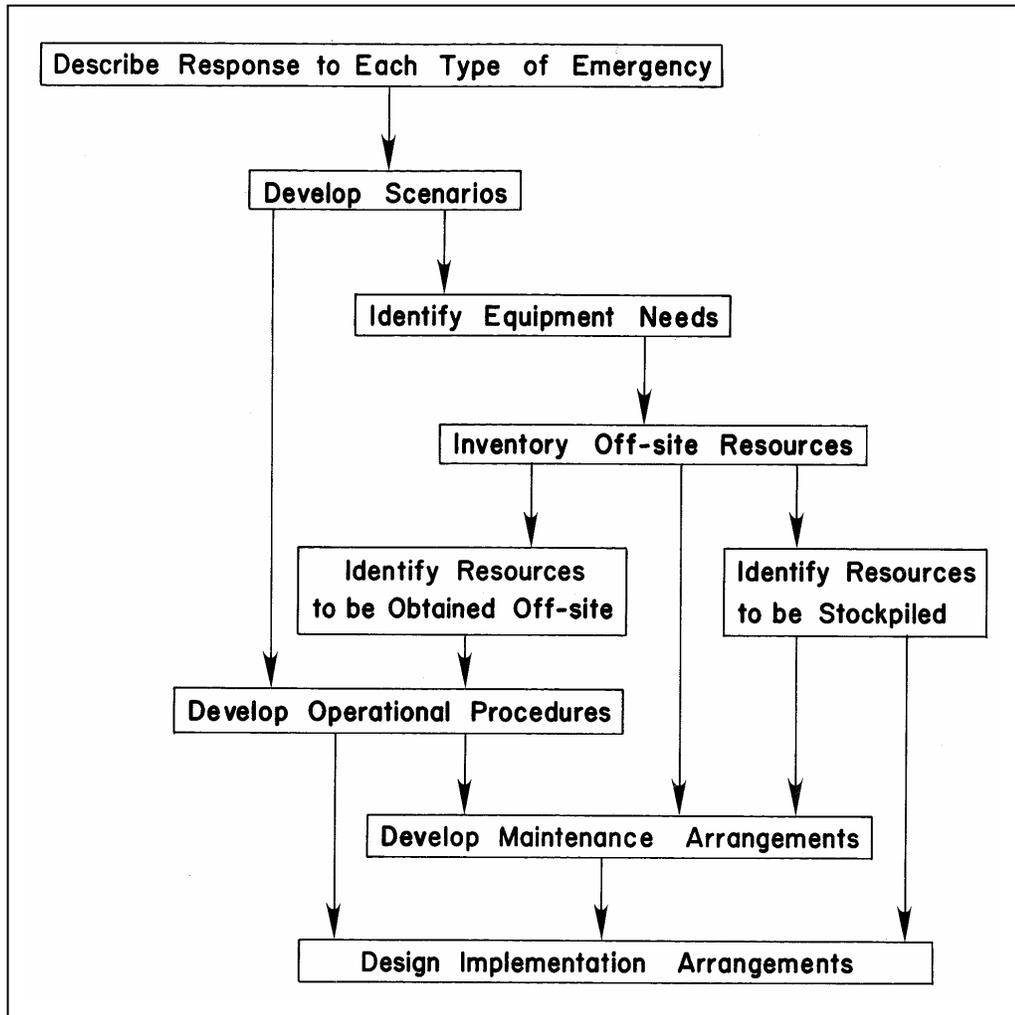


Figure 4 Formulation of Emergency Operations and Repair Subplan

response may also depend on the off-site assistance which can be obtained on short notice. Adequate consideration of all of the factors involved may require several iterations.

- (2) The decision as to which resources should be stockpiled and which should be obtained from off-site sources as the need arises also depends on a variety of factors. In general, stockpiling should be limited to equipment and materials which are:
 - (a) inexpensive;
 - (b) specialized or otherwise not readily available from off-site sources;
 - (c) suitable for long-term storage; and/or
 - (d) expected to be needed on such short notice that off-site procurement is impractical.

c. Format of Subplan Documents

Two versions of the Emergency Operations and Repair Subplan should be prepared including one intended to serve as a reference document, and one intended to serve as an action document for guiding the dam manager.

- (1) The version of the subplan intended to serve as a reference document should contain all of the information pertinent to the subplan including appropriate introductory and/or explanatory materials and descriptions or listings of:
 - (a) potential types of emergencies and appropriate response to each;
 - (b) scenarios evaluated and requirements for equipment, materials and labor to deal with each;
 - (c) total requirements for equipment, materials and labor to deal with emergencies;
 - (d) means of conduct and results of the inventory of off-site resources;
 - (e) identification of type and amount of equipment and material to be stockpiled on-site and stockpile locations;
 - (f) off-site sources for all needed equipment and materials not stockpiled, distance to normal location of equipment and materials, time to bring needed items on site, and information concerning persons to be contacted to obtain assistance;
 - (g) procedures to be followed in dealing with each type or severity of emergency including procedures for reservoir de-watering;
 - (h) arrangements for maintenance of the operational procedures, inventory of off-site resources, stockpiled items, and listing of off-site sources of assistance to be used; and
 - (i) implementation arrangements including cost estimates, assignments of responsibility and agreements with other parties.
- (2) The version of the subplan intended to serve as the action document for on-site personnel should be an abridgement of the full subplan and exclude all portions not necessary for day-to-day maintenance of the stockpiled equipment and material or for guiding emergency operations and repairs. For example, the abridged version of the subplan should be limited to such things as:
 - (a) listing of responsibilities for emergency operations and repair activities and related maintenance activities assigned to each on-site personnel position;

- (b) schedule of maintenance activities to be performed by on-site personnel;
- (c) description of action to be taken for each type and severity of emergency including the type of operation or repair to be undertaken, the assistance anticipated to be required, and the specifications of materials to be provided and/or work to be performed by others.

The action plan version of the subplan should be carefully organized for ease of use during hurried and stressful conditions. One means of accomplishing this is through organization and tabbing of the description of responses according to the nature of emergency or cause of potential emergency and placement in appendices of such items as schedules and listings of responsibilities.

18. Formulate Evacuation Subplan

Non-Federal Evacuation Subplans customarily consist of a general introductory section supported by a number of elements. The general introductory section usually sets out the legal authority for the plan and for actions contemplated by the plan, prescribes conditions and assignments of responsibilities for initiation and execution of the plan, defines terms, and provides other information applicable to all of the subplan's elements. The elements of the subplans commonly cover a variety of topics including warning, traffic control, provision of assistance in evacuation, housing and other care of evacuees, rescue, damage reduction, restoration of services, and others. The particular elements of non-Federal evacuation subplans which are of the greatest importance as a part of the emergency plans for Corps dams are those which relate directly to the minimal requirements of safety and effective evacuation of areas that may be endangered. Other potential elements of non-Federal evacuation subplans which pertain to the post-emergency period and/or which are not vital to reducing loss of life are of secondary interest to the Corps and less appropriate for technical assistance.

a. Procedure

Development of non-Federal Evacuation Subplans can proceed along any of a number of lines and selection of the process to be employed is up to the responsible non-Federal interests. However, the following major divisions of work are suggested in the event that technical assistance is requested:

- (1) Identification of the performance requirements pertinent to the various components of the evacuation plan such as:
 - (a) time available for and special problems to be overcome in the dissemination of warnings; and
 - (b) number of people to be evacuated from each part of the affected area, number of people requiring transportation or other types of assistance in evacuation, and time available to carry out evacuation;

- (2) Inventory and evaluation of existing arrangements for warning and evacuation to determine:
 - (a) what arrangements presently exist;
 - (b) deficiencies in existing arrangements; and
 - (c) needed supplemental studies;
- (3) Design of needed supplements to existing arrangements for warning and evacuation including:
 - (a) conceptual development of needed arrangements;
 - (b) collection of needed data and information;
 - (c) development of procedures; and
 - (d) assignment of responsibility for execution of plans;
- (4) Design of maintenance arrangements including those for:
 - (a) updating;
 - (b) testing; and
 - (c) practice;
- (5) Design of arrangements for implementation of:
 - (a) newly developed portions of the plan; and
 - (b) maintenance arrangements.

The interrelationship and sequence of these several steps are shown in Figure 5.

b. Considerations

The principal considerations to be borne in mind while providing technical assistance in the development of non-Federal evacuation plans are:

- (1) Workability and effectiveness is of far more importance than uniformity and each plan must therefore be tailored to the legal authorities and to the financial and technical capabilities of the implementing organizations;
- (2) The rare use expected to be made of evacuation plans generally makes it impractical to consider creation of new organizations for their maintenance or implementation;

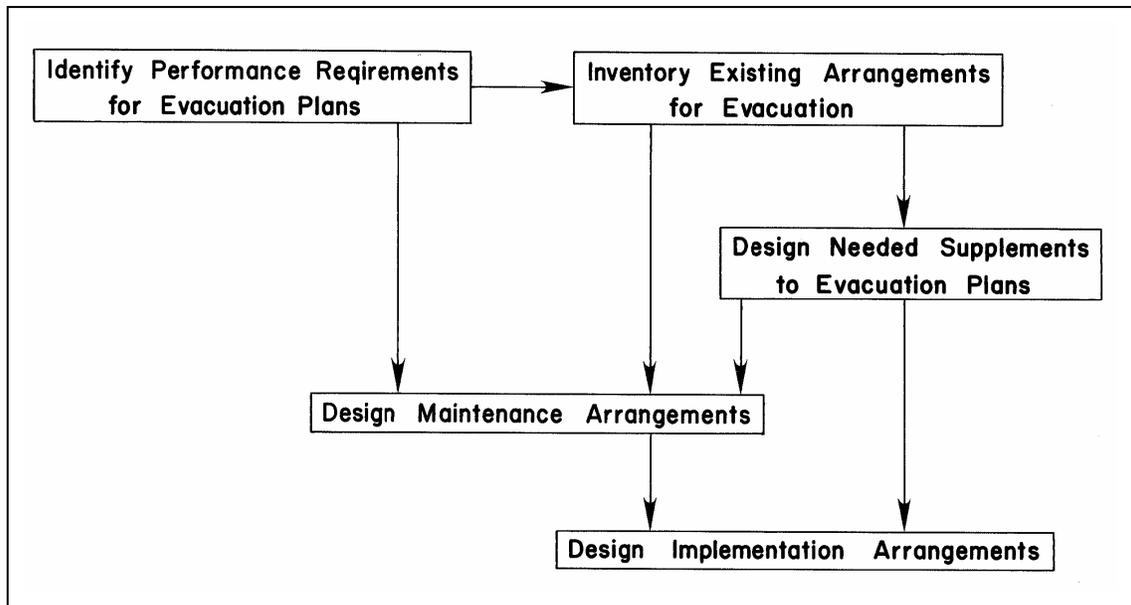


Figure 5 Technical Assistance

- (3) The resources of personnel and equipment required to maintain and execute an evacuation plan must be commensurate with what is likely to be readily available in the immediate area covered by the plan; and
- (4) Plans must provide detailed guidance with respect to what is to be done in carrying out an evacuation and the party responsible for each step.

c. **Format of Subplan Documents**

One version of the Evacuation Subplan is normally sufficient if organized so as to enable differentiating between the extents of areas to be evacuated for each emergency condition considered. This can be accomplished by providing general instructions relevant to all evacuations and using maps and/or lists to identify evacuation areas for the several emergency conditions.

Not all parties involved in the execution of an evacuation plan necessarily need to have a full copy of the plan. Organization of the document's assignment of responsibilities according to agency or organization facilitates provision to each participant of only those plan portions pertinent to its tasks.

19. **Formulate Notification Subplan**

The Notification Subplan provides the basis and procedures for notifications to Federal and non-Federal officials and other off-site parties of an existing or impending emergency. Identification of non-Federal officials with relevant responsibilities stems from the delineation of areas requiring evacuation (paragraph 14). Identification of other off-site parties to be notified stems from internal requirements of the Corps and the potential role of state and other Federal agencies in containing or mitigating a potential emergency. Formulation of the Notification

Subplan requires designing the procedures and sequence for notification appropriate to each of the emergency conditions addressed.

a. Procedure

The general procedure to be followed in formulation of the Notification Subplan is:

- (1) Identification of the parties to be notified of an existing or potential emergency;
- (2) Preparation of example releases for use in various emergency situations;
- (3) Preparation of lists of persons to be contacted about various types of emergencies including as appropriate, telephone numbers, radio call signals and addresses;
- (4) Development of the notification procedures;
- (5) Design of maintenance arrangements; and
- (6) Design of implementation arrangements.

Figure 6 shows the sequence and principal relationships between the various steps.

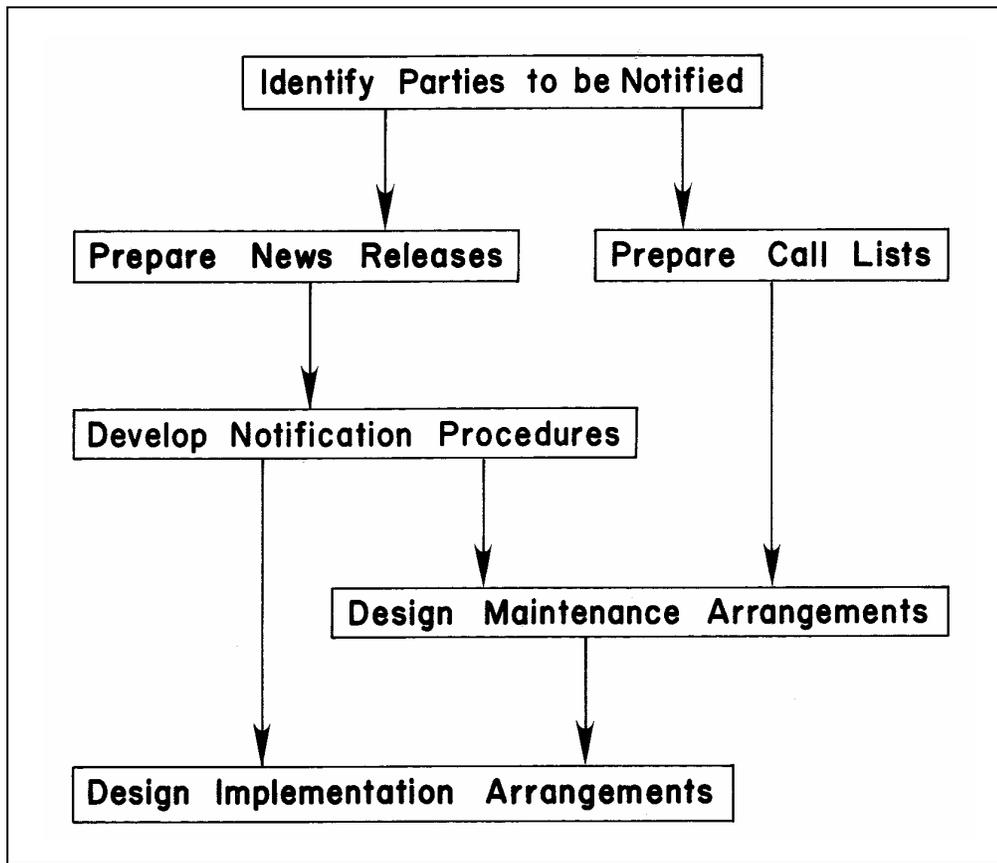


Figure 6 Formulation of Notification Subplan

b. Considerations

The identification of parties to be notified of an existing or potential emergency should include all of the local units of government with responsibility for carrying out the necessary evacuations, media with capability of disseminating information to the public on a timely basis, public in the immediate area of the dam and reservoir, and state and other federal agencies with relevant responsibilities.

Attention should be given to the means of communications to be used in making notifications. At least two avenues of delivering a message to each intended recipient should be identified. Care should be taken to insure the reliability of communications against:

- (1) Disruptions in telephone service;
- (2) Loss of normal power supplies; and
- (3) Damage to communications equipment by the causal agent of an emergency (e.g., damage to radio antenna by landslide, storm or earthquake) or by a potential failure (e.g., loss of power or telephone lines which cross dam).

Consideration should also be given to the need for procedures whereby the receipt of notifications is independently confirmed to assure no errors or misunderstandings take place and that the importance of messages is fully appreciated.

In addition to those parties with specific responsibilities for evacuation or other response to an existing or potential emergency, procedures should provide for alerting contractors and other off-site sources of equipment, material and labor which may be needed to remain on stand-by. The particular contractors and other sources which should be alerted depend on the nature of the existing or potential emergency.

Alternates should be provided for all persons listed to be called. Addresses, telephone numbers and other information for both business and home locations of primary contacts and alternates.

c. Format of Subplan Documents

Separate versions of the Notification Subplan should be prepared for use by the Corps and non-Federal interests. As noted earlier (paragraph 6c), each version of the subplan must be subdivided to give guidance as to the notifications to be made in each of the emergency conditions. Two general approaches are available for organization of the Notification Subplan including:

- (1) Use of procedural instructions specifying the lists of people to be notified for each emergency condition, supported by appropriate lists of names, addresses, and telephone numbers; and

- (2) Organization of the subplan into parts with one part corresponding to each emergency condition and with each part containing its own procedures and complete listing of parties to be notified.

20. Contact with Non-Federal Officials

District offices are to identify and contact appropriate State and local officials and suggest that evacuation plans be developed as a component of emergency plans for Corps dams. Pertinent information is to be furnished to assist non-Federal officials in preparation of the evacuation plans. Where non-Federal interests lack necessary expertise, district offices may respond to requests for assistance in development of evacuation plans.

There are three important matters to be considered concerning contact with non-Federal officials. These include identification of the particular officials to be contacted, timing of initial and subsequent contacts, and information to be provided at the first and subsequent contacts.

a. Identification of Officials

The initial contact should be made with the chief executive of each non-Federal governmental unit having relevant responsibilities for any or all of the area requiring evacuation which corresponds to one of the emergency conditions. In general, this will require contact with officials at the State, county and municipal level. In some areas, contacts may also be appropriate with township or special purpose district officials. The chief officials to be contacted should be made aware that one purpose of the meeting is to discuss establishment of arrangements for further coordination in order that they might have in attendance others likely to become involved. Subsequent contacts should be with parties specified by the chief executives.

b. Timing of Contacts

The initial contact with local officials should be made as soon as the first iteration in development of the emergency plan is completed to the point of delineating areas requiring evacuation. Contacts made at that time to encourage development of evacuation plans can be merged with efforts to identify non-Federal officials for inclusion in the Federal portion of the Notification Subplan. The first contact should result in establishment of arrangements for future coordination. The frequency and timing of subsequent contacts with non-Federal officials should be determined based on:

- (1) The extent of non-Federal interest and participation in development of the emergency plan; and
- (2) Needs for coordination between the Corps and non-Federal interests in the development of the components of the emergency plans.

A final contact should be made with non-Federal officials to present the emergency plan and to answer questions concerning the Corps input.

c. Information to be Provided

The key items of information to be provided at the initial meeting with non-Federal officials includes explanation or discussion as appropriate of:

- (1) Corps program for developing emergency plans;
- (2) Emergency conditions addressed and initial identification of areas requiring evacuation under each condition;
- (3) Need for development of evacuation plans and a portion of the Notification Subplan by non-Federal officials;
- (4) Availability of some technical assistance for development of evacuation plans; and
- (5) Schedule for remaining activities.

Information provided at subsequent meetings is dependent on the procedures used. However, sufficient details on the process and products should be provided to non-Federal participants to assure their understanding and contribution toward a complete emergency plan.

d. Assistance to be Provided

The types of technical assistance to be provided non-Federal interests in development of evacuation plans is not circumscribed. However, the intent of the assistance is to furnish necessary technical expertise which may be lacking, not to provide the necessary labor. Assistance given should therefore be limited to either performance of tasks requiring locally unavailable expertise, or provision of necessary guidance on plan development. Examples of appropriate assistance are:

- (1) Evaluation of existing emergency plans to identify deficiencies and additional needs and/or provision of guidance for performance of such evaluations by non-Federal officials or their contractors;
- (2) Provision of background information relevant to notification of emergencies and evacuation;
- (3) Description of the principal components and purposes of the Notification Subplan and evacuation plans;
- (4) Aid in developing a procedure for preparation of evacuation plans and the non-Federal portion of the Notification Subplan;
- (5) Consultation as work progresses on procedures, sources of information, formatting of plan documents etc.
- (6) Participation in conceptual formulation of evacuation plans and the non-Federal portion of the Notification Subplan;

(7) Review and comment on completed evacuation plans and the non-Federal portion of Notification Subplan; and

(8) Aid in identifying and describing needed implementation arrangements.

21. Background Information

Appendix D* consists of a packet of background materials relevant to the flood emergency plans to be developed by district offices and the evacuation plans by non-Federal interests which are encouraged. It consists of:

a. General bibliography of literature on related subjects which is categorized for easy reference to particular topics;

b. An annotated bibliography of several publications which are especially relevant to emergency and evacuation plans; and

c. Examples of non-Federal evacuation plans.

In addition to being of interest to Corps personnel, the material is suitable for reproduction and distribution to non-Federal officials responsible for development of evacuation plans.

*See Preface for comments on this appendix.

REFERENCES FOR PARAGRAPHS 11 AND 12

1. (Fread, D.L.), The development and testing of a dam-break flood forecasting model, Proceedings, Dam-Break Flood Modeling Workshop, U.S. Water Resources Council, Washington, DC, 1977, pp. 164-197.
2. HEC, "Flood Hydrograph Package (HEC-1) Users Manual for Dam Safety Investigations", September 1978 (new program released September 1981).
3. HEC, "Stream Hydraulics Package - Computer Program Description", October 1979.
4. McMahon, George F., "Guidelines for Determining Inundated Areas Resulting from Dam Failures - State of Georgia", U.S. Army Corps of Engineers, Savannah, Georgia, 1979.
5. Sakkas, J.G. "Dimensionless Graphs of Flood from Ruptured Dams", report prepared for HEC, January 1974.

APPENDIX

Preparation and Publication of Inundation Maps For Flood Emergency Plans

This appendix provides instructions for preparation and publication of inundation maps required as a part of flood emergency plans for Corps dams. Attachments to the appendix include examples of various maps to be prepared and information on obtaining base maps from the U.S. Geological Survey.

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APPENDIX

Preparation and Publication of Inundation Maps For Flood Emergency Plans

1. General Requirements

The guidelines for flood emergency plans for Corps dams require preparation of inundation maps for hypothetical cases of Spillway Design Flood with and without dam failure. Maps are to be prepared in preliminary and final form. Preliminary and final maps will include a Map Cover Page and Map Index Sheet. The following paragraphs provide basic information on obtaining the U.S. Geological Survey (USGS) base maps (Attachment 1), the layout of the base map plate frame (Attachment 2) the Map Cover Page (Attachment 3), the Map Index Sheet (Attachment 4), the inundation map - reduced size (Attachment 5), and the inundation map - full size (Attachment 6).

a. Maps Required for Corps Reports

The flood emergency plan for Corps dams will contain the following maps:

- (1) Map Cover Page (Attachment 3).
- (2) Map Index Sheet (Attachment 4).
- (3) Inundation maps - reduced (Attachment 5).

b. Maps Required for Local Governments

Local governments (communities, counties, etc.) will be provided with the following final maps for use in preparation of evacuation plans:

- (1) Map Cover Page (Attachment 3).
- (2) Map Index Sheet (Attachment 4).
- (3) Inundation maps - reduced (Attachment 6).

2. Map Cover Page

a. General

The full size final inundation maps prepared for distribution to local officials should be preceded by a Map Cover Page. See Attachment 3 for an example Map Cover Page.

b. Contents

The Map Cover Page should provide the following information:

- (1) Description of what the maps are, why they were prepared, and the remote nature of the hypothesized emergency conditions.
- (2) Discussion of use of the maps for evacuation planning.
- (3) Definition of key terms:
 - (a) River mile.
 - (b) Peak elevation.
 - (c) Peak time.
 - (d) Arrival time.
 - (e) National Geodetic Vertical Datum (NGVD) or other datum used.
 - (f) Spillway Design Flood.
 - (g) Other terms considered important.
- (4) Assumed conditions of flooding.

3. Map Index Sheet

a. General

A separate Map Index Sheet should be provided with each map set to show the general location and orientation of individual map panels. The Map Index Sheet should show the dam and reservoir area and the downstream routing reaches to a point of adequate floodwater disposal (that point below which no loss of life or significant property damage would be caused by the routed flows). It should also show the limits, locations, and orientation of each community and an accurate depiction of each inundation map panel. See Attachment 4 for an example Map Index Sheet.

b. Orientation

The Map Index Sheet and individual map panels must have north oriented to the top of the page. The locations and names of major streams, major roads, and selected railroads should be shown to facilitate the orientation and location of the individual map panels. Map panel neatlines should be accurately placed with respect to the other features shown on the Map Index Sheet.

c. Contents

The Map Index Sheet should be clear and easy to read. Contours and extraneous information should be avoided. The Map Index Sheet will contain the following:

- (1) Title block.
- (2) Dam and reservoir area.
- (3) Principal river and tributary streams.
- (4) North arrow.
- (5) Streamflow direction arrow.
- (6) Bar scale.
- (7) Community location(s).
- (8) Location of major roads and railroads.
- (9) Map sheet neatlines and plate numbers.
- (10) Location of prominent landmarks.
- (11) Description of the function of the Map Index Sheet
- (12) Cross section data table that includes:
 - (a) Plate number.
 - (b) Section number.
 - (c) River mile.
 - (d) Distance from dam.
 - (e) Time of arrival of dangerously high flows (to nearest 15 minutes), peak time (to nearest 30 minutes) and peak elevation (to nearest 0.5 ft.) for conditions of Spillway Design Flood with and without failure. Time for the case of Spillway Design Flood without failure will be measured from time at which the reservoir level exceeds the top of the flood control pool. Time for the case of Spillway Design Flood with failure will be measured from the beginning of failure.

4. Base Map Requirements

a. General

Maps used as a base must be of a scale and quality that enables portraying clearly the flood hazard for the two emergency conditions. This will generally require maps equivalent to, or more detailed than, the USGS 7.5 minute quadrangle series maps. Every effort should be made to use the best available topographic maps as a base. In most cases, the USGS 7.5 minute quadrangle series maps will be the best for use, if they are available. The use of different base maps is acceptable provided the overall objectives, including clarity, are met. The base map should be selected and obtained at the earliest possible time to avoid delays and errors caused by transposing data from one set of maps to another. The same base map should be used for preparation of both preliminary and final maps.

b. Acceptable Map Types

The following acceptable map types are listed in general order of preference:

- (1) USGS 7.5 minute quadrangle series maps.
- (2) Corps available topographic maps complete or strips.
- (3) Topographic maps from other sources.
- (4) Aerial photographs in which all information described in paragraph 4e below can be readily distinguished or shown.
- (5) Planimetric maps which accurately portray roads, flood plains, community locations, and other configurations.
- (6) 2X enlargement of USGS 15 minute quadrangle series maps.
- (7) Flood Insurance Study base maps.

c. Source of USGS Maps

If the USGS 7.5 minute quadrangle series maps are selected for use, reproducible separates with and without contours should be obtained to provide maximum flexibility in preparing the final maps. Reproducible separates of USGS quadrangle series maps can be ordered directly from USGS Cartographic Offices listed in Attachment 1.

d. Scale

The map scale should be such that all important features can be identified clearly when the map is reduced to one-half size. The full size map scale should range between 1"=400' and 1"=2,000'.

e. Minimum Contents

Base maps should include at least the following information:

- (1) Cultural features including natural landmarks and prominent manmade features such as railroads, airfields, streets, roads, highways, levees, dikes, seawalls and dams.
- (2) Drainage features such as rivers, streams, lakes and ponds, coastlines, tidal flats, canals and channels.
- (3) Corporate limits.
- (4) Dam and reservoir area.
- (5) Names of principal rivers and streams.
- (6) Number and location of each cross section used in the routings.
- (7) Location of prominent landmarks not shown on the original.
- (8) Existing development not illustrated on the original which is impacted by the routings.

f. Optional Contents

Base maps may also contain the following information:

- (1) Contours and spot evaluations (paragraph 4g).
- (2) Location of buildings.
- (3) Grid or section lines.
- (4) Other planimetric or cultural information which would assist in locating flood boundaries.

g. Use of Contours

Contours should be shown on maps if practical. However, they may be deleted where their density would detract from the clarity of the reduced final maps. Removal of the contours from USGS 7.5 minute quadrangle series maps can be readily accomplished by deletion of the separate overlay on which they appear.

h. Base Map Plate Frame

The base map should be superimposed on a plate frame containing the information shown on the example in Attachment 2.

5. Preliminary Maps

Preliminary maps should be prepared using the base maps described in paragraph 4, including the map frame (paragraph 4h). Information shown on preliminary maps should include the downstream area likely to be flooded, maximum depth of water at various points in the flooded area, time of arrival of dangerously high flows, peak time and peak elevation.

Information shown should also include the boundary of the reservoir at top of flood control pool, boundary of the inundated area at the maximum pool elevation during the Spillway Design Flood, and time of occurrence of the maximum pool elevation during the Spillway Design Flood.

Accuracy requirements are:

- a. Depth of water to the nearest half foot.
- b. Time of arrival of dangerously high water to nearest 15 minutes (hours and minutes should be used, not fractions of an hour).
- c. Peak time to nearest 30 minutes.
- d. River miles to nearest 0.1 mile.
- f. Distance from dam to nearest 0.1 mile.

Information for both emergency conditions should be placed, in pencil, on a copy of the base map. Any other information which would further clarify or assist in review of the study results should be included. Preliminary maps should be considered as original working maps with graphics kept as simple and concise as possible. Color pencil coding of inundation area outlines is permissible. A paper reproduction of the preliminary map should be used for review.

6. Final Maps

Final inundation maps will be prepared after preliminary inundation maps have been reviewed and technical comments satisfied. Maps are to be prepared full size (Attachment 6) for use by local officials and reduced size (Attachment 5) for inclusion in the Corps report. Clarity and simplicity are of prime importance in the final maps. It may be necessary to redraft certain portions of the maps to improve readability. Final maps should include at least the following information:

- a. Information pertaining to each cross section
 - (1) River mile.
 - (2) Distance from dam.
 - (3) Time of arrival of dangerously high flows.

- (4) Peak time.
- (5) Peak elevation.
- b. Information pertaining to the reservoir area including:
 - (1) Boundary of the reservoir at top of flood control pool.
 - (2) Boundary of the inundated area at the maximum pool elevation during the Spillway Design Flood.
 - (3) Time of occurrence of the maximum pool elevation during the Spillway Design Flood.
- c. Names of major streets and roads crossing the inundated areas.
- d. Names of communities and counties that would be affected by flood waters.
- e. Depiction of the limits of inundation including:
 - (1) Use of a heavy short dashed line to delineate the inundation area for the case of a Spillway Design Flood without dam failure.
 - (2) Use of a heavy solid line to delineate the inundation area for the case of a Spillway Design Flood with dam failure.
- f. Depiction, on a blue shaded overlay, of the inundation area for the case of a Spillway Design Flood with dam failure.
- g. Examples of reduced and full size final inundation maps showing desired line weights and lettering sizes are contained in Attachments 5 and 6, respectively. Similar type styles and sizes are acceptable providing they are clear and simple. Good cartographic practice should be followed.

ATTACHMENT 1

UNITED STATES GEOLOGICAL SURVEY CARTOGRAPHIC OFFICES

The following U.S. Geological Survey Cartographic offices are sources of reproducible map manuscripts:

Eastern Mapping Center National Cartographic Information Ctr. U.S. Geological Survey 536 National Center Reston, VA 22092	FTS-928-6336 Comm. 703/860-6336
Mid-Continent Mapping Center National Cartographic Information Ctr. U.S. Geological Survey 1400 Independence Road Rolla, MO 65401	FTS-277-0851 Comm. 314/341-0851
Rocky Mountain Mapping Center National Cartographic Information Ctr. U.S. Geological Survey Box 25046, Stop 504, Federal Center Denver, CO 80225	FTS-234-2326 Comm. 303/234-2326
Western Mapping Center National Cartographic Information Ctr. U.S. Geological Survey 345 Middlefield Road Menlo Park, CA 94025	FTS-467-2427 Comm. 415/323-8111 X2427

Procedures and technology for preparation of topographic maps by the U.S. Geological Survey have changed over time. In addition, procedures for map preparation vary between the agency's several mapping centers. The number and kind of separates which are available for maps therefore vary from case to case. Contact should be made with the appropriate mapping center to discuss needs, available separates, and ordering procedures.

All available 1:250,000 scale maps are distributed through the Eastern Mapping Center.

FLOOD EMERGENCY PLAN
FOR
PLATTE CITY DAM
PLATTE CITY, MISSOURI

EXPLANATION OF MAPS

The attached maps indicate the area which would be flooded under the hypothesized conditions of: a) occurrence of a spillway design flood at Platte City Dam; and b) occurrence of a failure of the dam concurrent with a spillway design flood. The possibility is extremely remote that either condition will occur.

Preparation of the maps does not reflect on the safety or integrity of Platte City Dam. They have been prepared as part of a national program to prepare similar maps for all Federal dams.

USE OF MAPS

The attached maps provide a basis for evaluating existing evacuation plans for the affected area and development of any further plans which are needed. The Corps of Engineers recommends that such evaluations be made and any needed supplemental plans be developed. Information on evacuation planning and examples of evacuation plans are available from the Corps of Engineers.

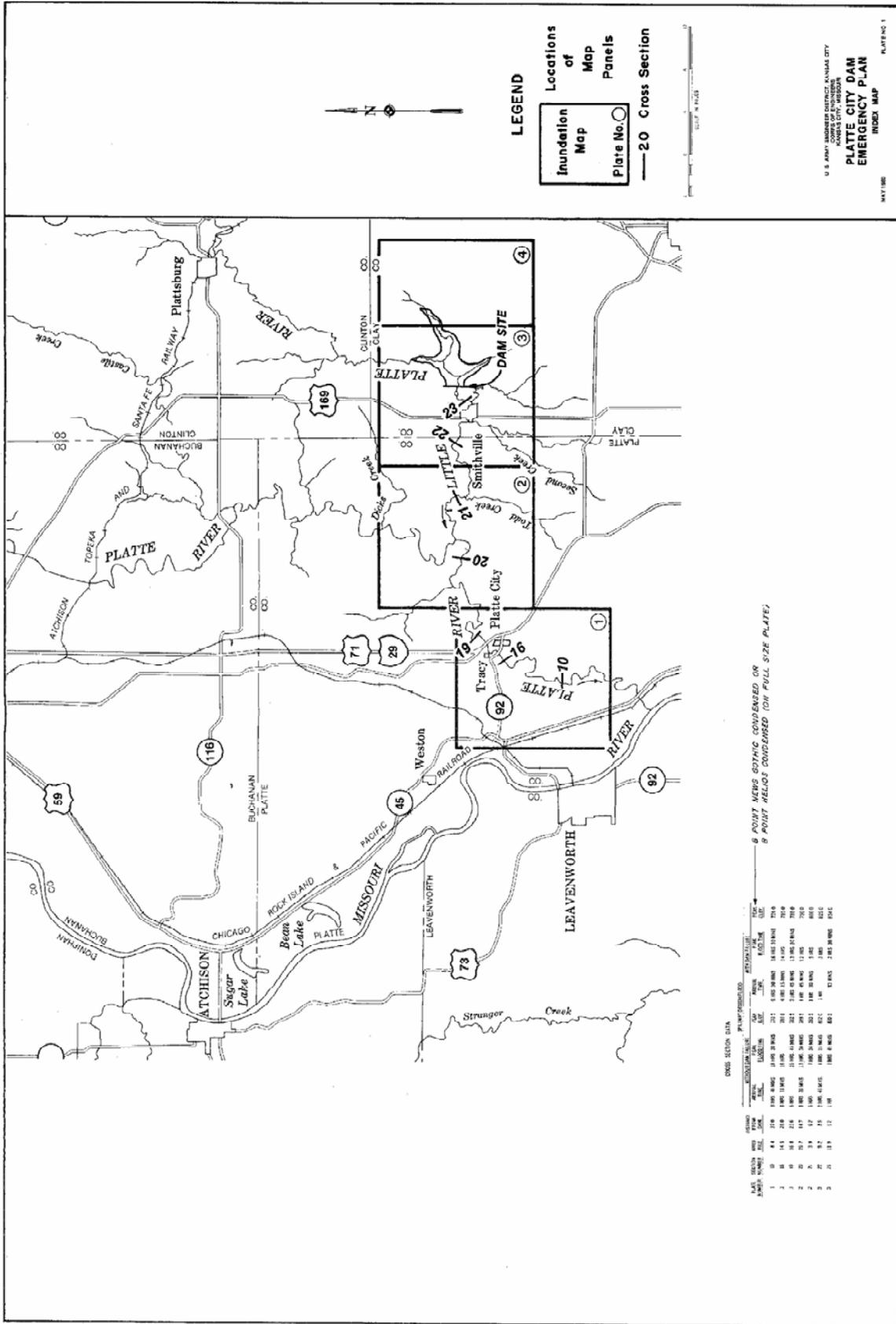
The general procedure for use of the attached maps is as follows:

1. Determine the portion of your area of concern which would be affected by inundation or isolation.
2. Identify routes which would be used for movement of people from each part of the area to be evacuated.
3. Identify the amount of time available for evacuation.
4. Use the information to assess whether existing evacuation plans cover all of the affected area and will provide for timely evacuation.

DEFINITION OF TERMS

River mile	The distance along the channel of the Platte River from its confluence with the Missouri River.
Peak elevation	The computed maximum water surface elevation which would be reached at a location due to assumed conditions.
Peak time	Elapsed time* after assumed event until peak elevation occurs.
Arrival time	Elapsed time* after assumed event until arrival of dangerously high flows at a point.
NGVD	National Geodetic Vertical Datum (distance above 1929 mean sea level).
Spillway Design Flood	The maximum flow which a dam's spillway is designed to pass safely.
Dam failure	Any condition resulting in the uncontrolled release of water other than over or through an uncontrolled spillway or outlet works.
Cross section	Point at which the shape of a stream channel or valley is measured, usually in a direction perpendicular to the direction of flow.

*Elapsed time for the case of Spillway Design Flood without failure is measured from the time at which the reservoir level exceeds the top of the flood control pool. Elapsed time for the case of Spillway Design Flood with failure is measured from the beginning of failure.



LEGEND

Locations of Map Panels

Inundation Map

Plate No. 0

—20 Cross Section

SCALE IN FEET

PLATE NO. 1

U.S. ARMY ENGINEER DISTRICT, KANSAS CITY
 OFFICE OF THE DISTRICT ENGINEER
 PLATTE CITY DAM
 EMERGENCY PLAN
 INDEX MAP

CROSS SECTION DATA

ELEVATION	SECTION DATA		PERCENTAGE	
	AREA	PERCENTAGE	AREA	PERCENTAGE
1	100	100	100	100
2	100	100	100	100
3	100	100	100	100
4	100	100	100	100
5	100	100	100	100
6	100	100	100	100
7	100	100	100	100
8	100	100	100	100
9	100	100	100	100
10	100	100	100	100
11	100	100	100	100
12	100	100	100	100
13	100	100	100	100
14	100	100	100	100
15	100	100	100	100
16	100	100	100	100
17	100	100	100	100
18	100	100	100	100
19	100	100	100	100
20	100	100	100	100
21	100	100	100	100
22	100	100	100	100
23	100	100	100	100
24	100	100	100	100
25	100	100	100	100
26	100	100	100	100
27	100	100	100	100
28	100	100	100	100
29	100	100	100	100
30	100	100	100	100
31	100	100	100	100
32	100	100	100	100
33	100	100	100	100
34	100	100	100	100
35	100	100	100	100
36	100	100	100	100
37	100	100	100	100
38	100	100	100	100
39	100	100	100	100
40	100	100	100	100
41	100	100	100	100
42	100	100	100	100
43	100	100	100	100
44	100	100	100	100
45	100	100	100	100
46	100	100	100	100
47	100	100	100	100
48	100	100	100	100
49	100	100	100	100
50	100	100	100	100
51	100	100	100	100
52	100	100	100	100
53	100	100	100	100
54	100	100	100	100
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56	100	100	100	100
57	100	100	100	100
58	100	100	100	100
59	100	100	100	100
60	100	100	100	100
61	100	100	100	100
62	100	100	100	100
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67	100	100	100	100
68	100	100	100	100
69	100	100	100	100
70	100	100	100	100
71	100	100	100	100
72	100	100	100	100
73	100	100	100	100
74	100	100	100	100
75	100	100	100	100
76	100	100	100	100
77	100	100	100	100
78	100	100	100	100
79	100	100	100	100
80	100	100	100	100
81	100	100	100	100
82	100	100	100	100
83	100	100	100	100
84	100	100	100	100
85	100	100	100	100
86	100	100	100	100
87	100	100	100	100
88	100	100	100	100
89	100	100	100	100
90	100	100	100	100
91	100	100	100	100
92	100	100	100	100
93	100	100	100	100
94	100	100	100	100
95	100	100	100	100
96	100	100	100	100
97	100	100	100	100
98	100	100	100	100
99	100	100	100	100
100	100	100	100	100

Example Map Index Sheet ATTACHMENT 4



8 POINT HELIOS CONDENSED OR
9 POINT HELIOS CONDENSED



LEGEND

Limit of Suburban
Without Storm Drainage
With Storm Drainage

32 Cross Section
Corporate Limits

Scale: 1" = 200' (SCALE AS SHOWN)

Contours Interval: 10 feet
Religious Coordinates: Vertical values of 1929
Horizontal values of 1983
Platte City, MO, 1987, when revised 1995.

NOTE: This inundation area shown on this map without flood insurance coverage is not to be construed as a warranty of the Platte City Dam.

J. B. JAMES ENGINEERS, INC., PLATTE CITY, MISSOURI
COUNTY ENGINEERS
**PLATTE CITY DAM
EMERGENCY PLAN
INUNDATION MAP**
PLATE NO. 1
MAY 1987