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# REPORT TO THE CONGRESS



BY THE COMPTROLLER GENERAL  
OF THE UNITED STATES



## Slow Progress In Developing And Implementing A National Dam Safety Program

Department of the Army  
Corps of Engineers (Civil Functions) *AGC 00325*

The National Dam Inspection Act of 1972 provided, among other things, for the Corps of Engineers to inventory and inspect dam structures throughout the United States. The purpose of the act was to protect life and property and provide information for designing a comprehensive national dam safety program.

The Corps' dam inventory was not adequately developed, and the Army never requested enough money from the Congress to inspect dams or to design a comprehensive national dam safety program. To obtain the information needed to design a national dam safety program, the Congress should direct the Corps of Engineers to:

- Obtain and verify inventory data on all dams that the law covers.
- Make at least a sampling of dam inspections.
- Determine whether Federal participation is needed for a program to be effective and, if so, the nature of involvement.
- Present possible alternatives to the Congress.

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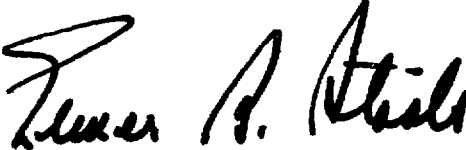
To the President of the Senate and the  
Speaker of the House of Representatives

The need for an effective nationwide dam safety program has been demonstrated repeatedly by such disasters as the failures of the Canyon Lake Dam in South Dakota and Buffalo Creek coal waste dam in West Virginia. This report discusses the actions that have been performed under the National Dam Inspection Act of 1972 (Public Law 92-367) and the Corps of Engineers' proposed national program for dam safety.

We made our review to assess and report to the Congress on the adequacy of the Corps' recommended program to protect human life and property from the dangers of dam failures.

This review was made pursuant to the Budget and Accounting Act of 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Office of Management and Budget; and the Secretaries of the Army and Defense.

  
Comptroller General  
of the United States

COMPTROLLER GENERAL'S  
REPORT TO THE CONGRESS

SLOW PROGRESS IN DEVELOPING  
AND IMPLEMENTING A NATIONAL  
DAM SAFETY PROGRAM

D I G E S T

The National Dam Inspection Act was enacted in 1972 after dam failures in that year alone caused about 350 deaths. The law directed the Secretary of the Army, acting through the Corps of Engineers, to

- inspect most of the dams in the Nation,
- inventory all dams conforming to the size criteria specified by the law,
- report inspection results to State Governors, and
- recommend to the Congress a comprehensive national program for dam safety.

The Secretary of the Army was to report to the Congress by July 1974 on the Corps' progress. (See p. 2.)

Not enough money was requested from the Congress to carry out all provisions of the act because the Office of Management and Budget concluded that inspection of non-Federal dams was a State responsibility. (About \$3 million was spent, primarily to inventory dams.) The Secretary submitted his final report to the Congress in November 1976. (See pp. 3, 5, and 11.)

Now, after about 5 years, the fundamental provision of the law (inspection of all dams) has not been carried out; the inventory is incomplete and based on data collected using inadequate definitions and procedures (most of the data has not been verified); and the national program for dam safety proposed by the Secretary of the Army lacks scope, depth, and alternatives. (See p. 24.)

The Congress should direct the Corps to supplement its November 1976 report to the Congress by providing:

- Information based on actual inspections of a scientific sampling of dams,

--Verified inventory data,

--Pertinent information showing whether Federal participation is needed to make certain an effective national dam safety program and, if so, the nature of involvement. The information should include estimates on the cost of dam inspections and remedial action needed and the availability of non-Federal funds for such actions.

--Possible alternatives for a dam safety program.

Before the Congress decides on a national dam safety program which requires Federal participation, it should be assured that the program includes

--an accurate inventory of dams, with realistic hazard ratings;

--mandatory minimum inspection criteria;

--provisions for requiring remedial measures for unsafe dams;

--other safety precautions, such as improved warning systems, zoning laws, and public educations; and

--a system for Federal or State monitoring of the program.

Since the Corps has made no inspections under the act, it does not know the nature and scope of the specific dangers that exist at dams in the Nation. Dam inspections are an essential first step in identifying unsafe dams and getting data to design a national dam safety program. (See pp. 10, 12, and 24.)

In reporting its recommended program to the Congress, the Corps emphasized voluntary State participation for about 43,500 non-Federal dams, even though many States told the Corps they could not carry out such a program without Federal funding. The Corps did not get enough information on cost of inspections, cost of remedial actions needed, and the adequacy of non-Federal sources of revenue to justify its conclusion. (See pp. 17-19.)

The Corps should make sure that the inventory of dams is reasonably accurate before the Congress is asked to decide on a national dam safety program. The best method for verifying the inventory data would be to require the Corps to see that visits are made to each dam site. (See p. 9.)

The Corps estimated the annual costs of its proposed program to be \$73.5 million for 49,000 dams. Reliable regulatory and inspection costs for an effective program have not been determined, because no inspections have been made and the accuracy of the dam inventory is questionable. Also, sizeable costs associated with remedial actions to fix dangerous dams have not been estimated and cannot be until inspections are made. Costs will be associated with implementing a good dam safety program, but spending the money could prevent the loss of life and property damage and the large relief costs which the Government otherwise would have to provide in the event of a disaster. (See pp. 5, 18-21, and 24.)

On April 23, 1977, the President directed heads of Federal agencies to immediately review their dam safety practices. These reviews will be used to coordinate dam safety programs and develop proposed Federal dam safety guidelines. Data developed during these reviews should be considered by the Corps in developing a national dam safety program as envisioned under the National Dam Inspection Act of 1972. (See pp. 22-23.)

Oral comments of Corps officials were considered in this report. They agreed with the general message of the report but would need additional appropriations to supplement their report as GAO recommended. (See pp. 25-26.)

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ABBREVIATIONS

GAO	General Accounting Office
OMB	Office of Management and Budget

## CHAPTER 1

### INTRODUCTION

In the early 1970s several events prompted the passage of legislation aimed at establishing a national program to inspect dams and protect human life and property from the hazards of improperly constructed or poorly maintained water storage dams. These events included:

- A June 1972 flood near Rapid City, South Dakota, when the Canyon Lake Dam failed as a result of unusually heavy rains. Over 230 people were killed and damage was set at over \$100 million.
- Failure of an unengineered coal waste dam in the Buffalo Creek Valley of West Virginia, in February 1972 resulted in at least 125 deaths, damage of about \$50 million, and 4,000 people left homeless.
- The Lower Van Norman Dam almost failed during the San Fernando earthquake in February 1971, threatening 80,000 people in the adjacent downstream community which would have been inundated.
- A large number of dams in the Northeastern United States were threatened in June 1972 by Hurricane Agnes which caused unusually heavy flooding. Some were overtopped and damaged. In the Northern Virginia area, the 118-acre Lake Barcroft was reduced to a stagnant, mud and debris flat; 1,000 lives were threatened when flood waters gouged out many thousands of tons of rock and earth from the right abutment of the concrete dam.

These and other events focused public concern on the potential hazards posed by water storage dams.

### ENACTMENT OF DAM SAFETY LEGISLATION

Congressional hearings were held in late spring and summer of 1972, and the Congress quickly voted for Federal legislation aimed at minimizing these hazards to human life and property.

On August 8, 1972, the President signed Public Law 92-367 (The National Dam Inspection Program). Under the law the Secretary of the Army, acting through the Corps of Engineers, was directed to inspect all dams in the United States except (1) dams under the jurisdiction of the Bureau of Reclamation, the Tennessee Valley Authority, and the International Boundary and Water Commission, (2) dams constructed pursuant to licenses

issued under the authority of the Federal Power Act, (3) dams which had been inspected by a State agency within the 12-month period immediately preceding the enactment of the law and for which the Governor of the respective State requested exclusion, and (4) dams which the Secretary of the Army determined do not pose any threat to human life and property. The Secretary also was required to report any potentially dangerous conditions to the concerned State Governors, and upon request, provide advice relating to remedial measures to rectify or eliminate any hazardous conditions.

The law further required the Secretary to report to the Congress by July 1, 1974, on his activities under the law. The report was to include, but not be limited to, (1) an inventory of all dams located in the United States, (2) a review of each dam inspection made, and (3) recommendations for a comprehensive national program for the inspection and regulation of dams for safety purposes, indicating the respective responsibilities which should be assumed by Federal, State, and local governments and by public and private interests.

The law defined the term "dam" to mean any artificial barrier that impounds or diverts water and which is 25 or more feet in height or has an impounding capacity of 50 or more acre-feet. The law specifically excluded any barrier which is 6 feet or less in height and barriers which have an impounding capacity of less than 15 acre-feet.

#### ACTIONS PERFORMED UNDER THE LAW

The Acting Secretary of the Army, by letter of July 24, 1974, advised the Congress of the Corps of Engineers' progress in fulfilling the requirements prescribed by Public Law 92-367. The Acting Secretary stated that the Corps was (1) compiling an inventory of all dams in the Nation, (2) surveying Federal and State dam safety inspection programs, (3) developing guidelines for dam inspections, and (4) formulating recommendations for a national program of dam inspection and safety.

In June 1975 the Chief of Engineers submitted to the Secretary of the Army a five-volume document containing his report "National Program of Inspection of Dams." This five-volume compilation included an inventory of dams, recommendations for a national program of dam safety, responses by State and Federal agencies to a questionnaire on dam supervision, a model law for State supervision of dams, and recommended guidelines for safety inspection of dams. Draft legislation for a dam safety program was submitted by the Chief of Engineers to the Assistant Secretary of the Army (Civil Functions) in December 1975.



In March 1976 the Secretary of the Army submitted to the Office of Management and Budget (OMB) the five volumes and draft legislation and recommended that the Corps' proposed national dam safety program be implemented. On April 2, 1976, four of the volumes containing the inventory of dams were released to the Congress, Federal agencies, and States. On November 16, 1976, the draft legislation and the fifth volume, which contained the Corps' recommendations for a national dam safety program, were released to the Congress.

#### RECENT CATASTROPHIES

Within the past 2 years two dam failures have refocused public concern on the potential hazards posed by water storage dams:

--On February 22, 1976, a 30-foot-high earthen dam on a private lake gave way and water lunged down the Newfound Creek near Canton, North Carolina. As a result of this flood, four people were killed, six homes were damaged or destroyed, and damage was estimated at \$115,600.

--On June 5, 1976, the Bureau of Reclamation's 300-foot-high Teton Dam in eastern Idaho, collapsed unleashing 80 billion gallons of water. Eleven people were killed and lifestyles of thousands of people residing in the basin were disrupted. Several communities were devastated and property damage was estimated at \$400 million.

#### SCOPE OF REVIEW

We examined the Corps' procedures and guidelines, records, and reports applicable to implementation of Public Law 92-367; interviewed Federal and State officials; and reviewed State legislation concerning dam safety. Our review was made at the Corps' Ohio River Division and the Huntington, West Virginia, and Louisville, Kentucky, district offices; the South Pacific Division and the Sacramento and Los Angeles district offices in California; and Corps headquarters in Washington, D.C. We also visited regional officials of the Mining Enforcement and Safety Administration, Barbourville, Kentucky, and Phoenix, Arizona; the Bureau of Reclamation regional office in Sacramento, California; and the National Forest Service regional office in San Francisco, California. We talked with State officials concerned with dam safety in California, Arizona, Nevada, West Virginia, Kentucky, and Indiana.

We reviewed various States' methods of collecting inventory data and obtained State officials' views on the Corps' proposal for a national program of dam safety and the cost of initiating the program.

## CHAPTER 2

### AN ACCURATE NATIONAL DAM INVENTORY

#### NEEDS TO BE DEVELOPED

The national dam inventory developed by the Corps is incomplete and is based on data collected using inadequate definitions and procedures. Also, most of the data was not verified.

Pursuant to the 1972 law, the Corps developed an inventory of approximately 49,000 dams located in the 50 States and 4 U.S. territories.<sup>1/</sup> The data for the dam inventory was gathered by Federal and State agencies and by private engineering firms under contract with the Corps. The inventory data was presented on a two-part form prepared by the Corps and requested the following information.

#### Inventory Data

##### Part I

1. Identification number
2. Location
3. Name of dam
4. Name of river or stream
5. Name of nearest downstream city, town, or village
6. Population of and distance from nearest downstream city, town, or village
7. Type of dam
8. Year completed
9. Purpose
10. Size and storage capacity
11. Remarks

##### Part II

1. Downstream hazard potential
2. Spillway information
3. Volume of dam
4. Power capacity
5. Navigation locks data
6. Owner
7. Engineered by
8. Constructed by
9. Regulatory agency
10. Inspection data, including date of last inspection

<sup>1/</sup>Guam, Puerto Rico, Virgin Islands, Trust Territories.

Because of fund limitations, the Corps discouraged dam site visits for inventorying purposes and required the completion of only Part I of the inventory data form, using available information and estimates. The Corps said that no funds should be spent for Part II of the inventory data and this data should be collected only if the information was readily available.

In 1973 Corps officials stated in an internal memorandum that submission of all Parts I and II data would result in a "first class" inventory at an estimated cost of \$7.4 million. However, they said that a "bare bones" inventory (excluding most of the information in Part II) could be compiled for an estimated \$3.4 million. Although Corps officials said that they preferred the first class inventory, the lesser amount was requested from the Congress because of fund limitations imposed by OMB. The \$3.4 million was appropriated by the Congress over a 3-year period, but only about \$3.0 million was spent by the Corps.

We found inaccuracies in both the data required to be collected (Part I) and the data not required to be collected (Part II). We also found that the Corps did little to verify the data and, thus, did not know how accurate the data was. We believe that additional assurances should be obtained on the accuracy of the data before it is used in designing a national dam safety program. Corps officials state that verification of inventory data, including site visits, would cost about \$3.6 million and take about 3 years.

#### INADEQUACIES IN PART I INVENTORY DATA

Most of the data included in the final inventory compilation came from Part I of the inventory data form; Corps officials told us that they consider it to be about 90 percent accurate. We did not determine the degree of accuracy of the inventory but we did find that some dams were listed more than once, some had different descriptive information, and some should have been listed in the inventory but were not.

In one State eight dams were included in the inventory twice--once by the State and again by the Corps district office. The two data collection sources for these eight dams reported varying inventory data. For example, the two sources reported different maximum water storage capacities for all eight dams and different nearest downstream hazard ratings for two dams.

Instances of dams which should have been included in the inventory but which were inadvertently excluded are:

- In one State hydroelectric structures and structures built on natural lakes to raise or hold the water level

were not included in the inventory even though they met all Federal dam criteria. This State excluded 15 of these dams from the inventory.

--In another State 33 dams were excluded from the inventory.

--In a third State a dam that failed in February 1976, killing four, was not included in the inventory.

The Corps' inventory also did not include dams that were smaller than the size required by law to be included in the inventory. However, many such dams posed a potential hazard to human life and property and the legislative history<sup>1</sup> of the law stated "\* \* \*it is not the intention of the Committee to preclude the Secretary (of the Army) from inspecting, upon appropriate request, smaller dams which do not meet this definition where such dams pose a threat to human life and property." We believe that these smaller dams that pose a hazard should have been included in the inventory. Officials from six States told us there are small hazardous dams in their States which are not included in the Corps' inventory. Forest Service officials also stated that many hazardous dams had not been listed because they did not fall within the size criteria specified under the law.

We noted also that an additional 12 dams in two States have been built since the inventory was completed. The Corps has no provision for updating the inventory, but in its proposed national dam safety program it is recommending that authority and funds be made available for that purpose. (See p. 16.) We believe that a proper dam safety program will require that the inventory be updated for new dams and that each dam, regardless of its present downstream hazard classification, should be visited periodically to ascertain whether downstream hazard conditions have changed. If hazard conditions have changed, the inventory data also should be changed accordingly.

#### INADEQUACIES IN PART II INVENTORY DATA

Because the Corps instructed that data collection for Part II of the inventory would be made only if the information was readily available, at least two important items of information (items 1 and 10 of Part II) received only cursory attention in many cases. Item 10, the date of last inspection, would have indicated which dams had been inspected by the respective States within the 12-month period immediately before enactment of Public Law 92-367. According to the law, the Governors of the

<sup>1</sup>House Report (Public Works Committee) No. 92-1232, July 20, 1972.

respective States could have requested that these dams be eliminated from the Corps' proposed inspection, thus reducing estimated costs for initial inspection as discussed on page 19. The Corps did not ask for nor did any Governors request elimination of such dams.

Item 1 of Part II, downstream hazard classification, was important because the Corps used it to determine which dams posed the highest potential hazards and warranted immediate inspection. However, the accuracy of this information is questionable because of the Corps' instructions, which de-emphasized the importance of spending much time or money in collecting data for Part II, and because of inadequacies in (1) definitions used to describe hazard classifications and (2) procedures used to determine hazard ratings.

Inadequacies in definitions

In determining hazard classifications, States were directed by the Corps to place each dam in one of the three categories shown in the following table.

<u>Hazard category</u>	<u>Potential downstream loss of life</u>	<u>Potential downstream economic loss</u>
Low	None expected--no structures for human habitation	Minimal--undeveloped to occasional structures or agriculture
Significant	Few--no rural communities or urban developments and no more than six small inhabitable structures	Appreciable--notable agricultural, industrial or structural
High	More than a few	Excessive--extensive community, industrial or agricultural

Since terms such as "few" were not quantified by the Corps, some States interpreted them differently. For example, in one State if a dam failure would result in the loss of one life, it was rated a high hazard; if the failure could result in loss of life, it was rated a significant hazard. In another State if it appeared that a habitable structure existed below the dam in such a way that failure would probably cause loss of life, the dam was considered a high hazard; if failure would cause significant property damage but no loss of life, the dam was considered a significant hazard. In a third State temporary employees assigned the hazard ratings and the State

official who supervised the collection of inventory data could not explain to us how the hazard ratings were assigned by these employees.

#### Inadequacies in procedures

There were significant differences in the procedures for determining hazard ratings. In one State hazard ratings were determined by a site visit to the dam and a visual inspection of the downstream population and property conditions. In another State hazard ratings were determined by review of downstream conditions portrayed by topographic maps. Because the maps may have been several years old, the rating did not necessarily reflect the conditions of the downstream area when the rating was assigned. One State initially submitted inventory data to the Corps without assigning hazard ratings, but later assigned hazard ratings based upon topographic maps.

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The national inventory lists about 49,200 dams of which about 54 percent were classified as having low downstream hazard potential; about 27 percent as having a high or significant downstream hazard potential; and about 19 percent, or about 9,200 dams, as having no classification. One State did not assign hazard ratings to any non-Federal dams. Eight other States submitted hazard classifications on less than half of their dams. We believe that because of the limited attention given by the Corps on compilation of this data; the ambiguity of hazard definitions used; and the procedures used by Federal agencies, States, and private contractors to determine the classifications, the resulting data is incomplete and its accuracy is questionable.

#### INADEQUATE VERIFICATION OF INVENTORY DATA

The Corps did not adequately verify the data collected by the States, other Federal agencies, and contractors. At Corps district offices the data collected from the inventory data forms was transferred to punchcards and computerized. A computer edit program was designed to identify missing data and make general tests for the reasonableness of the data, but the edit program did little to verify accuracy. The Corps' Ohio River Division staff reviewed some of the inventory data submitted by three States, but this review was limited to general accuracy tests of the structures, reported longitude, and verification of the reported streams on which the structures were located. The accuracy of size, capacity, hazard classification, and other data was not verified.

A more systematic and complete verification of the inventory data would have been desirable because of the importance of having an accurate inventory that could be used--as the Corps did--to determine downstream hazards. We believe that the best method for verifying the inventory data would be to require visitation of each dam site. A Corps headquarters official said that it does not appear to be advisable to exempt dams from inspection requirements solely on the basis of information gathered from a variety of sources, especially since the information was not necessarily gathered at dam sites.

We believe that since the Corps has not determined the inventory's accuracy, more assurances should be obtained as to its accuracy before the Congress decides on a national dam safety program based on the information contained in the inventory.

### CHAPTER 3

#### DAMS WERE NOT INSPECTED

The Corps of Engineers has made no actual inspections of dams pursuant to the National Dam Inspection Act. As a result, the Corps does not know the nature and scope of the specific dangers at dams in the United States, and the Congress has not been given adequate information to consider a national dam safety program.

The House Committee on Public Works said in its 1972 report on the then-pending dam inspection legislation that because of the large number of dams in the Nation it did not expect the Secretary of the Army to inspect all dams before submitting the July 1974 progress report required by the bill. However, the Committee expected that by July 1974 inspections would be completed on at least those dams which could cause loss of human life and property if they failed. The Committee also stated that after July 1974 the Secretary should complete the inspection of all dams as contemplated by the 1972 law.

#### WHY THE CORPS HAS NOT INSPECTED DAMS

The Acting Secretary of the Army informed the Congress in July 1974 that while the authorizing legislation provided for the inspection of non-Federal dams, no such inspections had been made and none were planned. Instead of Corps inspections, the Acting Secretary said that:

"\* \* \* each State is being encouraged to establish and conduct an adequate dam inspection program if one does not already exist. The Corps of Engineers, upon request, will assist any State in establishing or strengthening a dam inspection program \* \* \* and \* \* \* technical assistance and advice will be provided upon request to eliminate or mitigate any hazardous conditions which may be found by the States."

The Acting Secretary said that while the authorizing legislation provided for the inspection of non-Federal dams, he believed that the States should perform the inspections as part of their normal responsibilities. Earlier, in February 1973, the Corps had advised the Senate and House Subcommittees on Public Works, Committee on Appropriations, that it did not intend to implement that section of the law which pertained to actual inspection of non-Federal dams. No appropriations requests were made to the Congress for such inspections.



Corps officials told us that they had originally intended to inspect dams, beginning with a sample. In September 1972 the Corps had planned to staff 200 additional positions for dam inspectors, contract reviewers, and other administrative personnel. Most of these were to be engineers who would have inspected or supervised dam inspections. In December 1972 the Undersecretary of the Army requested \$5 million to initiate a nationwide program of dam inspection. The funding proposal was rejected by OMB and no appropriation request was made thereafter to the Congress to carry out Public Law 92-367 except for collecting inventory data and preparing recommendations for a national dam safety program.

In January 1973 OMB issued a policy statement directing the Corps to perform an inventory of dams and make recommendations for a comprehensive national program to inspect and regulate dams for safety purposes. The OMB policy statement stated further that:

- Inspections, to the extent they were made, were to be accomplished by the concerned States as part of their normal responsibilities.
- The Corps was to develop inspection guidelines to be included in the national program.
- The Department of the Army was to provide advice to the respective State Governors, upon request, for correcting or eliminating any hazardous conditions found by the States.<sup>1/</sup>

#### BENEFITS OF INSPECTIONS

Corps officials told us that because the Corps has made no inspections under the act, they do not know the nature and scope of specific dangers at dams in the United States. They told us also that sample dam inspections would have helped in formulating recommendations for a national dam safety program.

Although the Corps did not make inspections, it recognized the benefits of inspections and designed inspection guidelines to be included in the Corps' proposed dam safety program. (See p. 16 for the discussion on weaknesses of the Corps' proposal.)

<sup>1/</sup>Between 1972 and November 1976, the Corps had provided such advice for about 150 Federal and non-Federal requests. Corps officials told us there was no procedure to document other defective dams found by the States or corrective action taken since the law was passed.

In a May 1975 report to the Secretary of the Army, the Corps proposed initial inspections by Federal agencies and States for 20,000 dams which would present potential hazards to life and property downstream if they failed. The report stated that the

"\* \* \*initial inspections would provide a better understanding of the scope and nature of the problem and would develop information upon which an accurate assessment of the impact on the owners of dams, both public and private, could be based."

The Chief of Engineers said that

"\* \* \*we have not attempted to assess the total impact on economic resources of the follow-on design and modification work. The information needed for preparing such estimates can be developed only by the inspection program."

We believe that dam inspections are an essential step in protecting human life and property. Inspections can identify unsafe dam structures and can provide otherwise unavailable data for designing a national dam safety program.

#### Inspections can identify unsafe dam structures

Corps district officials told us that the critical needs for dam safety are the (1) timely performance of investigations and analysis to establish whether an existing dam is adequate or deficient and (2) execution of the necessary modifications or repairs. The Corps of Engineers' regulation, "Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures," stresses the importance of periodic inspections to detect structural deficiencies and provide for remedial measures.

Concerning their inspection program for Corps-operated dams, Corps officials stated that:

"The periodic inspection program has paid significant dividends through the early detection of abnormal behaviors which might have gone undetected if a less comprehensive program had been in effect. Such early detection has enabled construction of less costly remedial works than if constructed at a later stage of structural deterioration and has averted possible structural failure or partial failure."

For example, a 1972 engineering survey report concerning the Buffalo Creek disaster in West Virginia stated that "\* \* \*there appears to be little doubt that an adequate program of technical inspections of the Middle Fork dams would have indicated them to be in danger of failure."

As a result of a Senate Committee on Public Works resolution on February 28, 1972, following the Buffalo Creek disaster, coal waste structures in the Eastern United States were inspected under the supervision of the Corps. The inspections were made jointly by various State and Federal agencies and were intended to evaluate the flood hazard of all coal waste structures that impounded water. A total of 687 structures were inspected under the program and 230 were determined to be critically or potentially dangerous.

The inspections of coal waste structures and the inspections the Corps has made of its own dams in the past have demonstrated the importance of inspection for individual dams and the potential positive results of identifying and correcting structural deficiencies.

Inspections can provide otherwise unavailable data for designing a national dam safety program

In 1972 the Congress did not have adequate information on the scope and nature of the dam safety problem and therefore needed additional data to determine the type of national dam safety program that would be effective. Also, according to the Corps, at that time sufficient information was not available to arrive at an accurate estimate of the cost of a dam safety program. Approximately 5 years later the scope, nature, remedial action, and costs of such a program still had not been defined because inspections, which were necessary to establish criteria for defining these program elements had not been made by the Corps.

Although the Corps tried to identify dams which, if they failed, could cause human life and property loss downstream (see ch. 2), it did not determine the scope of individual structural deficiencies and dangers as described in the law and the remedial actions needed. The law refers to structural conditions of dams rather than the downstream hazard potential when it states:

"For the purpose of determining whether a dam (including the waters impounded by such dam) constitutes a danger to human life or property, the Secretary shall take into consideration the possibility that the dam might be endangered by overtopping, seepage, settlement, erosion,

sediment, cracking, earth movement, earthquakes, failure of bulkheads, flashboard, gates on conduits or other conditions which exist or which might occur in any area in the vicinity of the dam."

In order to protect human life and property, additional data is needed on the physical condition of individual dams. We believe that the most effective method of collecting this data is through actual dam inspections.

The International Commission on Large Dams reported in 1973 on failures and accidents to large dams and stressed the importance of periodic dam inspections. The Commission collected information concerning areas of potential weaknesses in different types of dams. We believe that inspections could provide this same type of information to the Corps for dams in the United States.

If the Corps had inspected existing dams as required by the law, better information would be available on dam structural problems and cost estimates for inspections and remedial actions. Such information would provide a better foundation than exists now for designing a national dam safety program.

Although it is not essential to inspect all dams before a national dam safety program is designed, a statistical sample of dams for initial inspection by the Corps would be desirable before the program is approved. After such inspections, the Corps should have a better idea of the cost of inspections, nature and type of structural problems for different types of dams, number of dams needing remedial actions, and expected costs of these remedial actions.

The statistical sample might include a stratification of dams by size, construction type (e.g., concrete and earth), or some other engineering consideration. One stratification that could be used is included in the Corps' inspection guidelines in which dams are classified according to their hazard potential and size. Other engineering classifications could be added as deemed necessary so that the sample is representative.

We believe that inspections are essential to identify unsafe dam structures and determine remedial measures necessary to make these dams safe. We also believe that a sample of inspections can give the Corps information needed to make realistic estimates of the scope, nature, and cost of a national dam safety program.

## CHAPTER 4

### MORE NEEDS TO BE DONE TO DEVELOP A

#### NATIONAL DAM SAFETY PROGRAM

The Corps' report and recommendations for a national dam safety program, required by Public Law 92-367, was released to the Congress on November 16, 1976. In our view, the report is inadequate because it:

- Places primary emphasis on voluntary participation by the States for non-Federal dams without presenting adequate information to the Congress as to the cost to the States or as to how the States could carry out the program without Federal assistance.
- Does not require minimum inspection criteria.
- Contains unreliable inventory and cost data.
- Recommends primarily an inspection rather than a safety program and does not present information to the Congress on safety matters, such as public information programs, possible revisions in zoning laws, and emergency warning systems.
- Does not provide the Congress with alternatives for carrying out a dam safety program.

In submitting its report, the Corps defined the respective responsibilities that should be assumed by Federal, State, and local governments, and by public and private interests.

In formulating its recommendations, the Corps:

- Studied State and Federal agencies' dam safety programs to determine their capabilities, practices, and regulations concerning the design, construction, operation, and maintenance of dams.
- Gathered inventory data on dams as discussed in chapter 2.
- Sent survey questionnaires to all 50 States and 4 territories as well as all Federal agencies concerned with designing, constructing, operating, or maintaining dams. The Corps evaluated the State programs almost exclusively on the basis of the questionnaire answers.

The Corps' report stated that a few States and some Federal agencies (i.e., Bureau of Reclamation, Tennessee Valley Authority, the International Boundary and Water Commission, and the Federal Power Commission) were maintaining adequate dam safety programs, and that these Federal agencies would need to assist States and other agencies that have inadequate programs. (However, in a GAO report entitled "Actions Needed to Increase the Safety of Dams Built by the Bureau of Reclamation and the Corps of Engineers," CED-77-85, dated June 3, 1977, we questioned the adequacy of the Bureau's and Corps' dam safety programs.) The Corps' report concluded that a national dam safety program was necessary to reduce the risk of failure or misoperation and to provide for consistent regulation of design, construction, operation, and maintenance of dams. It concluded that authorities should be established to regulate, supervise, and monitor dam activities.

The report recommended that:

- A National Dam Safety Program should be implemented by encouraging all States and Territories to pursue individual dam safety programs encompassing all dams not under Federal authority.
- All existing dams that have a high or significant hazard potential should be inspected over a reasonable time as a first step in implementing the national program.
- Federal agencies with technical expertise should furnish guidance to the States upon request, and Federal agencies should pursue safety programs of their own.
- The Corps should be provided authority and funds to maintain the national dam inventory.

In addition, the Corps' proposed legislation for a national dam safety program recommended mandatory participation for Federal agencies with dam regulation responsibilities and directed all Federal agencies with inadequate safety programs to improve their programs.

#### WEAKNESSES IN THE CORPS' RECOMMENDED PROGRAM

In presenting its recommended program, the Corps has primarily emphasized voluntary participation by the States for non-Federal dams, even though many States have advised the Corps that they cannot carry out such a program without Federal funding. The Corps proposed no Federal financial assistance in the program.

In presenting its recommended program, the Corps (1) has proposed guidelines for dam inspections, but has not provided for minimum inspection criteria nor required implementation of the guidelines, (2) made unsupported adjustments to its inventory data and did not adequately consider or develop pertinent information to estimate the cost of the program, (3) did not present alternative methods for consideration by the Congress in designing a national dam safety program, and (4) designed a dam inspection program rather than a dam safety program which would include inspection, repair of defective dams, installation of warning systems, more restrictive zoning laws, and public education.

State participation under the Corps'  
recommended program

In its report to the Congress, the Corps stated that a national dam safety program is necessary and that responsibility for dam safety should rest with dam owners. The Corps recommended that regulation of federally owned or controlled dams rest with the controlling agency, and that all non-Federal dams should be the responsibility of State governments which should (1) define dam owners' responsibilities and (2) provide safety regulations and inspections. The report also stated that governmental regulation is needed to insure that owners' obligations are properly carried out. Similar regulations have already been established for building codes, elevator inspections, bridge inspections, and other areas where governmental regulation has been necessary to protect the public. The report said that the national dam safety program should seek to strengthen, not supplant, existing State efforts.

On the basis of a questionnaire sent to States and agencies, the Corps has concluded that 11 States and territories were without a dam safety program. The Corps also concluded that many States with existing programs have inadequate statutes and/or staffs and when compared with the requirements of the Corps' recommended guidelines for inspection, few States are carrying out a program comparable to the Corps' recommended program. The Corps said that this is due primarily to lack of funds and staff at the State level to perform inspections.

The dam safety program proposed by the Corps would not be mandatory for States. Although the Federal agencies would be required to comply, the States' compliance would be on a voluntary basis.

Corps officials told us, however, that there are no assurances the States would carry out a dam safety program unless they receive Federal funding. They told us also that in 1970 the United States Committee on Large Dams published the "Model Law for State Supervision of Safety of Dams and

Reservoirs" to encourage States to enact adequate dam safety programs, but since that time only two States have changed their laws. Other States tried to pass dam safety laws but failed, due primarily to funding difficulties.

The Corps officials told us that there is no reason to believe that voluntary implementation of its recommended program will meet any greater success than that proposed by the Committee on Large Dams unless Federal funding is provided.

The Corps, in recognizing State funding difficulties, stated in its report that "\* \* \*it may be considered desirable to provide incentives to the States to implement their share of a National dam safety program." However, the specific recommendations in the Corps' report did not propose Federal incentives to the States.

The Corps believes such funding or other incentives might be necessary to obtain the States' full participation in a national dam safety program. This is indicated by the fact that in January 1975 the Corps proposed to the Secretary of the Army that he recommend financial incentives for the States. The incentives would be based on the cost of performing the initial inspections of existing dams posing a hazard to human life or property. The Corps also proposed that "\* \* \*following completion of the initial inspections, the extension of State programs could be assured by the proposed consequential loss of Federal financing of local water resources projects\* \* \*" if the States do not follow a national dam safety program.

Officials of the Office of the Secretary of the Army rejected the Federal financial assistance proposal as inappropriate and stated that "\* \* \*the first step would appear to be a period of testing to see how the program works without Federal financial assistance." The officials also stated that it may be possible to ensure participation in the initial inspections by withholding Federal assistance for local water resources projects. However, this suggestion was not included in the Corps' recommendations to the Congress for a national program.

It appears to us, therefore, that under the Corps' recommendations, as revised by the Secretary of the Army, many State programs could remain as they are and the safety of those dams would remain unchanged. At this time the safety of many of those dams is unknown and cannot be known without inspections. We believe that a national dam safety program that does not require inspections of approximately 43,500 non-Federal dams will not be an adequate national program.

We believe that the Corps did not obtain sufficient information regarding cost of inspections, cost of remedial



actions needed, and the adequacy of non-Federal funding sources, to justify a conclusion as to whether or not a national dam safety program can be effectively implemented on a voluntary basis without Federal financial assistance.

Proposed guidelines for future safety inspection of dams did not provide minimum inspection criteria nor require implementation

The Corps developed inspection guidelines to be included in the national dam safety program. These were to be used to determine existing and potential structural hazards in dams. The guidelines provided for

--phase one inspections, i.e., expeditiously identifying dams which may pose hazards to human life or property, and

--phase two inspections, i.e., detailed inspections warranted as a result of phase one findings.

We believe these guidelines may provide a base for initiating inspections necessary for a dam safety program. However, the guidelines do not set forth minimum inspection criteria, nor require States and agencies to implement the guidelines. Although Corps officials say that developing minimum inspection guidelines would be difficult, other agencies and State officials state that it is possible. We believe that minimum criteria should be required and could be developed by making a sample of inspections and identifying problem areas which should be observed during inspections. This minimum criteria would not preclude inspection of other areas by participating inspectors but would provide uniformity among Federal, State, and local participants in a dam safety program and would provide required standards to ensure adequate guidance for inspection.

Unsupported estimates of number of dams for inspection and cost for the proposed safety program

The Corps used data from the dam inventory to estimate that there were about 20,000 dams that were potentially hazardous to downstream populations if they failed. Since the accuracy of the number of dams and the hazard designations are questionable (see ch. 2), we believe that the Corps cannot accurately determine the number of potentially hazardous dams. We noted that Corps officials arbitrarily added about 3,400 dams to the number of hazardous dams estimated during its inventory because they were not certain of the accuracy of the inventory.

The Corps reported that

"\* \* \*the total cost of implementing and prosecuting a National dam safety program is extremely difficult to forecast because of uncertainties such as total number of dams to be investigated; the depth of investigations which would be found necessary; the amount of effort which would be involved in licensing and inspecting new construction including the review and approval of plans and specifications; and the supervision which would be needed in connection with repair and modifications."

According to the Corps' report, there is a wide range of such costs among agencies, and no direct cost comparisons can be made.

The Corps estimated the annual costs of its recommended program to be \$1,500 per dam or \$73.5 million for 49,000 dams. The program includes such things as review and approval of plans, periodic inspections, and initial inspection costs of \$30 million annually. According to the Corps, this estimate is about 7 times that currently being spent across the Nation for such approvals and inspections.

In estimating the annual cost of \$1,500 per dam, Corps officials estimated the annual per dam cost of California's dam safety program and then added \$250 because they were not certain what the costs would be. However, other States estimate the annual cost to be much less: Indiana, \$501; Kentucky, \$394; and West Virginia, \$418.

Also, the Corps estimated the cost of initial inspections without

- performing inspections to determine the depth of inspections which might be needed,
- examining properly the large number of small dams that cost less to inspect,
- considering adequately State estimates that were considerably lower, and
- eliminating Federal and non-Federal dams that were already included in existing inspection programs.

In addition, the Corps' proposal has not estimated the cost of remedial actions necessary to correct or eliminate dangers in dam structures. Without knowledge of the types and numbers of dangers which exist, these costs cannot reasonably be estimated and the Congress lacks sufficient information

to make an informed judgment as to the type of program required to ensure that timely remedial actions are taken where needed. The dangers cannot be known nor the costs reasonably estimated without actual inspections.

Another important factor which must be taken into account is that a good dam safety program can prevent the loss of life and property damage and the large relief costs which the Government otherwise would have to provide in the event of a disaster.

#### Alternative approaches for carrying out a national dam safety program

We believe that in implementing any program various options are available and should be considered. To assist the Congress in deciding on an appropriate national dam safety program, it would have been helpful if the Corps had included in its report other approaches or modifications to its proposal for carrying out such a program. Based on a number of views we received from Federal and State officials and private concerns interested in dam safety, some of the alternatives for carrying out a national dam safety program are:

- Establish a national dam safety insurance program that would require implementation of safety measures such as performing inspections and correcting deficiencies found. Conceptually, an insurance program would involve private insurance companies with some initial Federal underwriting. Existing dam structures could be rated and premiums established on the basis of potential damage, including replacement costs of the dam. The insurance could be written by local insurance agents with a portion of the premiums going to the national insurance pool. With the national pool and Federal underwriting, individual insurance companies would not be exposed to astronomical loss, thereby protecting their solvency and keeping premiums at a reasonable level. In the long run, States and private dam owners would hopefully adhere to mandated regulations which would render dams safe, and then premiums would drop to a point where Federal assistance would not be needed.
- Require the States to adopt and implement an adequate dam safety program as a prerequisite to future funding of Federal dam projects.

There are other alternatives to the Corps' proposal that States perform their own inspections, including (1) having a Federal agency perform initial inspections with joint participation by States where possible, as opposed to States being responsible for the inspection under the individual State's

guidelines, (2) having States, Federal agencies, or private contractors initially inspect in detail only those dams which are believed by knowledgeable officials to have structural deficiencies instead of inspecting all highly or significantly hazardous dams, and (3) selecting a private agency to perform inspections in place of Federal or State inspections.

Corps' recommended program is  
for inspection, not safety

Other matters to be considered in establishing a comprehensive dam safety program which are not included in the Corps' recommendations include educating the public about dam safety and encouraging State and local governments to (1) adopt zoning laws to prevent building in hazardous areas downstream from dams and (2) devise warning systems for existing communities.

While many State and Federal dam safety officials agree there is need for dam safety programs, some question the need for a nationwide program. Some have said that the States should be able to determine the need for or extent of their own programs. Others indicated to us that the Corps is not recommending a nationwide program and is therefore questioning the need for such a program.

We believe that the Corps' recommended national dam safety program proposes that States carry out a program which States say they cannot do and that the Corps has insufficient data to design a comprehensive national dam safety program. We also believe that the Corps designed only an inspection program without essential safety aspects and without presenting alternatives to its program. Also, the cost estimates presented by the Corps' proposal do not address remedial costs and are based on (1) a dam inventory which has not been verified and (2) limited cost data gathered by the Corps.

ACTIONS BEING TAKEN TO COORDINATE  
FEDERAL DAM SAFETY PROGRAMS AND  
DEVELOP PROPOSED FEDERAL GUIDELINES

In an April 23, 1977, memorandum the President directed that the head of each Federal agency responsible for or involved with site selection, design, construction, certification or regulation, inspection, maintenance and operation, repair, and ultimate disposition of dams immediately undertake a thorough review of practices which could affect dam safety and integrity. On the basis of this review and reports thereon, an interagency report and proposed Federal dam safety guidelines are to be prepared by an ad hoc interagency committee convened by the Chairman of the Federal Coordinating Council for Science, Engineering, and Technology.

The interagency committee's report and proposed Federal guidelines are to be prepared by October 1, 1977. The purposes of this interagency report and the proposed Federal guidelines are to coordinate dam safety programs, seek consistency and commonality as appropriate, and provide recommendations for improving the effectiveness of the Government-wide dam safety effort.

In addition, the Director of the Office of Science and Technology Policy is to arrange for a review of the interagency report and the proposed Federal guidelines by a panel of experts who will obtain the views and advice of established organizations, professional societies, and others concerned with dam safety. This review and the report thereon are to be completed no later than October 1, 1978.

In a recent GAO report entitled "Actions Needed to Increase the Safety of Dams Built by the Bureau of Reclamation and the Corps of Engineers" (CED-77-85, dated June 3, 1977), we recommended that the Bureau and the Corps specifically address GAO recommendations in any report resulting from the April 23, 1977, memorandum. We also recommended that the applicability of our recommendations to other Federal agencies be evaluated in developing the proposed Federal dam safety guidelines. Also in our report we noted that the National Academy of Sciences' National Research Council is expected to complete in February 1978 an assessment of the criteria for evaluating and reviewing the safety of existing Bureau dams.

We believe that data developed by the Bureau and the National Academy of Sciences should be considered by the Corps in developing a national dam safety program as envisioned under the National Dam Inspection Act of 1972.

## CHAPTER 5

### CONCLUSIONS, RECOMMENDATIONS, AND AGENCY COMMENTS

#### CONCLUSIONS

The need for an effective Nation-wide dam safety program has been demonstrated repeatedly over the years by a series of disasters. The National Dam Inspection Program of 1972, authorized by Public Law 92-367, was an attempt to deal with this problem on a national scale, but the law has never been fully implemented. The Secretary of the Army has not assumed responsibilities which the Office of Management and Budget believed to belong more properly to the States and, the respective roles and responsibilities of the Federal and State governments for implementing a dam safety program are largely unsettled.

Approximately 5 years after Public Law 92-367 was enacted, the fundamental provision of the law--inspection of all dams--has not been carried out; an inventory of dams has been prepared but has not been verified; and the national program for dam safety proposed by the Secretary of the Army is lacking in scope, depth, and alternatives.

We believe that inspections are essential to protect human life and property by identifying unsafe dam structures and determining remedial measures necessary to make dams safe. Although we do not believe it is essential to inspect all dams before a national dam safety program is designed, initial inspection of a statistical sample of dams by the Corps would be desirable before the program is approved. A sample of inspections can provide the Corps with information necessary to make realistic estimates of the scope, nature, and cost of a national dam safety program.

Although the Corps prepared an inventory of dams as called for by the law, the inventory is based on data collected using inadequate definitions and procedures, and most of the data was not verified. We believe that the Corps should ensure the reasonable accuracy of the inventory before the Congress is asked to decide on a national dam safety program that is based on information contained in the inventory. We also believe that the best method for verifying the inventory data would be to require the Corps to ensure that visits are made to each dam site.

The Corps' recommendations to the Congress for a comprehensive national dam safety program place primary emphasis on voluntary participation by the States even though the Corps was advised by many States that they cannot carry out such a program without Federal funding. We believe

that the Corps did not obtain sufficient information regarding cost of inspections, cost of remedial actions needed, and the adequacy of non-Federal funding sources to justify a conclusion as to whether or not a national dam safety program can be effectively implemented on a voluntary basis without Federal financial assistance.

In our view, the Corps does not have sufficient data to design a comprehensive national dam safety program. We believe that the Corps has designed only an inspection program without considering the broader aspects of dam safety and without presenting alternatives for its program.

#### RECOMMENDATIONS TO THE CONGRESS

We recommend that the Congress direct the Corps to supplement its report to the Congress for a dam safety program and include full consideration of possible alternatives. We recommend that the supplemental information furnished by the Corps include (1) information based on actual inspections of a scientific sampling of dams, (2) verified inventory data, (3) information as to whether Federal participation is needed and, if so, the nature of involvement needed to ensure an effective national dam safety program, including estimates as to the cost of dam inspections and remedial actions needed and the availability of non-Federal funds for such actions, and (4) realistic cost estimates of the different alternatives.

We recommend also that before the Congress decides on a national dam safety program that requires Federal participation in the inspection, funding, monitoring, or regulation of non-Federal dams, the Congress should be assured that the program includes (1) an accurate inventory of dams with realistic hazard ratings, (2) mandatory minimum inspection criteria, (3) provisions for requiring remedial measures for unsafe dams, (4) other safety precautions, such as improved warning systems, zoning laws, and public education, and (5) a system for Federal or State monitoring of the program.

#### AGENCY COMMENTS

To expedite issuance of this report, copies of a draft of the report were not sent to the Secretary of the Army or the Corps of Engineers for formal review and written comments. Copies of a draft of the report were made available, however, to officials of the Corps and we met with the officials and obtained their oral comments. They emphasized that their comments were preliminary in nature and might change after a more careful and detailed review of the report.

The Corps officials stated that they did not object to the general message of the report and that they had no objections to making the inspections required by the act provided the Congress appropriated funds for such inspections. The officials stated that there might be significant difficulties involved in enacting mandatory Federal legal requirements in the area of non-Federal dams. They agreed, however, that Federal mandatory requirements probably could be made a condition of a national dam safety program which provided Federal financial assistance.

The officials pointed out that some States, such as California, had implemented an effective dam safety program without Federal financial assistance. They pointed out that most States probably could finance an effective dam safety program if they considered such program of sufficient priority. The Corps officials recognized, however, that in order to implement an effective dam safety program with State funding, some States might have to cut back on other high-priority activities such as education, police and other municipal services, or aid to the poor.

As discussed in other chapters of this report, we believe that the Corps needs to obtain additional information before a decision is made as to whether Federal participation is needed and, if so, the type of participation needed to ensure an effective national dam safety program.



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FOR ACTIVITIES DISCUSSED IN THIS REPORT

Tenure of office  
From                      To

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SECRETARY OF DEFENSE:

Harold Brown	Jan. 1977	Present
Donald H. Rumsfeld	Nov. 1975	Jan. 1977
James Schlesinger	June 1973	Nov. 1975
William P. Clements, Jr., (acting)	May 1973	June 1973
Elliott L. Richardson	Jan. 1973	Apr. 1973
Melvin Laird	Jan. 1969	Jan. 1973

DEPARTMENT OF THE ARMY

SECRETARY OF THE ARMY:

Clifford L. Alexander	Feb. 1977	Present
Martin R. Hoffman	Aug. 1975	Feb. 1977
Howard H. Calloway	May 1973	July 1975
Robert F. Froehlke	July 1971	May 1973

ASSISTANT SECRETARY OF THE  
ARMY FOR CIVIL WORKS:

Charles R. Ford (acting)	Feb. 1977	Present
Victor V. Veysey	Mar. 1975	Jan. 1977

CHIEF OF ENGINEERS:

Lt. Gen. John W. Morris	July 1976	Present
Lt. Gen. William C. Gribble, Jr.	Aug. 1973	June 1976
Lt. Gen. Frederick J. Clarke	Aug. 1969	July 1973

OFFICE OF MANAGEMENT AND BUDGET

DIRECTOR:

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James T. Lynn	Feb. 1975	Jan. 1977
Roy L. Ash	Feb. 1973	Feb. 1975
Caspar W. Weinberger	June 1972	Feb. 1973

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