



National Flood Insurance Program
Community Rating System

CRS Credit for Dam Safety

2006



FEMA

A community interested in more information on obtaining flood insurance premium credits through the Community Rating System (CRS) should have the *CRS Application*. This and other publications on the CRS are available at no cost from

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They can also be viewed and downloaded from FEMA's CRS website,
<http://training.fema.gov/EMIWeb/CRS/index.htm>

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Introduction

Objective

One of the objectives of the Community Rating System (CRS) is to protect lives and health. CRS credit is provided for both state and local dam safety programs.

Dam failures have resulted in numerous disasters in the United States and around the world. Although catastrophic dam failures are rare in the United States, the threat is real, and communities should be aware of the potential for a dam failure that would affect their residents, and prepare for such a disaster.

Dams can create a false sense of security for floodplain residents. Unlike levees, they do not need flood conditions to fail. They can be breached with little or no warning and send a wall of water downstream. The combination of high velocity, great depth, and short notice has proven particularly deadly and destructive. One way to minimize this hazard is to enforce construction and maintenance standards. This is usually done through a state dam safety program.

Recent Disastrous U.S. Dam Failures

- Toccoa Falls, Georgia—On November 5, 1977, the Kelly Barnes Dam failed, killing 39 students and college staff and causing about \$2.5 million in damage.
- Teton, Idaho—The Teton Dam failed on June 5, 1976, killing 11 people and causing property damage totaling \$400 million.
- Buffalo Creek, West Virginia—The Buffalo Creek Dam failed on February 26, 1972, killing 125 people.

Although the legal definition of a “dam” for regulatory purposes varies from state to state, many dams are very small. A dam may be as low as 5 feet, with an impoundment of no more than 5 acre-feet of water. In many states, highway and railroad embankments may legally be dams, although they may not be rigorously regulated. Thus, if a community has one or more high hazard dams upstream, it should not necessarily expect a 100-foot wall of water to suddenly swamp developed areas. On the other hand, if a dam failure caused even a 25- or 50-year flood with no warning or preparation on a clear day, the results still could be devastating.

In the last 20 years, federal and state agencies have made great strides in inventorying, inspecting, and repairing unsafe dams. There are approximately 75,000 U.S. dams listed on the National Inventory of Dams. These dams are over 25 feet high or have over 50 acre-feet in storage, or they are smaller structures that pose a safety hazard to a downstream population.

There are almost 11,000 dams in the United States that are classified as “high hazard” dams. A high hazard dam is one whose failure threatens life and property. Of these 11,000 high hazard dams, fewer than 45% have emergency action plans (EAPs). All



View northwest toward the breach in Teton Dam (Idaho) during the dam's failure. The canyon floor is flooded from bank to bank, and all works there are completely inundated. Photo by Mrs. Eunice Olson (Sylvester, 2006).

states require EAPs for new dams, but only a few have statutes that require owners of existing dams to produce EAPs.

Data from a dam's EAP are needed by downstream communities to prepare for their own emergency response activities.

Even though most communities are downstream from one or more hazardous dams, few have an emergency response plan that adequately addresses dam failure emergencies.

The objectives of this activity are

- To encourage state dam safety officials to complete their inventories of dams;
- To encourage state dam safety officials to get the most dangerous dams repaired or modified to reduce the threat of dam failure;
- To encourage state dam safety officials to get EAPs completed for all dams that pose high or significant hazards to downstream residents; and
- To encourage communities to integrate dam failure planning into their emergency plans.

The CRS

The Community Rating System (CRS) is a part of the National Flood Insurance Program (NFIP). When communities go beyond the NFIP's minimum standards for floodplain management, the CRS can provide discounts up to 45% off flood insurance premiums.

Communities apply for a CRS classification and are given credit points that reflect the impact of their activities on reducing flood losses, insurance rating, and promoting the awareness of flood insurance. The Insurance Services Office's ISO/CRS Specialist reviews the community's program and verifies the CRS credit. This includes a review of the written procedures and records of an activity and, in some cases, a visit to sites in the field.

A community applies using the *CRS Application*. CRS credit criteria, scoring, and documentation requirements are explained in the *Coordinator's Manual*. Copies of both are available free from the office listed on the inside front cover of this publication.

630 Dam Safety

The CRS credit for state dam safety programs and community dam failure planning is provided under Activity 630 (Dam Safety) in the *Coordinator's Manual*. This publication explains the CRS credit criteria and gives examples.

Elements Recognized in Activity 630

This activity recognizes two approaches to improving dam safety:

- A **state dam safety program** provides a state-wide basis for developing an inventory of dams, determining the risk downstream from dams, and monitoring the condition of dams throughout the state. Except for dams they own, communities generally have limited authority over dams that affect them, especially if they lie outside the community. The acronym used in credit calculation formulae, “SDS,” is a shorthand way to refer to the CRS credit. The credit criteria are explained in Section 631.a of the *Coordinator's Manual*.
- With detailed information on how upstream dams might fail, and based on regular communications with upstream dam owners, communities should incorporate a **dam failure emergency response plan** in their overall emergency response plans. “DFP” is a shorthand way to refer to the CRS credit. The credit criteria are explained in Section 631.b of the *Coordinator's Manual*.

This publication reviews these elements and explains the requirements for verification of credit by the CRS.

Definitions

Some terms and acronyms are used in this publication that may not be familiar to CRS Coordinators.

Association of State Dam Safety Officials (ASDSO)—The Association of State Dam Safety Officials (ASDSO) is a not-for-profit organization formed in 1984 in response to several major dam failures across the United States during the previous decade. It was recognized at the time that there was a great need for stronger regulatory programs. ASDSO was established to encourage and assist states in setting up or upgrading their dam safety programs.

Dam failure inundation area map—A map that shows areas subject to inundation after a dam failure. These maps are similar to a floodplain map. They are usually part of an emergency action plan (EAP) prepared by a dam owner. They may extend a long distance downstream and affect a number of communities.

Emergency action plan (EAP)—A plan developed for a specific dam, usually prepared by the dam owner, which specifies actions to be taken by the dam owner or operator in the event of an impending or actual dam failure.

Emergency response plan—For purposes of this document, an emergency response plan is a plan developed by a community, a group of communities, or a county that defines the local responsibilities in dealing with an emergency. This plan probably includes different types of natural and human-caused emergencies, such as floods, tornados, hurricanes, hazardous chemical spills, terrorist acts, etc. For CRS credit under this activity, it must also include a response plan for failure of an upstream dam. Locally, it may be titled an “Emergency Plan,” an “Emergency Preparedness Plan,” or other similar names.

National Inventory of Dams (NID)—The Water Resources Development Act of 1986 (P.L. 99-662) authorized the U.S. Army Corps of Engineers to maintain and periodically update the National Inventory of Dams, and appropriated funds for that purpose. Section 215 of the Water Resources Development Act of 1996 (P.L. 104-303) re-authorized periodic update of the National Inventory of Dams. For the 1998 update and beyond, the Corps of Engineers has the lead responsibility, and is working with the Association of State Dam Safety Officials, the Federal Emergency Management Agency (FEMA), and other state and federal agencies. As of early 2001, the national inventory had 75,000 entries.

Security

The threat of terrorist activity in recent years presents a very real problem to dam owners and operators and to local emergency management officials. Dam owners may be reluctant to provide detailed information about their dams to others, and community emergency managers may be constrained in how they use and disseminate dam failure information.

These problems are very real, and the CRS makes no recommendations on how they should be approached. To prepare its response to a dam failure emergency, a community must have the kind of information contained in EAPs prepared by dam owners. In order for the public to be prepared to respond to a dam failure in accord with the community’s dam failure emergency response plan, some amount of information on the effects of a dam failure must be made public. The CRS leaves it to the community to determine the best way to provide the documentation required for CRS credit while keeping vital information about the dams secure.

631 Credit Points

This section discusses the two elements (state dam safety program and the community's dam failure emergency response plan) and the corresponding CRS credit points under Activity 630. As in the *Coordinator's Manual*, the credit criteria of the *CRS Schedule* are shown in shaded boxes with double line borders. Scoring examples are shown in this typeface.

This section also covers how the elements are scored, provides example language, and identifies some of the more common problems and misunderstandings found in community CRS applications.

a. State Dam Safety Program (SDS)

State dam safety programs are scored according to a separate *Schedule for State Dam Safety Programs*, based on the standards outlined in the Model State Dam Safety Program developed by the Association of State Dam Safety Officials and published by FEMA as Publication 123. If the status of a state's dam safety program is unknown, the community should contact the FEMA Regional Office (see Appendix A of the *Coordinator's Manual*) or the ISO/CRS Specialist for that state (see Appendix G of the *Coordinator's Manual*). If a state program receives few or no points, it is hoped that local interest will encourage the appropriate state agency or legislature to improve the state program.

This credit is available to all communities in states with credited dam safety programs, including communities that are not downstream from any dams. However, if a community owns or regulates the construction, operation, or maintenance of any dams, the community dam safety program must meet the state standards for dam safety in order for the community to be eligible for SDS credit. The separate dam safety schedule requires states to advise FEMA when any community is in violation of the state's program.

Scoring

a. Two conditions are prerequisites for credit under this element:

1. If a state does not receive credit for this element, no community within that state is eligible for credit for this element.
2. A community must meet state dam safety standards to receive credit for this element.

SDS = up to 75 points, if the community is in a state with a dam safety program that has been accepted by FEMA for CRS credit. The state dam safety office must have stated that the community's program is in compliance with the state program.

A CRS community does not have to do anything to receive SDS credit. Each year, state dam safety officials complete a questionnaire and send it to FEMA for evaluation. FEMA assigns the SDS credit for states that qualify. Each state also provides a list of communities that are not compliant with its dam safety requirements.

The 2002 SDS credit for each state is shown below. This credit usually does not change much from year to year, but the most current state credit can be obtained from the FEMA Regional Office. A list of communities that are not compliant with their state dam safety programs is also available from the FEMA Regional Office.

CRS Credit for State Dam Safety Programs

subject to revision

State	Credit	State	Credit
Alaska	58	Nebraska	68
Arizona	72	Nevada	60
Arkansas	75	New Hampshire	75
California	74	New Jersey	67
Colorado	75	New Mexico	57
Connecticut	56	New York	56
Florida	67	North Carolina	58
Georgia	64	North Dakota	68
Hawaii	68	Ohio	63
Idaho	71	Oklahoma	56
Illinois	59	Pennsylvania	75
Kansas	64	South Carolina	57
Kentucky	69	South Dakota	71
Louisiana	74	Texas	55
Maryland	75	Utah	68
Massachusetts	52	Virginia	75
Michigan	57	Washington	63
Minnesota	61	Wisconsin	68
Mississippi	68	Wyoming	54
Montana	72		

If its state has not earned SDS credit, a community could use whatever influence it has with the state legislature to get the state dam safety program up to the minimum CRS standards for SDS credit. If there is a state association of floodplain or emergency managers, it may be able to help.

NOTE: A community that received credit for Activity 630 in a previous application does not need to submit a modification to revise or update its SDS credit. Its credit will be revised automatically by the ISO/CRS Specialist to reflect its state's credit.

Documentation Needed for Verification

All documentation for this element is provided to FEMA by the state dam safety official.

b. Dam Failure Emergency Response Plan (DFP)

Emergency preparedness planning and emergency response take place at the community level. In many locations, a county agency is responsible for emergency management throughout the county, including the incorporated communities. In other locations, each municipality is responsible for its own emergency planning and response.

Local emergency managers prepare for many natural and human-caused emergencies, from floods, tornados, and earthquakes to hazardous materials spills, nuclear accidents, and airplane crashes. They usually have a general plan that applies to all types of emergencies and more specific plans for specific emergencies. To a specific emergency, the local emergency manager must have specific information.

The first thing for the community to do is determine if there are dams upstream that would adversely affect the community if they failed. On large rivers, such dams may be a long ways upstream, outside the county the community is in, or even outside the state. For most communities, the place to begin is with the state dam safety office. Other sources of information are regional offices of the Corps of Engineers and the U.S. Geological Survey.

If there is a dam that would cause flooding in the community, the next step is to obtain the dam's EAP, if one exists. Much of the information needed by the local emergency manager must come from an EAP prepared for the dam.

EAPs are usually prepared by dam owners so that they and downstream communities can understand the potential results of a dam failure and be prepared for them. A good EAP will discuss the different ways that the dam may fail and the floods that will result if such failures occur. An EAP that allows a community to qualify for DFP credit must also include a hydraulic analysis that produces a dam failure inundation map, flood elevations, and arrival times at various points downstream from the dam.

If there is no EAP for the dam, it is unlikely that the community will be able to receive DFP credit for that stream reach. The state dam safety office may be able to require an EAP from the owner, the community may produce an EAP for the dam, or the community may be able to convince the dam owner that he or she should produce an EAP in order to be a good neighbor. However, an EAP is a major technical undertaking.

Some states require that dam owners prepare EAPs. California's statutes include the following requirements for maps of dam failure inundation areas:

8589.5. (a) Inundation maps showing the areas of potential flooding in the event of sudden or total failure of any dam, the partial or total failure of which the Office of Emergency Services determines, after consultation with the Department of Water Resources, would result in death or personal injury, shall be prepared and submitted as provided in this subdivision within six months after the effective date of this section, unless the time for submission of those maps is extended for reasonable cause by the Office of Emergency Services.

The local governmental organization, utility, or other owner of any dam so designated shall submit to the Office of Emergency Services one map that shall delineate potential flood zones that could result in the event of dam failure when the reservoir is at full capacity, or if the local governmental organization, utility, or other owner of any dam shall determine it to be desirable, he or she shall submit three maps that shall delineate potential flood zones that could result in the event of dam failure when the reservoir is at full capacity, at median-storage level, and at normally low-storage level.

A dam failure emergency is possible whether there are structural problems with a dam or not. As noted in the Washington State Department of Ecology Dam Safety Section's *Example EAP*, the following situations may cause a sudden release of water downstream from a dam: earthquake; flood water entering the dam reservoir; erosion, slumping/sloughing or cracking of the dam abutment; springs, seeps, bogs, sandboils, increased leakage, or sinkholes; and landslides that affect dam operations.

An emergency plan adopted by a community usually gives the emergency manager special authority to deal with emergencies. For example, he or she may use vehicles and personnel from all community departments as needed. A good emergency response plan tries to anticipate what materials and personnel will be needed for each type of emergency. Section 610 of the *Coordinator's Manual* has more information about emergency response plans. Also, see *CRS Credit for Flood Warning Programs*, which is available from the address on the inside front cover of this publication.

Scoring

b. Dam failure emergency response plan (DFP) (Maximum credit: 100 points)

$$\text{DFP} = \text{DFP1} + \text{DFP2} + \text{DFP3}$$

1. DFP1 = 25, if the community has the following:

- (a) An emergency response plan that
 - (1) Specifies that the community will be notified of an impending or actual failure of a dam upstream from the community;
 - (2) Provides projected inundation areas, flood elevations, and estimated arrival times for flood peaks arising from a failure of the dam; and
 - (3) Calls for an exercise at least annually. The results of the exercise are evaluated and used to revise the response plan;
- (b) A procedure to obtain annual reports by the dam operators on the safety and operational status of their dams. Copies of these reports must be sent to the community and the state dam safety office; and
- (c) Monthly communication checks between dam operators and emergency services officials.

(a) Emergency Plans: Many communities have prepared multi-hazard emergency response plans or comprehensive emergency management plans. Unless such a plan has an annex, standard operating procedures, or other parts that specifically address the community's dam safety problem, it may not be specific enough to qualify for CRS credit. For CRS credit, a dam failure EAP must specifically relate to the dam safety issue and identify appropriate response activities.

An emergency response plan is adopted by the governing body of the community. These plans generally reassign authority over community agencies during a declared emergency. For example, in an emergency, the director of emergency management may have authority over vehicles and other equipment normally assigned to public works. Community staff from any department in the community may be temporarily assigned to respond to the emergency. The dam failure emergency plan must be part of this adopted plan.

In most states, most emergency management planning is done at the county level, with specific community plans subordinate to the county plan. This recognizes the fact that many types of disasters are widespread in area, and may affect several communities at once. In these cases, the dam safety emergency plan may be partly contained in the county emergency preparedness plan, and partly within the city's emergency preparedness plan. For example, the county may have the ability to receive dam failure warnings on a 24-hour basis, while the city does not. In that case, the county would activate its countywide emergency response plan and notify affected communities. Each community would then activate its plan. The San Diego County Emergency Plan states

In the early 1960s, all the cities and the County got together and formed a Joint Powers Agreement which established the United San Diego County Emergency Services Organization (USDCEO) and the Unified Disaster Council which is the policy making group of the Organization. It also created the Office of Disaster Preparedness, which is staff to the Unified Organization . . .

This document was created by representatives of all of the jurisdictions in the Operational Area and all of the agencies with any responsibilities in the plan. It is intended to be adopted by all of the jurisdictions in the Operational Area with minor modifications. The goal is to have emergency plans which are as similar as possible throughout the Operational Area. That way if any one of the members needs assistance from any of the other jurisdictions, everyone will be familiar with the Emergency Plan. With representation from all agencies and jurisdictions, it assures that the commitments that have been made in the plan are realistic.

The basis for a community's dam failure response planning is the kind of information contained in the EAP(s) for an upstream dam(s). A community can develop the dam failure inundation maps and estimated arrival times of peak flows and conduct exercises of its plan, but the dam owner or operator must agree to notify the community in the event of an emergency that may lead to a dam failure.

The dam owner or operator must also cooperate with the community to provide the annual reports and monthly communications checks required for DFP credit. The best way to ensure this cooperation is to have it included in the EAP(s).

- (b) Annual Report:** The annual report by the dam operators must include any factors that have changed since the EAP was written that affect the safety of the dam or increase the likelihood of its failure. Such factors might include the results of recent inspections, revisions to the hydrologic studies used to forecast possible dam failures, revisions in the operation plans, and/or current conditions such as the water level of the reservoir and the snowpack in the watershed above the dam.

If an upstream dam owner is reluctant to prepare the annual report required for DFP credit, the community should use any means necessary to obtain the information. If a dam fails and the community is not prepared, there will be unnecessary suffering, loss of property, and perhaps loss of life. Communities should work with their state dam safety office and legislature to get such reports required from all dam owners.

- (c) Monthly Communications Checks:** Monthly communications checks with the dam ensure that the dam owner or operator knows who to contact in the event of an emergency. It may be decades between the time an EAP is prepared and the occurrence of an emergency, and for most dams, a dam failure emergency will never occur. However, the dam owner or operator and the community must be prepared for an emergency every minute of every day.

If communication with the dam is made by telephone, the community's emergency plan should require a telephone call by emergency management staff to the dam every month. If the dam is so remote that communication requires radio or satellite communication, that system should be tested monthly.

2. DFP2 = 25, if the community has the following:

(a) credit for DFP1, and

(b) an adopted emergency plan that details at least three methods of notifying affected residents of an imminent flood event resulting from a possible or ongoing dam failure. At least three of the following notification methods must be available:

- Sound or voice siren system;
- Telephonic notification, AM transmitters, and receivers dedicated to dam failure notification;
- NOAA Weather Radio. Receivers with Specific Area Message Encoding (SAME) are preferred;
- Mobile public address;

- Emergency Alert System;
- Cable television override; and
- Door-to-door notification.

Because a dam failure is generally unexpected, and because the flood wave resulting from many dam failures travels downstream rapidly, the warning dissemination methods appropriate for this hazard are those used in flash flood situations. In many cases, there will be only a few hours to evacuate, and in some cases, only minutes.

Credit for DFP1 ensures that the community can be notified of an upstream dam failure and that it has some idea how bad the emergency will be. DFP2 credit is provided if the community is prepared to notify those residents who will be directly affected by a dam failure.

Large institutions may need their own information dissemination plans. The following is from a university's emergency response plan:

ABC University recognizes its responsibility to provide accurate and timely information to the campus community and the public during emergencies. The University also recognizes its responsibility to students, faculty and staff to respond to concerns about personal safety and security, and to follow University policies concerning the release of personal information. During emergencies, information will be provided to the campus community through a variety of methods, including announcements in the news media, e-mail and audix announcements, web pages, emergency hotlines, telephone trees, and meetings in affected buildings and residence halls.

3. DFP3 = 50, if the community:

- (a) Has credit for DFP1 and DFP2;
- (b) Has an adopted emergency plan that includes evacuation routes and detailed procedures for notifying and evacuating critical facilities, specifically including schools, hospitals, nursing homes, jails, and other locations where there are populations that may have difficulty evacuating the dam failure inundation area; and
- (c) At least annually notifies occupants in the dam failure area of the hazard, the area affected, evacuation routes, and flood safety topics appropriate to the hazard.

Because dam failures are rare events, it will be difficult for people to believe that they are in danger. It is necessary for them to receive repeated messages so that if the event occurs they understand that they have to act quickly. When the time comes, they also have to know what to do and where to go. Depending on the community's situation, they may have to put the family in the car and leave immediately, leaving animals to fend for themselves and leaving all of their possessions.

Facilities with special populations are a particular concern in this type of emergency. It is likely that the staff of such facilities do not have the ability to evacuate their students, patients, clients, inmates, etc., and will need extraordinary assistance to avoid a catastrophe. They should have an emergency plan, and they should exercise it regularly. The community emergency manager should work with the management of such facilities to ensure that these emergency plans address the potential hazards and meet the needs of their populations.

DFP3 gets into more detailed planning. Because dam failures are unusual events, people need to have information readily available in order to know how to respond to a warning. A nursing home may not have any idea how to move its residents if the community tells them that there has been a dam failure upstream and they need to evacuate within six hours. Just like the community, the nursing home needs an emergency response plan. The management needs to know how long it will take to evacuate the clients, how many vehicles they will need, where they will get them, etc.

Families and others also need to know what to do if notified of a dam failure. More information on flood safety topics can be found in Activities 330 and 610 in the *Coordinator's Manual*.

Documentation Needed for Verification

The community must provide the following documentation:

- a. [Required only if the community is applying for credit under Section 631.b.1]
The portions of the community's emergency plan or other documentation that show the dam failure inundation areas, flood elevations, and estimated arrival times, an annual report from the dam operator, annual exercises, and monthly communications checks.

The community must provide a copy of the cover or other page that shows the date the plan was adopted. It should also show the date the plan was last reviewed and/or revised. The appropriate sections of the plan should be marked with the acronym "DFP1."

- b. [Required only if the community is applying for credit under Section 631.b.2]
The portions of the community's emergency plan that detail at least three methods of disseminating a dam failure warning.

The appropriate sections of the plan should be marked with the acronym "DFP2."

- c. [Required only if the community is applying for credit under Section 631.b.3]
1. The portions of the community's emergency plan that indicate evacuation routes and procedures for notifying and evacuating critical facilities; and
 2. A copy of the materials that notify occupants of the dam failure inundation area as discussed in Section 631.b.3. The materials must be distributed each year and must reach at least 90% of the properties in the dam failure inundation area. An outreach project to the community or to floodplain properties credited under Activity 330 (Outreach Projects) may qualify for this credit provided that it explains the dam failure hazard, the area affected, evacuation routes, and appropriate flood safety topics.

The appropriate sections of the plan should be marked with the acronym "DFP3." Some or all of this documentation may have been provided for Activity 330 (Outreach Projects).

Annual Recertification

Each year, a CRS community must submit an annual recertification to FEMA through its ISO/CRS Specialist. For continued credit for DFP, the recertification must include a statement that an exercise has been conducted for the dam failure emergency response plan, that regular communications checks between the community and the dam have been made, and that the community has received an annual report from the dam owner/operator. This recertification is due by October 1. The ISO/CRS Specialist provides the forms with specific instructions.

Common Problems

This element requires documentation from the community emergency manager. The CRS Coordinator cannot provide documentation for this element without assistance from someone who is familiar with the community's emergency response plan.

Some communities have tried to receive credit for providing the EAP for an upstream dam. While information from the EAP is needed to develop the community's emergency response plan, DFP credit is for the community's own plan.

Some communities have applied for DFP credit without a dam failure inundation map and flood arrival times. They may have a generic emergency response plan that includes exercises, dissemination, and other information, but without the dam failure inundation area the plan does not receive CRS credit.

Some communities have difficulty documenting the monthly communications checks required in DFP1. In some cases, communications between the community and the dam are so frequent and routine that they are not mentioned in the emergency response plan. In this case, a letter from the emergency manager describing the communications checks will provide sufficient documentation.

632 Impact Adjustment

The CRS measures the impact of an activity on the community. It does not matter who owns an upstream dam, or if the dam safety emergency plan is developed by the community or the county. What counts is that the community has a positive way to receive notification of a potential dam failure, that the community knows what areas are likely to flood if there is a failure, and that the community is prepared to take action when it is threatened by a dam failure.

To simplify the CRS application process, the impact adjustment is not included in the *CRS Application*. The ISO/CRS Specialist will help the community determine the impact adjustment for dam failure planning.

There is no impact adjustment for SDS.

a. Option 1 (for DFP):

If the dam failure emergency plan covers all buildings in the SFHA, the impact adjustment ratio $rDFP = 1.0$.

If all buildings in the Special Flood Hazard Areas (SFHAs) on the community's Flood Insurance Rate Map (FIRM) are on streams with upstream dams, and if dam failure emergency plans have been developed for all upstream dams, the community should use Option 1 for $rDFP$. If any of the community's SFHA is coastal, and there are buildings in that part of the SFHA, the community cannot use Option 1.

Example: Community 1 has one stream on its FIRM. The total number of buildings in the SFHA is 100. $bSF = 100$

There is a flood control dam on the stream. The owner produced an EAP, which Community 1 used to develop the dam failure portion of its emergency response plan. Since all buildings in the SFHA are covered by the dam failure emergency plan, Community 1 uses Option 1. $rDFP = 1.0$.

b. Option 2 (for DFP):

If only some of the buildings in the SFHA are covered by the dam failure emergency plan, the community may use the default value $rDFP = 0.25$.

The default value provides 25% of the credit the community has for DFP. If more than 25% of the buildings in the community's SFHA are in dam failure inundation areas, and the community cannot use Option 1, it should use Option 3.

Example: Community 2 has two streams on its FIRM. One is a large river and the other is a small tributary. The total number of buildings in the SFHA is 150, of which 20 are in the floodplain of the tributary.

Community 2 uses Option 2. rDFP = 0.25.

c. Option 3 (for DFP):

The impact adjustment ratio rDFP is computed by dividing the number of buildings covered by the dam failure emergency response plan by the total number of buildings in the SFHA (bSF):

$$rDFP = \frac{bDFP}{bSF}, \text{ where}$$

bDFP = the number of buildings covered by the dam failure emergency response plan, and

bSF = the number of buildings in the SFHA.

rDFP cannot be greater than 1.0.

If some of the SFHA is covered by a dam failure emergency plan, the community will maximize its credit for this element by using Option 3 to determine the impact adjustment. To calculate rDFP using Option 3, the community must know how many buildings are in its SFHA (bSF) and how many buildings are within the dam failure inundation areas that have DFP credit (bDFP).

Note that for any watercourse, if the dam failure inundation area is larger than the 100-year floodplain, the number of buildings in the dam failure inundation area may be greater than the number of buildings in the SFHA for that watercourse. Therefore, it is possible that a community can earn full credit for this element even if all of its SFHA does not have a dam failure preparedness plan. However, rDFP cannot exceed 1.0, regardless of the calculation.

Sections 302 and 303 of the *Coordinator's Manual* discuss ways to count buildings for CRS credit. The number of buildings in the SFHA (bSF) is also used to calculate credit for Activities 310, 520, 530, 610, and 620. This is also the number that should be on the community's biennial report to FEMA.

It is likely that the number of buildings in the dam failure inundation area (bDFP) was determined during development of the dam failure emergency response plan. The emergency manager is a likely source for this information.

Example: Community 3 has three streams on its FIRM. One is a large river and the other two are small tributaries. The total number of buildings in the SFHA is 150, of which 100 are in the floodplain of the large river. $bSF = 150$

There is a flood control dam on the large river. The owner produced an EAP that Community 3 used to develop the dam failure portion of its emergency response plan. The EAP indicates that the dam failure inundation area for the large river is about the size of the 500-year floodplain.

The number of buildings in the dam failure inundation area for the large river is 176. $bDFP = 176$

Community 3 uses Option 3 to calculate $rDFP = \frac{bDFP}{bSF} = \frac{176}{150} = 1.17$

Since $rDFP$ cannot exceed 1.0, the community uses $rDFP = 1.0$ to calculate its credit.

633 Credit Calculation

The end result of this work is a score for the community's dam failure emergency response plan (DFP). It is the product of the credit points multiplied by the impact adjustment ratio. In the *Coordinator's Manual* it is shown as

$cDFP = DFP \times rDFP$, where

cDFP is the final credit DFP;

DFP is the credit for the community's dam failure response plan, which ranges from 25 to 100; and

rDFP is the impact adjustment ratio, which ranges from 0.25 to 1.0.

cDFP can range from 6.25 to 100 points.

$c630 = SDS + cDFP$.

634 Credit Documentation

a. State Dam Safety Program (SDS)

There is no documentation required for the community to receive credit points based on the state's dam safety program (SDS). The credit points will automatically be added to the community's credit, provided the state verifies the community's compliance with the state's program.

b. Dam Failure Emergency Response Plan (DFP)

To receive credit for its dam failure emergency response plan (DFP), the community must provide certain documentation to the ISO/CRS Specialist. The documentation requirements are discussed in Sections 631.b and 632, above.

635 For More Information

Most of the references listed below are on EAPs that are prepared by dam owners. Information from an EAP, especially the dam failure inundation area map and arrival times of the flood peaks, are needed for the community's emergency response plan. The dam failure emergency response plan itself is prepared just like the emergency response plan for any other hazard, based on the specific hazard the community faces.

Alaska Department of Natural Resources, Division of Mining, Land & Water Dam Safety and Construction Unit, 2003. *Guidelines for Cooperation with the Alaska Dam Safety Program*.

http://www.dnr.state.ak.us/mlw/water/dams/AK_Dam_Safety_Guidelines092603.pdf

Arizona Department of Water Resources, 2002. *Simplified Emergency Action Plan Form*, ADWR, Phoenix, AZ.

Federal Emergency Management Agency, 1998. *Federal Guidelines for Dam Safety: Emergency Action Planning for Dam Owners*, FEMA-64. FEMA, Washington, D.C.

Pennsylvania Department of Environmental Protection, 2002. *Guidelines for Developing an Emergency Action Plan for Hazard Category 1 & 2 Dams*. Harrisburg, PA. <http://www.dep.state.pa.us/dep/deputate/watermgt/WE/DamProgram/EmActPlan/Main.htm>

San Diego County Office of Disaster Preparedness, 2000. *Unified San Diego County Emergency Services Organization Operational Area Emergency Plan*.

Sylvester, Arthur G. 2006. "Teton Dam Failure." Slide show posted on the website of the Geological Sciences Department, University of California at Santa Barbara.

http://www.geol.ucsb.edu/faculty/sylvester/Teton%20Dam/welcome_dam.html

Washington State Department of Ecology, Dam Safety Section, 1998. *Example EAP*.

<http://www.ecy.wa.gov/programs/wr/dams/exameap.html>.

Wisconsin Department of Natural Resources, no date. *Sample Emergency Action Plan*,

Wisconsin DNR, Madison, WI. <http://www.dnr.state.wi.us/org/water/wm/dsfm/dams/documents/damseap.pdf>

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APPENDIX A

ELEMENTS OF AN EMERGENCY ACTION PLAN

An EAP includes a description of the dam and a set of specific actions to be taken by the dam owner/operator if there is a dam failure or a threat of one. There may be related actions to be taken by others, but the primary emphasis is on actions to prevent or delay a dam failure and to notify agencies and facilities that may be affected by it.

It is virtually impossible for a community to properly prepare for a dam failure emergency without an EAP prepared by the dam owner. It should also be apparent that downstream communities should participate in the development of EAPs for all dams upstream from them. The communities certainly need to know that they are included in the dam owner's/operator's notification list. They should also be aware of the nature of the dam failures that are forecast and the assumptions used to develop them. Finally, the community should be sure that it always has the latest revision of the EAP.

Although the community is not responsible for the preparation of EAPs unless it owns dams, it is important that community officials understand what is included in an EAP. There are many models for EAPs, just as there are for community emergency response plans, but they have many common elements.

Statement of Purpose

From *Dam Safety Guidelines, Part III, An Owner's Guidance Manual*, Washington State Department of Ecology:

Although most dam owners have a high level of confidence in the structures they own and are certain their dams will not fail, history has shown that on occasion dams do fail and that often these failures cause loss of life, injuries and extensive property damage. A dam owner should prepare for this possibility by developing an emergency action plan which provides a systematic means to:

- Identify emergency conditions threatening a dam
- Expedite effective response actions to prevent failure
- Reduce loss of life and property damage should failure occur.

A dam owner is responsible for preparing a plan covering these measures and listing actions that the owner and operating personnel should take. He should be familiar with the local government officials and agencies responsible for warning and evacuating the public.

It is important that dam owners make full use of others who are concerned with dam safety; emergency plans will be more effective if they integrate the actions of others who can expedite response. People and organizations with whom the dam owner should consult in preparing an emergency action plan include numerous local participants, state and federal agencies.

An EAP may have a statement of purpose that explains why it was developed. However, many EAPs are strictly working documents that do not include such a statement. They start immediately with contact lists or descriptions of emergency conditions.

Description of the Dam

This section includes a brief description of the watershed above the dam, the type of construction, the storage capacity, a discussion of the spillway and other outlets, and the normal operation of the dam. There is also a short description of the river and floodplain downstream from the dam.

It is important for downstream communities and floodplain residents to understand some of the characteristics of an upstream dam.

- A flood control dam is normally kept empty or nearly empty. When a flood arrives from upstream, it releases water at a rate that will keep it from overtopping. These releases may cause downstream flooding of roads and low areas, but they are necessary to control and reduce the peak flow from upstream.
- A storage dam for water supply is normally kept as full as possible. It releases water on a schedule for municipal or irrigation purposes. The operator of a storage dam may only be able to release a small flow of water until the reservoir is full and water flows over the spillway. In this case, the dam may do little to reduce downstream flood peaks. That is not a decision the operator makes; it is inherent in the design of the dam.
- Like a storage dam, a dam built primarily for the generation of electric power needs to maintain a certain reservoir elevation for this purpose, and the ability to release water when a large inflow is expected may be limited.

The normal operation of a dam affects the outcome of a dam failure.

Notification

A notification flow chart is a prioritized list of people and agencies the dam owner/operator notifies whenever there is an emergency or a potential emergency that could lead to a dam failure. This may be the first chapter of the EAP. This is the first thing the dam operator needs to do in a dam failure.

This list may include dam maintenance staff and others who need to monitor the dam. It will always include state dam safety officials and downstream communities. It may also include specific facilities that need immediate notification, such as the operators of recreational facilities adjacent to the river near the dam.

There may be two or more notification flow charts. One may be used when dam failure is imminent or has already occurred. The priorities in this event are to notify facilities and agencies downstream that a flood peak is coming and that they should take immediate and appropriate actions to save lives and property. Another notification flow chart may

be used when the dam owner/operator sees a situation developing that could lead to a dam failure. The priorities and the messages to be used in this event vary according to the situation.

The notification flow charts include names, telephone numbers, radio frequencies and call signs, cell phone numbers, and other information on the people who need to be contacted. There may be office and home numbers, and information for office hours and after hours.

Like a community's emergency response plan, each page in the EAP should have a revision date. It is essential to keep these notification flow charts current.

Emergency Detection and Evaluation

Dams are regularly inspected, monitored, and maintained. Emergency situations may be identified as a result of these inspections and monitoring. Other events, such as an earthquake or a forecast of a large upstream flood, may signal an impending emergency.

During an emergency situation, extra efforts are made to monitor a dam. For example, under normal conditions, the reservoir level may only change a few tenths of a foot per day. Reservoir levels may be recorded hourly or daily. If there is a sudden drop in the reservoir level, that signals an emergency. A large flood entering the reservoir may cause the level to rise several feet in a matter of hours. In these situations, reservoir levels may be recorded every few minutes.

Most large dams today have telemetered gages so that the dam operator can monitor the dam and reservoir at all times. Typical measurements include the flow of the river above the reservoir, the level of the reservoir, and the flow in the river downstream from the dam. In some cases, there are instruments to measure movement of the dam, moisture content inside an earthen structure, and other parameters of the dam itself.

During an emergency, it may be necessary for staff to take additional measurements, and other data may be needed by the operator. For example, if the reservoir is nearly full and a storm is expected above the dam, the operator may need rainfall data, weather radar data, and streamgage data from gages far upstream from the dam.

The EAP tries to anticipate these data needs and provide procedures to meet them.

Responsibilities

Responsibilities are specified in the EAP for the dam owner/operator and staff. Their primary responsibilities are to transmit warning messages according to the notification procedures specified, to protect the dam from damage, and to limit downstream peak flows as much as possible.

The emergency preparedness and response of downstream floodplain occupants is the responsibility of the communities and facility managers. These should be coordinated

with the dam owner/operator through the development and periodic revision of the EAP to ensure that warning messages are clear and unambiguous, and that the appropriate response will be made.

Preparedness

Emergency preparedness by the dam owner/operator includes

- Ensuring that data collection (and telemetry) equipment is functioning properly at all times;
- If the dam is not staffed at all times, ensuring that there is a plan to respond whenever there are no personnel at the dam;
- Ensuring that there is all-weather access to the dam;
- Ensuring that there are sufficient equipment and supplies for an emergency, including food and water for the staff, at all times; and
- Ensuring that there are alternative means of communications from the dam to decision makers.

Forecasts of Dam Break Floods

The engineering analysis for an EAP consists of determining the most probable mode of failure for the various project features and preparing an inundation map for the affected areas downstream of the dam. The EAP is to consider those things that cannot be forecast such as instantaneous or rapid failures. Earthquakes, rapid dam or foundation failure, penstock or spillway failure, and landslides are examples of the failure modes considered. A Probable Maximum Flood emergency is not considered because advance warning would be given by the weather. Based on engineering judgments, several assumptions are made to produce a hypothetical worst dam breach flood. An emergency response can then be prepared based on this hypothetical worst-case dam breach flood.

This section of the EAP should discuss the type of hydrologic and hydraulic models used to determine the “hypothetical worst-case flood,” the assumptions made in the modeling, and the results of the modeling. The results may include several scenarios, including the cause of a dam failure, water level in the reservoir at the time of failure, current weather conditions, etc.

The “results” section will generally include a table showing the expected peak flow at different points downstream, travel times for the flood from the dam to these points, maximum flood velocities and other information, and maps of dam failure inundation areas. If there are a number of scenarios, there may be several of these tables. See the fictitious example at the top of the next page.

These tables are essential to downstream emergency preparedness. As seen in the fictitious example for Alamo Dam on page A-5, they provide estimates of the downstream arrival time and peak flood elevations. Both of these factors are needed for

the emergency manager to order effective evacuations. If there are several hours of warning time, it may be possible for residents to remove some items of value. If the time is shorter, it may be difficult even to get the people out of harm's way.

Closely related to a data table like the one in this example, there may be a flood profile for the dam failure(s). The figure on page A-6 is an example of a profile for the Trask River in Washington. This profile shows the ground elevation and the elevations of the 10-, 100- and 500-year floods, probably from the Flood Insurance Study. It also shows a "sunny day" dam break flood profile. Because this EAP was developed at least partially because of a proposal to raise the height of the dam, it also shows flood elevations for two dam break scenarios with the larger dam in place.

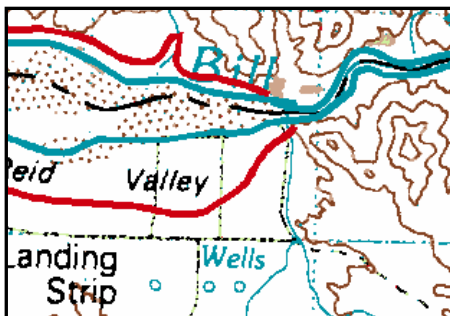
Alamo Dam Extreme Wet Weather Break¹				
Cross Section (Miles from dam)	Peak Flow (cfs)	Peak Water Level (ft)	Travel Time (hours)²	Maximum Velocity (feet/sec)³
Alamo Dam (0.0)	1,250,000	Elev 2332	0.0	41.0
Highway 23 (7.8)	900,000	Elev 2251	0.7	12.5
Salt Creek (12.2)	725,000	Elev 2205	1.1	10.1
Highway 154 (20.5)	550,000	Elev 2140	2.5	9.8
Big River (28.6)	350,000	Elev 2102	4.0	8.7

¹ Based on a Probable Maximum Flood (PMF) inflow to Alamo Dam and 100-year antecedent flooding downstream from the dam.

² Travel time is based on the start of water level rise at the cross section.

³ Velocity is average cross section velocity.

Inundation Maps

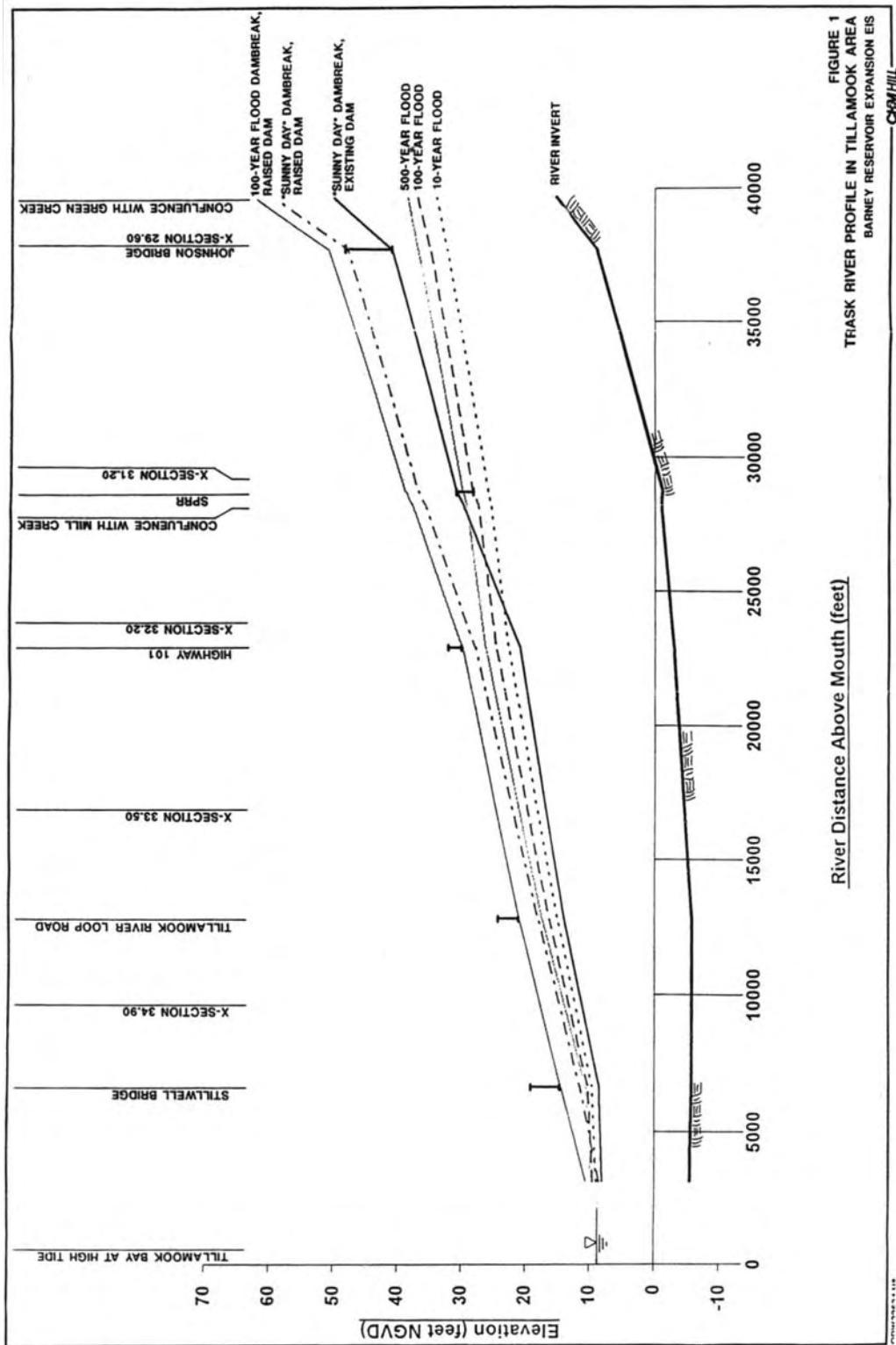


Maps showing the area that will be inundated are the final parts of the EAP that are essential to downstream emergency preparedness and response. The example to the left shows a rudimentary dam failure inundation map for a fictitious dam. The area inside the inner lines is the 100-year floodplain. The area inside the outer lines is the dam failure inundation area.

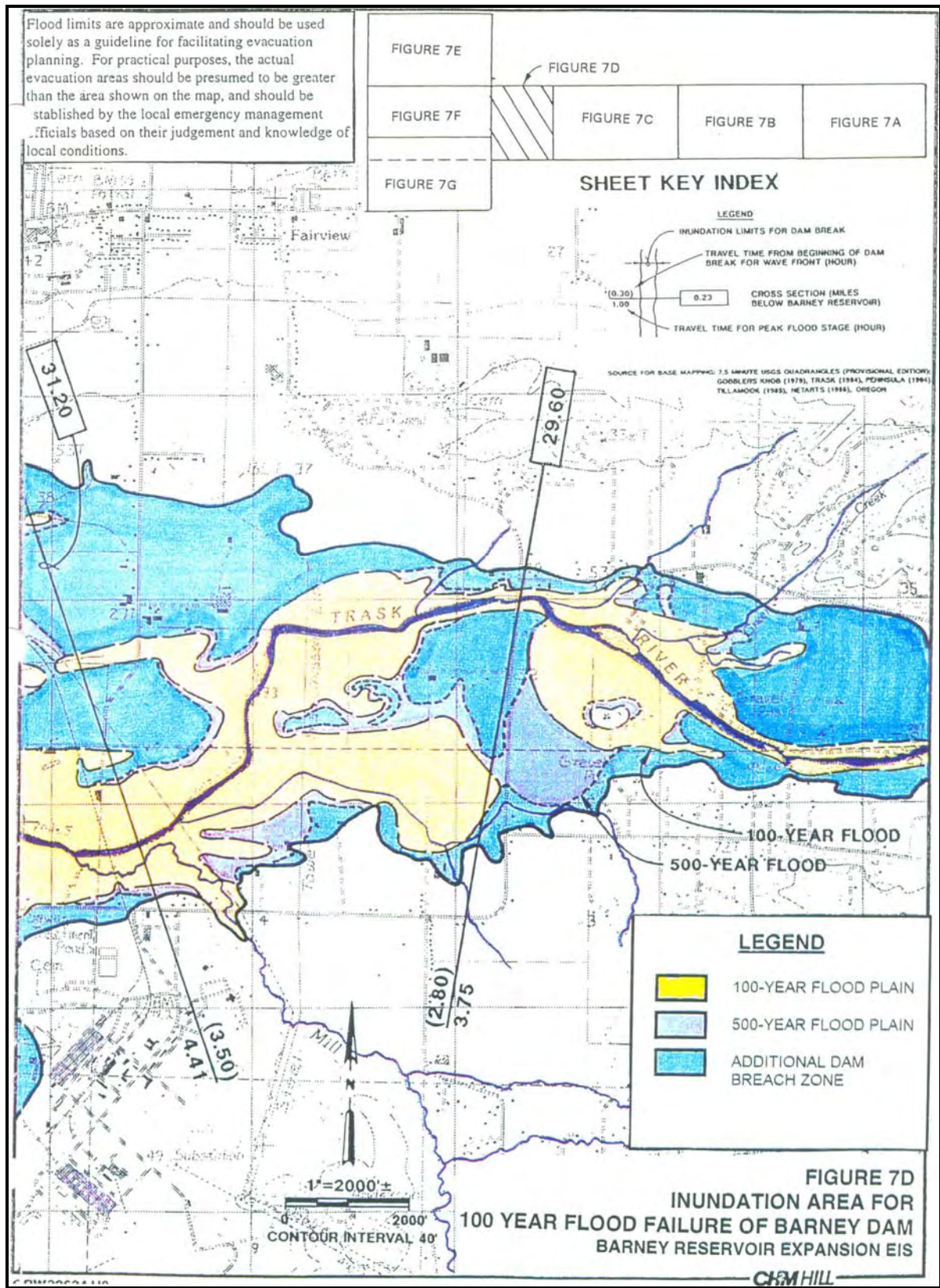
The map on page A-7 shows an actual dam failure inundation area for an area downstream from a dam on the Trask River in Washington. There is a lot of information on this map that will help in emergency preparedness planning and emergency response.

First, the note in the upper left hand corner explains that the information on this map is approximate. If the emergency manager has reason to believe that the flood approaching this area is larger than that used to develop this map, he or she may need to evacuate a larger area. This map shows the area expected to be inundated by a dam failure flood. This map can help the emergency manager plan evacuation routes, areas needing evacuation, and emergency shelters.

The map also shows the 100- and 500-year floodplains. This is useful to indicate that a dam failure on this river would cause a much larger flood than residents have ever seen. Note that the map shows the cross section number that would be related to a table similar to the example on the top of this page. For each cross section, there is a line showing where the cross section is located, what the cross section number is, and the times when water is expected to start to rise and when the peak flow is expected to arrive.



A profile for the Trask River, Washington.



An inundation area map for Barney Dam, Washington.

APPENDIX B

AN EXAMPLE OF CRS CREDIT FOR A LOCAL DAM FAILURE EMERGENCY PLAN

NOTE: The examples in this appendix are from a real county emergency plan. For security reasons, the county emergency manager asked that information on the threat posed by dam failures in the county not be widely disseminated. Therefore, all place names and some geographic facts have been altered to disguise the identity of the community and the dams.

The Jones County Emergency Management Plan has been adopted by both Jones County and Jones City. Although it is an all-hazards plan, it has a separate document called the “Jones County Flood Contingency Plan.” This document, which includes the dam failure plan, is in a 2-inch ring binder.

The first section of the plan includes the purpose, legal authority, general responsibilities for various city and county agencies and others, and other general information.

The second section, “Implementing Procedures,” includes emergency phone numbers, levels of response, public protection strategies, and public information messages for evacuation and other actions.

The third section of the Flood Contingency Plan includes more detailed information on the Jones River, the largest river that flows through the population centers in the county. It has a more specific list of responsibilities and flood data and maps for the Jones River.

The fourth section has detailed information on several tributaries to the Jones River. Since these cause different flood problems in different areas of Jones City and Jones County, the specific responsibilities are somewhat different.

The fifth section of the plan discusses dams that affect the county. This is discussed in more detail below.

The sixth section has detailed information on another large river in the county that runs through rural areas.

Here is how Jones County documents its dam failure plan and the CRS credit it receives for DFP in Activity 630.

631 Credit Points

Section 631.b in the *Coordinator's Manual* specifies the following:

b. Dam failure emergency response plan (DFP) (Maximum credit: 100 points)

$$\text{DFP} = \text{DFP1} + \text{DFP2} + \text{DFP3}$$

1. DFP1 = 25, if the community has the following:

(a) An emergency response plan that

- (1) Specifies that the community will be notified in the event of an impending or actual failure of a dam upstream from the community;
- (2) Provides projected inundation areas, flood elevations, and estimated arrival times for flood peaks arising from a failure of the dam; and
- (3) Calls for an exercise at least annually. The results of the exercise are evaluated and used to revise the response plan.

The Jones County Emergency Manager has copies of the EAPs prepared by the owner/operator of the three dams upstream from Jones City on the Jones River. Although each dam has a capability of operation at the dam, the dams are normally monitored and operated remotely from an operations center in Jones City. Each of the EAPs includes notification of the Jones County Emergency Management Office in the event of any emergency situation that might affect the county. These EAPs are updated annually.

The Jones County Flood Contingency Plan includes tables and maps showing dam failure inundation areas, flood elevations, and flood arrival times at various points downstream from each dam.

Although the Flood Contingency Plan itself does not call for annual exercises, it states that “the Jones City-County Emergency Management Office, through the Local Emergency Planning Committee, is responsible for scheduling, designing, conducting and evaluating flood incident exercises.” A separate resolution of the Local Emergency Planning Committee states that the City-County Emergency Plan will be exercised at least annually, and there is documentation that there have been four exercises in the last three years. Three of these exercises were flood-related and one was a simulation of a plane crash near the airport.

(b) A procedure to obtain annual reports by the dam operators on the safety and operational status of their dams. Copies of these reports must be sent to the community and the state dam safety office; and

During the verification visit, the County Emergency Manager demonstrated that the safety and operational status of the dams is maintained on the internet by the owner/operator of the dams, and is monitored daily by emergency management staff.

(c) Monthly communication checks between dam operators and emergency services officials.

County emergency management staff are constantly in communication with the dam operators. During normal operations, this communication is by telephone. During a dam failure emergency, the EAPs and the Jones County Flood Contingency Plan both specify that a liaison person will be stationed in the City-County Emergency Center with radio communications with the dams.

DFP1 = 25

2. DFP2 = 25, if the community has the following:

- (a) credit for DFP1, and
- (b) an adopted emergency plan that details at least three methods of notifying affected residents of an imminent flood event resulting from a possible or ongoing dam failure. At least three of the following notification methods must be available:
 - Sound or voice siren system.
 - Telephonic notification, AM transmitters and receivers dedicated to dam failure notification.
 - NOAA Weather Radio. Receivers with Specific Area Message Encoding (SAME) are preferred.
 - Mobile public address.
 - Emergency Alert System.
 - Cable television override.
 - Door-to-door notification.

The first page of the Jones County manual is a joint resolution signed by the city and the county, adopting the plan in 1995.

The Flood Contingency Plan lists the following methods for alerting the public:

- National Weather Service,
- NOAA Weather Radio (CRS credit),

- Emergency Alert System (CRS credit),
- Television and radio news broadcasts,
- Vehicles equipped with loudspeakers (CRS credit), and
- Door-to-door notification (CRS credit).

Since the county has four creditable methods for notification,

DFP2 = 25

3. DFP3 = 50, if the community:
- (a) Has credit for DFP1 and DFP2;
 - (b) Has an adopted emergency plan that includes evacuation routes and detailed procedures for notifying and evacuating critical facilities, specifically including schools, hospitals, nursing homes, jails, and other locations where there are populations that may have difficulty evacuating the dam failure inundation area; and
 - (c) At least annually notifies occupants in the dam failure area of the hazard, the area affected, evacuation routes, and flood safety topics appropriate to the hazard.

Although the Flood Contingency Plan has a detailed list of critical facilities, there is generalized information on how some of them should respond, and they have notification lists, there are no detailed procedures for evacuating these facilities. Also, perhaps because all of downtown Jones City is within the dam failure inundation area, annual notifications are not made to occupants of this area.

DFP3 = 0

$DFP = DFP1 + DFP2 + DFP3$

For Jones County, **$DFP = 25 + 25 + 0 = 50$**

632 Impact Adjustment

a. Option 1:

If the dam failure emergency plan covers all buildings in the SFHA, the impact adjustment ratio $rDFP = 1.0$.

b. Option 2:

If only some of the buildings in the SFHA are covered by the dam failure emergency plan, the community may use the default value $rDFP = 0.25$.

c. Option 3:

The impact adjustment ratio $rDFP$ is computed by dividing the number of buildings covered by the dam failure emergency response plan by the total number of buildings in the SFHA (bSF):

$$rDFP = \frac{bDFP}{bSF}, \quad \text{where}$$

$bDFP$ = the number of buildings covered by the dam failure emergency response plan, and

bSF = the number of buildings in the SFHA.

$rDFP$ cannot be greater than 1.0.

Because there are no dams on several tributaries of the Jones River in Jones County, the county cannot use Option 1. It chooses Option 3 to determine $rDFP$.

Jones County had to determine the number of buildings in its Special Flood Hazard Areas (bSF) for Activity 520. It determined that $bSF = 227$ for the county.

The dam failure inundation area for the worst-case dam failure on the Jones River includes 1,117 residences and 84 non-residential structures. $bDFP = 1,117 + 84 = 1,201$.

$$rDFP = \frac{1,201}{227} = 5.29. \quad \text{Since } rDFP \text{ cannot exceed } 1.0, \text{ the county uses } rDFP = 1.0.$$

Note that Jones County uses $rDFP = 1.0$ even though there are portions of its SFHA that have no dam failure planning. This is because the dam failure inundation area is larger than the SFHA on the Jones River, and there are buildings within the dam failure inundation area that are not in the SFHA but that do benefit from the county's dam failure planning.

633 Credit Calculation

$$cDFP = DFP \times rDFP$$

$$cDFP = 50 \times 1.0 = 50$$