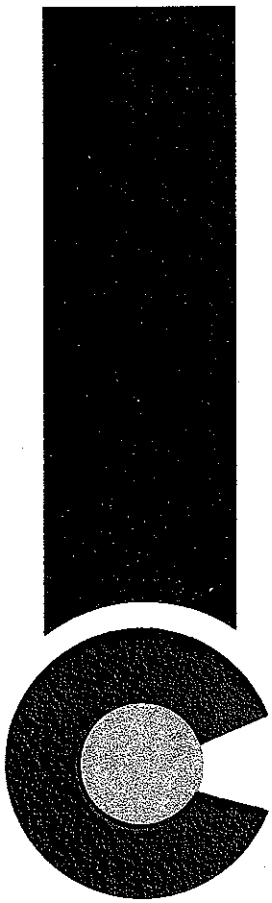

STATE ENGINEER'S NINTH ANNUAL REPORT TO THE COLORADO GENERAL ASSEMBLY ON DAM SAFETY FOR F.Y. 92-93

November 1, 1993

OFFICE OF THE STATE ENGINEER
DIVISION OF WATER RESOURCES

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1992-1993

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COLORADO STATE ENGINEER'S NINTH ANNUAL REPORT
TO THE
GENERAL ASSEMBLY
ON
DAM SAFETY
FOR
FISCAL YEAR 1992-1993

INTRODUCTION

Statutory Provisions

Colorado's Dam Safety Program is implemented and managed by the State Engineer in accordance with Title 37, Article 87, of C.R.S. (1993 Supp.), and the Livestock Water Tank Act, Title 35, Article 49, of C.R.S. (1993 Supp.), as amended. The "Rules and Regulations for Dam Safety and Dam Construction" and Standard Specifications for Livestock Water Tanks and Erosion Control Dams establish the procedures and requirements of the State Engineer in the implementation of these statutes.

This report is submitted in compliance with Section 37-87-114.4, C.R.S. (1993 Supp.) concerning the dam safety activities of the State Engineer and the Colorado Division of Water Resources relating to Sections 37-87-105 to 37-87-114, C.R.S. (1993 Supp.)

Organization

Implementation of the Dam Safety Program is achieved by the State Engineer through the Dam Safety Branch. A major reorganization of the Branch occurred during the past six years. The State Engineer has been decentralizing the program by moving members of the division to the field division offices for the past several years, especially within the Dam Safety Branch. Transfer of the Dam Safety Engineers to Division 1 in Greeley in 1992 has completed the plan to place supervision of the inspection program under the Division Engineers. The Chief of the Branch, who is located in Denver, has program wide responsibilities, and also supervises the Design Review and Construction Inspection Unit. (See Appendix A for tables and charts of the personnel and organization of the Branch.)

The Dam Safety Engineer's principal duties are to conduct safety inspections of existing dams, review the adequacy of spillways under the rules, enforce the requirement for emergency planning, and assist dam owners in developing their Emergency Preparedness Plans (EPP), do design review and construction inspection of repairs and alterations, and investigation of complaints on the safety of dams. They investigate the construction of dams in violation of Section 37-87-105(1) and (4), C.R.S. (1993 Supp.), and conduct training on the inspection of dams for division personnel, dam owners, interested agencies, engineers, and the public.

The responsibility to process and approve Livestock Water Tank and Erosion Control Dam applications was transferred to the Division Engineers and the Dam Safety Engineers in February, 1991. They also do other related work as assigned.

The Design Review and Construction Inspection Unit's principal duties are to review the plans and specifications for the construction, alteration, modification, repair, and enlargement of reservoirs or dams in accordance with Section 37-87-105, C.R.S. (1993 Supp.). This involves a comprehensive engineering review of the plans and specifications to assure that a safe design has been developed, and to inspect the construction of the dam. The Unit assists the Department of Health in the technical evaluation of tailing impoundments through a Memorandum of Understanding, participates in the state's Joint Review Process with the Department of Natural Resources, provide technical assistance to the division engineer's offices on dam safety, and perform other related work as assigned.

Goals and Objectives of the Program

The mission of the program is to prevent loss of life and property damage as a result of the failure of dams within the resources available to this office. The program concentrates on "jurisdictional" dams and reservoirs as defined in Section 37-87-105, C.R.S. (1993 Supp.), which are greater than ten feet high at the spillway, or twenty acres in surface area at the high water line, or 100 acre-feet in capacity at the high water line. Because of their non-hazardous situation, Class IV dams are not inspected regularly, but observed for changes in hazard class periodically. Particular focus is placed on inspecting Class I and II dams annually, and Class III dams are inspected every five years.

Safety inspections are made of U.S. Bureau of Reclamation and U.S. Army Corps of Engineers' dams on a cooperative basis with their safety inspections being done in accordance with the "Federal Guidelines for Dam Safety." Arrangements are made with other Federal agencies for the safety inspection of their dams by the U.S. Bureau of Reclamation, the Corps of Engineers, their own people, consulting engineers, or by the State Engineer. When other than State Engineer personnel conduct the safety inspections, the agency submits the findings/recommendations and follow-up to the State Engineer in order to assure the safety of these dams. A Memorandum of Understanding has been formulated with the U.S. Bureau of Reclamation relating to dam safety activities in Colorado. It provides for the exchange of safety related information of dams under each agency's jurisdiction. An MOU has also been executed with the U.S. Forest Service, Rocky Mountain Region, to provide inspections by the State Engineer of their dams. An MOU is still being pursued with the U.S. Bureau of Land Management, but has not been completed due to reservations on their part to submit information to us on their dams.

Another objective is the inspection during construction for compliance with approved plans, and to assure that plans are adequate for the site conditions. Inspections are made of the foundation, outlet works, spillways, and final construction as a minimum. Interim inspections are made as necessary.

An adjunct to the inspection objectives is the goal to have each owner of Class I and Class II hazard dams prepare an Emergency Preparedness Plan (EPP) to combat any incident which jeopardizes the safety of the dams, and to give warning to appropriate emergency preparedness agencies/officials so they may mobilize their plans for mitigating the consequences of dam-break flooding. An inundation map is required for Class I dams. See EMERGENCY PREPAREDNESS PLANS on page 13 for more discussion.

The Dam Safety Branch annually identifies specific goals for the Dam Safety Program. For calendar year 1993, the following goals were adopted:

1. To make annual safety inspections of Class I and Class II dams, and to inspect Class III dams every five years.

2. To make quality reviews of the plans and specifications for the construction of dams within the statutory 180-day limit.

3. To inspect the construction of a dam as often as necessary to assure that the work is being performed in accordance with the approved plans and specifications, and to assure that changed conditions will not jeopardize the approved design.

4. To implement the requirements of the regulations (adopted September 1988) in a timely manner. (The hazard classification must be ascertained before implementation of the standards in the regulations, or other requirements). This requires the following actions:
    - Hydrologic reviews,
    - Outlet inspections,
    - Emergency Preparedness Plans,
    - Owner inspections and maintenance plans.

5. To maintain a database of the dam safety program (DAMS), including the update of the National Inventory of Dams (NATDAM).

6. To develop state-of-the-art computer capabilities for engineering analysis of dams, and the Dam Safety Program.

7. To provide training as necessary, and encourage teamwork.

8. To maintain good relations with the dam owners and the public.

In order to achieve the goals, each of the division engineer offices prepare workplans (objectives) which are reviewed by the program supervisor, and used for monitoring progress of the program.

Each of the goals for 1993 were either accomplished in whole or in part. Goal 1 to make annual safety inspections of Class 1 and Class II dams was accomplished. See page 11 for more details on the number of inspections done.

Goal 2 was also accomplished with the Design Review Unit completing the review of plans and specifications in an average time of 87 days. See page 8 for more details on the number of plans reviewed and approved.

The construction inspection of dams was accomplished under Goal 3, with critical inspections being made in a timely manner on all projects because of the high priority assigned to this important task.

A long term program for implementing the regulations was begun in 1991 in accordance with Goal 4. For example:

- A five-year plan was implemented for evaluating the adequacy of existing spillways beginning in 1992. This plan was postponed one year however, to prepare an updated hydrologic procedure. Dr. George Sabol, Consulting Hydrologist, was engaged to conduct a peer review of our hydrologic procedures for evaluating the adequacy of spillways. He found them adequate. Reviews began again in August 1992.

- A ten-year program was begun on 1989 to accomplish the internal inspection of outlet works. In order to economically evaluate the condition of outlet works too small to enter, Mr. James Norfleet, Resident Dam Safety Engineer for Division 4, designed and built a prototype sled and 35mm camera system for photographing the interiors of small outlet pipes. Two working models of the sled have been manufactured, and are being used to inspect outlets.

- The requirement for Emergency Preparedness Plans for dams has been only partially successful to date. See page 13 for more information on initiatives being implemented to accomplish this goal.

- No long term plan has been developed for owner inspections yet.

Per Goal 5 the maintenance of the DAMS database has been very successful. See page 14 for more information about this and the NATDAM project.

In accordance with Goals 6 and 7, training has been an on-going activity at all levels within the Dam Safety Branch. The engineers have taken technical courses at Universities, supervising and developmental courses by the Department of Personnel, and attended Technical Seminars offered by the Association of State Dam Safety Officials. Total Quality Management is being implemented division wide by the State Engineer.

Finally, in accordance with Goal 8, public relations is an on going process.

Tables of Jurisdictional Dams

The following Table 1 shows the ownership of jurisdictional dams in Colorado by type of owner, and Table 2 shows the distribution of dams in the state by water division and hazard rating.

TABLE 1

JURISDICTIONAL[1] DAM OWNERSHIP STATUS
IN COLORADO

TYPE OF OWNER

HAZARD RATING	FEDERAL	STATE	OTHER GOVT.	PRIVATE	TOTAL
Class I	49	11	75	138	269
Class II	14	20	79	205	318[2]
Class III	61	25	123	865	1074
Class IV	16	1	6	129	152
TOTAL	**140**	**57**	**283**	**1337**	**1817**

Class I - Loss of human life is expected in the event of failure of the dam while the reservoir is at the high water line.

Class II- Significant damage to improved property is expected in the event of failure of the dam while the reservoir is at the high water line, but no loss of life is expected.

Class III - Loss of human life is not expected, and damage to improved property is expected to be small in the event of failure of the dam while the reservoir is at the high water line.

Class IV - Loss of human life is not expected, and damage will occur only to the dam owner's property in the event of failure of the dam while the reservoir is at the high water line.

[1]Greater than ten feet high to spillway, or twenty acres in surface area at the high water line, or 100 acre-feet in capacity at the high water line.

[2]Includes ten Class II non-jurisdictional dams.

TABLE 2

DISTRIBUTION OF DAMS BY IRRIGATION DIVISION/CLASS

HAZARD RATING	DIVISION	NONFEDERAL	FEDERAL	TOTAL
Class I	1	117	14	131
Class II	1	127	9	136
Class III	1	427	12	439
Class IV	1	30	9	39
Class I	2	33	6	39
Class II	2	53	3	56
Class III	2	147	12	159
Class IV	2	67	4	71
Class I	3	9	1	10
Class II	3	14	0	14
Class III	3	28	4	32
Class IV	3	14	0	14
Class I	4	24	9	33
Class II	4	38	0	38
Class III	4	153	7	160
Class IV	4	1	3	4
Class I	5	19	15	34
Class II	5	40	1	41
Class III	5	116	16	132
Class IV	5	10	0	10
Class I	6	12	0	12
Class II	6	12	0	12
Class III	6	103	9	112
Class IV	6	9	0	9
Class I	7	10	4	14
Class II	7	20	1	21
Class III	7	39	1	40
Class IV	7	5	0	5
TOTALS		**1677**	**140**	**1817**

Class I - Loss of human life is expected in the event of failure of the dam, while the reservoir is at the high water line.

Class II - Significant damage to improved property is expected in the event of failure of the dam while the reservoir is at the high water line, but no loss of life is expected.

Class III - Loss of human life is not expected, and damage to improved property is expected to be small in the event of failure of the dam while the reservoir is at the high water line.

Class IV - Loss of human life is not expected, and damage will occur only to the dam owner's property in the event of failure of the dam while the reservoir is at the high water line.

APPROVAL OF PLANS AND SPECIFICATIONS FOR CONSTRUCTION OF DAMS AND RESERVOIRS

During FY 92-93, the State Engineer's Office received plans for two new dams and thirteen plans for alteration, modification, repair, or enlargement. Four separate hydrology studies were also approved for determination of the inflow design flood for spillway design or hazard classifications. The estimated cost of construction for the submitted plans was $2,408,790.00. Seven thousand three hundred six dollars and sixty five cents ($7,306.65) was collected for the examination and filing of the submitted plans.

Thirteen sets of plans and specifications were approved by the State Engineer for construction during FY 92-93. (See Appendix B for lists of dams which were approved.) In order to expedite the approval of repair plans for dams, the Dam Safety Engineers may review them and perform the construction inspections. This enables the owners to repair their dams sooner by shortening the review time. A special study for the design of a water collection system for the Division of Wildlife's fish hatchery at Buena Vista was also done.

Upon completion of construction, the owner's engineer submits copies of the "AS-CONSTRUCTED" plans showing any changes made during construction. These plans are reviewed by the engineer who monitored the construction for completeness before being accepted for filing. The superseded plans are disposed of and the "AS-CONSTRUCTED" plans serve as the public record as required by the statutes.

Section 37-87-114.5., C.R.S., (1993 Supp.) exempts certain structures from the State Engineer's approval. They are, structures not designed or operated for the purpose of storing water, mill tailing impoundments permitted under Article 32 or Article 33 of Title 34, C.R.S. (Minerals or Coal Mines), uranium mill tailing and liquid impoundment structures permitted under Article 11 of Title 25, C.R.S., siltation structures permitted under Article 33 of Title 34, C.R.S. (Coal Mines), and structures which only store water below the natural surface of the ground.

In order to prevent administrative problems as a result of the construction of small dams which do not fall under the jurisdiction of the State Engineer's review and approval, Section 37-87-125, C.R.S. (1993 Supp.) requires that a Notice of Intent to Construct a Nonjurisdictional Water Impoundment Structure must be submitted to the State Engineer prior to beginning construction.

SAFETY INSPECTIONS AND CONSTRUCTION OBSERVATIONS

Scheduling

Jurisdictional dams identified for inspection in accordance with the objectives of the State Engineer are assigned to the Dam Safety Engineers in each division. The engineers are required to each schedule the inspection of approximately 70 to 125 separate dams each "inspection season," which begins around April 1st, and ends approximately November 1st, depending upon the weather. Subsequent follow-up and problem solving results in additional inspections each year. A reasonable workload is approximately 85 dams each. A revision of the frequency of inspections of dams needs to be considered in order to reduce the inspection workload to this amount in order to accomplish the other goals and objectives of the program, especially implementation of the regulations in a timely manner (Goal 4). Within the planned schedules are the inclusion of all the Class I and Class II hazard dams, and approximately one-fifth of the Class III hazard dams. Inspection of federal dams are integrated with these schedules. The Dam Safety Engineers therefore, collectively conduct about 900 to 1000 safety inspections on an inspection year basis.

The State Engineer has executed a Memorandum of Understanding (MOU) with the Regional Forester, Rocky Mountain Region, USDA Forest Service, concerning the statutory obligations each has in regard to the administration and safety of dams on National Forest lands in Colorado. The Memorandum of Understanding provides for the exchange of information, assuring access to dams (e.g. wilderness areas), scheduling of the inspection of Forest Service dams, and the joint review for approval of plans and specifications. An MOU has also been executed with the Bureau of Reclamation (Upper Colorado Region and the Great Plains Region). This MOU provides for the exchange of information at an annual meeting, or when requested, the observation of construction at Bureau dams, the notification of emergency conditions at mutually affected dams, and the access to technical information when requested. An MOU is being pursued with the Bureau of Land Management.

In order to track potential problems which could develop at Class III dams, the Division's Water Commissioners are assigned these dams to observe by the Resident Dam Safety Engineer, and they fill out a report. The report is reviewed by the Dam Safety Engineer, and a copy is furnished to the owner for their information and to implement any recommendations for maintenance and repair. A copy of the WATER COMMISSIONER DAM OBSERVATION REPORT is in Appendix C.

Scope

A safety inspection involves more than a trip to the dam. The site visit is preceded by a review of the file and history of performance, coordination with the owner, division staff, and other interested parties so they may take part in the inspection. The statute specifies that a safety inspection include the review of previous inspection reports and drawings, site inspection of the dam, spillways, outlet facilities, seepage control and measurement system, and permanent monument or monitoring installations.

The safety inspection must also include an evaluation of the adequacy of the spillway to pass the appropriate sized flood for the dam's size and hazard class, to make an evaluation of the dam's hazard classification and whether it has changed, and to assess the adequacy of the Emergency Preparedness Plan for the dam. The internal inspection of the outlet works and evaluation of instrumentation has also been added to the workload as required by the regulations. The hydrologic evaluation of spillways was postponed due to the publication of the Third Edition, Design of Small Dams, U.S. Bureau of Reclamation, and the revision of the hydrologic procedures. The State Engineer had been using the Second Edition as the procedure for evaluating spillways. New procedures have been developed in accordance with the Third Edition and the HEC1 program for calculating flood hydrographs, and evaluations began again on August 31, 1992.

With the increased efforts directed towards the inspection of outlets, old wooden outlets are being found that are collapsing, and metal pipe outlets which are in various stages of rusting, are being evaluated for adequacy. For example, Military Park dam on the Grand Mesa, which had a sinkhole on the upstream face over the 12-inch corrugated metal outlet pipe, was inspected with the sled and a hole was found in the pipe near the upstream end. The pipe was also deteriorated and was replaced with a 12-inch Polyvinyl Chloride pipe. The sleds have proved to be a reliable tool for the evaluation of the condition of outlets too small to enter at a reasonable cost. More sleds and cameras are needed for the other divisions. See page 12, Program Funding.

The findings of the inspection are documented on a report form which rates the conditions observed of the several components of the dam and reservoir. The overall conditions are rated as satisfactory, conditionally satisfactory, or unsatisfactory (unsafe) for full storage, and a recommendation is made for the safe storage level by the Dam Safety Engineer. The report also identifies the several repair and maintenance items which the owner should take care of, and any engineering and monitoring requirements necessary to assure the safety of the dam. A copy of the ENGINEERS INSPECTION REPORT is in Appendix D.

Orders to repair or maintain the dam usually require the reinspection of the dam in order to verify that the work has been done in a workmanlike manner. Re-inspections also occur to assure follow-up of the State Engineer's orders, or as requested by the owner. If the safety inspection finds that the overall conditions are unsafe, an order is written by the State Engineer restricting the storage in the reservoir to a safe storage level. If the findings

are conditionally satisfactory, full storage is recommended contingent upon appropriate monitoring being provided by the owner. Restriction letters are accompanied by orders to rehabilitate the dam to make it safe for full storage or to breach the dam. In the event the owner fails to comply with an order to make the dam safe, a breach order is issued to remove the hazard created by the dam and reservoir.

The supervision of the Resident Dam Safety Engineers is the responsibility of the Division Engineers in their respective divisions. The Division Engineers are responsible for implementation of the Dam Safety Program, exclusive of design review, including enforcement of reservoir level restrictions and performance evaluation of the engineers. The Chief of the Dam Safety Branch is responsible for development of a comprehensive statewide Dam Safety Program to include planning for training of dam safety personnel, monitoring of the program in the field, and reporting to the State Engineer on the progress and problems related to the program.

Number of Inspections

During FY 92-93, a total of 760 safety inspections and 114 construction inspections were conducted for a total of 874. In addition, 181 follow-up inspections were made. This included 222 safety inspections of Class I hazard dams, 312 safety inspections of Class II hazard dams, 217 safety inspections of Class III hazard dams, and 9 inspections of Class IV dams (includes Federal dams). Construction inspections were maintained at a high level compared to the past, due to reorganization and more emphasis placed on these inspections. Construction inspections are important because we must assure that the approved plans are being followed and to assure changed conditions during construction don't jeopardize the safety of the design. The objective of inspecting all Class I and Class II hazard dams on an annual basis and Class III dams on a five year basis is an inspection year objective versus a fiscal year objective. This objective was attained for 1992 with the assistance of the Chief of the Branch, and engineers in some of the divisions, and is expected to be achieved for 1993. The frequency of inspection of Class II dams was reduced to bi-annually in August 1993 in order to provide the engineers with more time to devote to hydrologic reviews and assisting owners with things like EPPs, and outlet inspections.

USE OF APPROPRIATED FUNDS

Dam safety personal service expenditures for the FY 92-93 were $749,992.00. Total operating and travel expenditures were approximately $37,555.00.

Whenever possible, the members of the Dam Safety Branch are provided training. Several members of the Branch have attended conferences and meetings of the Association of State Dam Safety Officials, participated in university courses on hydrology, the state's Supervisory Certificate Program, and computer related courses. Funds for these are

partially provided from a training fund made up of 2% of each Sections/Divisions operating budget, and managed by a training officer and committee. Training is also paid for with operating funds from the Division Engineer's and the Dam Safety Branch.

RECEIPTS GENERATED FOR COSTS OF FILING PLANS

Fees collected by the State Engineer and deposited in the General Fund for dam safety amounted to $7,306.65 for filing plans and specifications during the period. House Bill 90-1130, approved April 12, 1990, amended the fees charged by the State Engineer effective July 1, 1990. The fee for safety inspections was repealed, and the fees for filing plans were increased to three dollars for each one thousand dollars of estimated costs of engineering and construction, with a minimum fee of one hundred dollars, and a maximum fee of three thousand dollars.

PROGRAM FUNDING

Rapid changes occur in the field of dam safety engineering and related disciplines. New designs for dams (and rehabilitation of dams) are utilizing new materials whose behavior and properties are unknown to the staff. Many conferences are held throughout the country with the objective of sharing knowledge and experience in the field of dam safety. It is still proposed to establish training plans to send our engineers to these training courses to maintain a knowledge of state-of-the-art dam safety. The estimated first year's cost for the program is about $5,000. The training fund presently provides about $2000 for training within the branch. This means that we will not be able to train all of our dam safety engineers at one time, but over a period of several years.

Another funding area is the acquisition of computer programs that have been developed by companies, such as the generic models of DAMBRK, BREACH, STABL, HEC1,and HEC2, to make them more "user-friendly," and improving the efficiency of the users to apply them to engineering problems. The estimated cost for these programs is about $15,000.

The SLED and 35mm camera have been useful for evaluating the condition of small outlets. Presently only two complete SLEDS have been developed for use in Division 1 (4 engineers) and Division 4. In order to more effectively conduct the internal inspection of outlet works, each division engineer's office should have a SLED and water-resistant 35mm camera for use during safety inspections. The estimated cost for four additional SLEDS is $7,200 (Sled and 300 ft. push-pipe - $1500 ea., and weather-resistant 35mm camera - $250 ea.).

ENFORCEMENT ORDERS AND PROCEEDINGS

There were no enforcement proceedings under Section 37-87-114, C.R.S. (1993 Supp.) during the fiscal year.

EMERGENCY PREPAREDNESS PLANS

Emergency preparedness for incidents at dams that jeopardize the public safety, including the failure of dams, has become an important part of dam safety programs. All the federal dam owning/regulating agencies, and most states require that plans be formulated to detect incidents at dams, give adequate warning, and maintain preparedness, for the eventual failure or misoperation of dams. Colorado has been actively involved in this area since 1981, ultimately requiring that EPPs be prepared for Class I and Class II dams as part of the regulations for dam safety adopted in September 1988. As a result of increased effort, at the end of the period of this report, June 30, 1993, emergency plans have been prepared for 88% of the Class I dams of record statewide. Completion varies from 67% to 100% by Division. Division 1 with 131 Class I dams is at 98%, with Divisions 3, 5, and 6 greater than 90%. March 31, 1994 has been established as the date for 100 % compliance for Class I dams. A Legislative audit of the State Engineer's Office, dated March 1991, also found that the State Engineer's guideline for emergency plans was deficient compared to the national standard. In order to remedy these deficiencies, several initiatives were implemented during the period. Some of these were:

1. The Colorado Natural Hazards Mitigation Council created a subcommittee on Dam Safety and Warning, chaired by the Chief of the Dam Safety Branch.

2. An updated guideline for preparing a dam safety emergency preparedness plan following a nationally recognized guideline was distributed for use in October 1992.

3. Increased efforts were made to encourage/assist dam owners to complete their EPPs. Emergency preparedness was part of a Public Awareness Seminar organized by Division 4, and held in Grand Junction for dam owners.

4. Alan Pearson participated in the Colorado Natural Hazards Mitigation Council's 1993 Spring Workshops. The presentations were on the purpose of Emergency Preparedness Plans, and how to develop and implement an emergency preparedness plan.

5. Workshops were held in September 1992 to educate dam owners and emergency managers about the need and value of emergency preparedness for dam incidents/failures. The division offices assisted dam owners in the preparation of their plans. Division 1 held workshops to get the EPPs done.

Further work is required on some EPPs as submitted in order to get them to 100% compliance of developing an adequate plan.

Functional Exercises of the EPPs were held for Rampart Dam,owned by the City of Colorado Springs, and Barker Dam, owned by the Public Service Company, in compliance

with Federal Energy Regulatory Commission relicensing requirements. These types of exercises are planned to be future objectives of the Dam Safety Program after we achieve 100% compliance for the plans.

DAM SAFETY DATABASE MANAGEMENT SYSTEM

During FY 91-92, the dams database (DAMS) was permanently transferred to a personal computer system (PC) using dBASE IV as the data management program. While the main database is kept on the PC in Denver, the several dam safety engineers maintain the data for their divisions on division PCs. The main database in Denver is updated from the several divisions on a periodic basis. The Dam Safety Branch's capability to maintain the database was enhanced by the receipt of computer hardware for the Denver office, and the division offices, from the Association of State Dam Safety Officials (ASDSO), for participation in their National Inventory of Dams Project.

In accordance with a Memorandum of Agreement with the Association, the State Engineer completed the National Inventory of Dams project during the period. The inventory (NATDAM) is produced from the Branch's DAMS database, which also serves the information management needs of the division, and provides data and reports for the public. The authorization to proceed with the update of the national inventory with Colorado dams was given on November 3, 1992.

EFFECTIVENESS OF PROGRAM

As expressed by the goals and objectives of the State Engineer, the program's effectiveness can be measured by the prevention of dam failures. No significant failures occurred during the period, or since the Sage Creek Dam failure in Routt County, in 1985. The enforcement of the State Engineer's orders is also instrumental in assuring the effectiveness of the program. The combination of the State Engineer's safety inspections, restrictions, Emergency Preparedness Plans, and programs to make dam owners more knowledgeable about the safe operation and maintenance of their dams, makes Colorado's Dam Safety Program one of the most effective in the United States.

At the end of the reporting period, there were 191 dams restricted in storage for various safety problems related to things like serious leakage, cracking and sliding of embankments, and inadequate spillways. The restrictions provide for the safety of the dams until the problems are fixed. In some cases the owners are unable to obtain financing for repairing their dams from commercial sources. The Colorado Water Conservation Board's Construction Fund is available to the owners to obtain low cost, long term loans for this purpose. In May 1993, the CWCB created a $2 Million emergency infrastructure repair account in their fund in order to provide financing for structures like dams that are found to be unsafe and in need of repair to protect the public safety. The loans must be beneficial and meet the board's requirements.

Due to the greater than normal snowpack conditions in the mountains, the state prepared for the excess flooding that was expected to occur in the spring. A plan was prepared to assure that the several streams and dams in the state were adequately monitored to respond to problems, and to coordinate activities with federal and private dam owners to lower reservoirs in anticipation of runoff, to make public announcements of increased flows from dams, and to send letters to dam owners to remind them to take appropriate actions at their dams to assure their safety. Except for a few incidents that occurred, the flooding did not create serious problems at most of the dams in the state.

Although not specifically a reservoir dam problem, John Blair of our Glenwood Springs office, responded to an emergency caused by a snow avalanche damming up Castle Creek near Aspen in February 1993. John conducted site inspections, and did dam break analysis to evaluate the hazard. The upstream area was temporarily evacuated, but the hazard determined to be minimal to the downstream area, as the snowdam dissipated from the melting/erosion from the stream water.

The decentralization of the dam inspection program to the Division Engineer's offices throughout the state has been very beneficial. One benefit is the more efficient cost of conducting inspections by reducing travel expenses. Another benefit is the accessibility of the Dam Safety Engineers to the dam owners and consulting engineers to assist them with working on problems with their dams, and to obtain records. A potential problem exists however, trying to maintain quality control of a decentralized program. The Association of Dam Safety Officials have been requested to conduct a peer review of the Dam Safety Program, which they have agreed to do in October 1993. They will be requested to evaluate this part of our organization.

The response to five incidents at dams during the period is also indicative of the effectiveness of the program. One was a slide on the left abutment at Monument dam near Paonia; another was erosion of the emergency spillway due to snowmelt runoff at Hughes dam near Glenwood Springs; and another was a leakage/stability problem of the left abutment at the Rio Grande dam near Creede. In these cases serious consequences were prevented, first by the actions of the owners to respond, and second by the State Engineer's actions to lower the reservoirs, and require close monitoring. The Emergency Preparedness Plans were implemented in the first two cases. Lesser incidents occurred due to a slide on the downstream face of Barnes Meadow dam, and a sinkhole at Ramona dam, both west of Fort Collins

As a service to dam owners, the Dam Safety Branch has and makes available at no charge, a brochure on the construction and operation of dams in Colorado (June, 1989). It contains general information on requirements for approval of plans, water rights, financing, liability, insurance, Emergency Preparedness Plans, statutes, publications, and Division Engineer and Water Court addresses. A "Dam Safety Manual" is also available at a reasonable cost that instructs dam owners on the safety inspection of their dams.

All of the engineers in the Dam Safety Branch are members of the Association of State Dam Safety Officials (ASDSO) and actively participate in its programs. Alan Pearson, Chief of the Dam Safety Branch was elected to the Board of Directors in September 1992. The purpose of ASDSO is to provide a forum for the exchange of ideas and experiences on dam safety issues, foster interstate cooperation, provide information and assistance to dam safety programs, provide representation of state interests before Congress and Federal agencies for dam safety, and to improve efficiency and effectiveness of state dam safety programs. The State Engineer nominated Woodward-Clyde Consultants of Denver to receive ASDSO's special recognition at their Annual Meeting in Baltimore, Maryland in September, 1992. They were nominated for their innovative design repair of Douglas dam, owned by the Windsor Reservoir and Canal Company. Alan Pearson is also participating on an ASDSO workgroup for developing a manual on the performance of dams. The manual will be used by states and others to submit data to a library which will be maintained by Stanford University. Mr. Gregory Hammer, a Dam Safety Engineer, serves on the Subcommittee for Geosynthetics. Several of the Engineers have made presentations at the conferences. Colorado hosted the Western Region meeting of ASDSO in May 1993. The program included emergency preparedness of the western states, and a Technical Seminar on Engineering Geology for Dams.

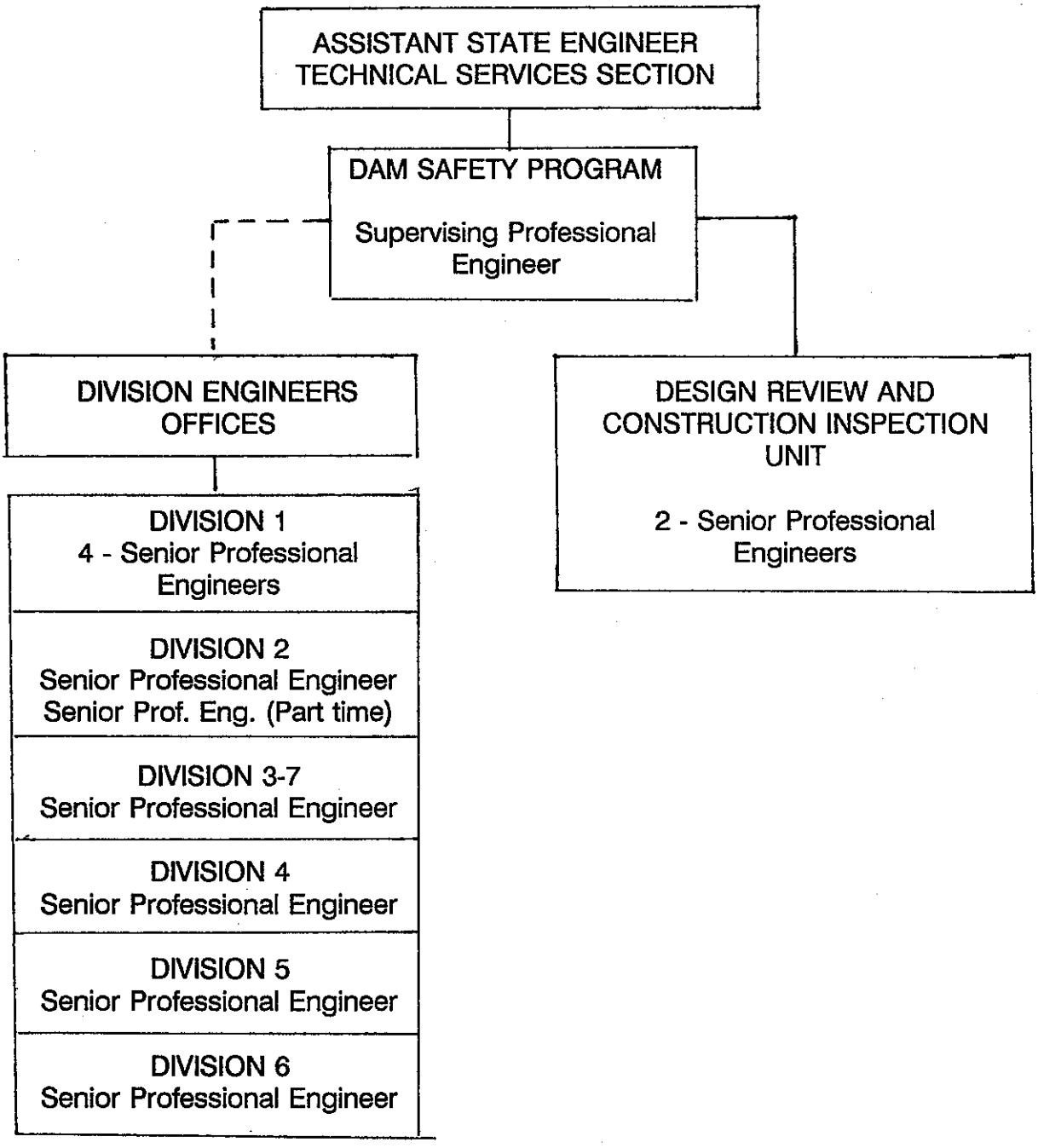
LEGISLATION

No legislation affecting dam safety was enacted during the period.

annrep93.aep

APPENDIX A

DAM SAFETY BRANCH
CHART



APPENDIX A

PERSONNEL
DAM SAFETY BRANCH

TITLE	NAME	AREA OF RESPONSIBILITY
Denver Office		
Superv. Profess. Engineer	Alan Pearson	Supervisor, Dam Safety Program
Senior Professional Engineer	Steve Spann	Design Review/Const. Inspection
Senior Professional Engineer	Mark Haynes	Design Review/Const. Inspection
Resident, Division Offices		
Senior Professional Engineer	John VanSciver	Dam Safety Engineer, Division 1
Senior Professional Engineer	Michael Cola	Dam Safety Engineer, Division 1
Senior Professional Engineer	James Dubler	Dam Safety Engineer, Division 1
Senior Professional Engineer	Gregory Hammer	Dam Safety Engineer, Division 1
Senior Professional Engineer	Michael Graber	Dam Safety Engineer, Division 2
Senior Professional Engineer	Gary Barta	Dam Safety Engineer, Division 2[1]
Senior Professional Engineer	Frank Kugel	Dam Safety Engineer, Divisions 3&7
Senior Professional Engineer	James Norfleet	Dam Safety Engineer, Division 4
Senior Professional Engineer	John Blair	Dam Safety Engineer, Division 5
Senior Professional Engineer	Sally Lewis	Dam Safety Engineer, Division 6

[1] Part time

APPENDIX B

APPROVED PLANS AND SPECIFICATIONS FOR ALTERATIONS ENLARGEMENTS, OR REPAIRS OF EXISTING DAMS

NAME	DAMID	C_NO(1)	DATE	USE
JULESBURG	640104	C-43D	08/31/92	IRRIGATION
GOOSE PASTURE	360105	LTR	07/27/92	MUNICIPAL
BEAVER	400115	LTR	09/28/92	IRRIGATION
WOODMORE COUNTRY CLUB	100310	C-1166B	12/30/92	RECREATION
CRYSTAL CREEK	100116	C-280B	02/25/93	MUNICIPAL
TROUT LAKE	600124	C-675D	04/15/93	HYDRO POWER
TWIN LAKE #2	400621	C-1458A	03/31/93	IRRIGATION
BIG BEAVER	430103	C-1122A	05/03/93	RECREATION

[1] Filing system for approved plans (C-43D). Letter at end of number denotes revision/additions to previously approved plans. LTR indicates letter approval and work is of such a scope that filing of formal drawings are not required prior to construction.

APPROVED PLANS AND SPECIFICATIONS FOR NEW DAMS OR OLD DAMS NOT PREVIOUSLY APPROVED

NAME	DAMID	C_NO(1)	DATE	USE
ALSBURY	450123	C-1727	07/02/92	AUGMENTATION
ZIFF	380123	C-1728	07/12/92	PRIVATE
FAIRMONT	070312	C-1729	09/08/92	RECREATION
OLD TOWN	600182	C-1730	02/25/93	RECREATION
BEHRMANN	050320	C-1731	04/27/93	MUNICIPAL

[1] Filing system for approved plans (C-1727). Assigned to plans for existing dams that are being altered, enlarged, or repaired that were without previously approved plans, and plans for new dams.

APPENDIX C

WATER COMMISSIONER • DAM OBSERVATION REPORT • OFFICE OF THE STATE ENGINEER

DIVISION OF WATER RESOURCES • DAM SAFETY BRANCH — 1313 SHERMAN STREET, ROOM 818, DENVER, CO 80203, (303) 866-3581

DAM NAME _____ W. DIV. _____ W. DIST. _____ DATE OF INSPECTION ___/___/___

DAM ID _____ FILE NO. C- _____ FOREST I.D. _____ DATE OF LAST INSPECTION ___/___/___

OWNER NAME _____ OWNER PHONE _____

ADDRESS _____ ZIP CODE _____

CONTACT NAME _____ CONTACT PHONE _____

CLASS _____ CAPACITY _____ AF SURFACE AREA _____ AC. HEIGHT _____ FT. CREST LENGTH _____ FT CREST WIDTH _____ FT

CURRENT RESTRICTION ☐ (NO) ☐ (YES) LEVEL _____ EPP ON FILE ☐ (NO) ☐ (YES) SPWY WIDTH _____ FT. FBD. _____ FT. Z _____

FIELD CONDITIONS OBSERVED WATER LEVEL: BELOW DAM CREST _____ FT., BELOW SPILLWAY _____ FT., GAGE ROD READING _____

GROUND MOISTURE CONDITION: DRY _____ WET _____ SNOWCOVER _____ OTHER _____

DIRECTIONS: MARK AN X FOR CONDITIONS FOUND AND UNDERLINE WORDS THAT APPLY.

UPSTREAM SLOPE

PROBLEMS NOTED: ☐ (0) NONE ☐ (1) RIPRAP - MISSING, SPARSE, DISPLACED, WEATHERED ☐ (2) WAVE EROSION-WITH SCARPS
☐ (3) CRACKSWITH DISPLACEMENT ☐ (4) SINKHOLE (5) APPEARS TO STEEP ☐ (6) DEPRESSIONS OR BULGES (7) SLIDES
☐ (8) CONCRETE FACING-HOLES, CRACKS, DISPLACED, UNDERMINED ☐ (9) OTHER _____

CREST

PROBLEMS NOTED: ☐ (10) NONE ☐ (11) RUTS OR PUDDLES ☐ (12) EROSION ☐ (13) CRACKS - WITH DISPLACEMENT ☐ (14) SINKHOLES
☐ (15) NOT WIDE ENOUGH ☐ (16) LOW AREA ☐ (17) MISALIGNMENT ☐ (18) IMPROPER SURFACE DRAINAGE
☐ (19) OTHER _____

DOWNSTREAM SLOPE

PROBLEMS NOTED: ☐ (20) NONE ☐ (21) LIVESTOCK DAMAGE ☐ (22) EROSION OR GULLIES ☐ (23) CRACKS - WITH DISPLACEMENT
☐ (24) SINKHOLE ☐ (25) APPEARS TOO STEEP ☐ (26) DEPRESSION OR BULGES ☐ (27) SLIDE ☐ (28) SOFT AREAS
☐ (29) OTHER _____

SEEPAGE

PROBLEMS NOTED: ☐ (30) NONE ☐ (31) SATURATED EMBANKMENT AREA ☐ (32) SEEPAGE EXITS ON EMBANKMENT
☐ (33) SEEPAGE EXITS AT POINT SOURCE ☐ (34) SEEPAGE AREA AT TOE ☐ (35) FLOW ADJACENT TO OUTLET ☐ (36) SEEPAGE INCREASED/MUDDY
DRAIN OUTFALL SEEN ___ No ___ Yes ☐ (37) FLOW INCREASED/MUDDY (38) DRAIN DRY/OBSTRUCTED
☐ (39) OTHER _____

OUTLET

PROBLEMS NOTED: ☐ (40) NONE ☐ (41) NO OUTLET FOUND ☐ (42) POOR OPERATING ACCESS ☐ (43) INOPERABLE
☐ (44) UPSTREAM OR DOWNSTREAM STRUCTURE DETERIORATED (45) OUTLET OPERATED DURING INSPECTION? ☐ YES ☐ NO
INTERIOR INSPECTED ☐ (120) NO ☐ (121) YES ☐ (46) CONDUIT DETERIORATED OR COLLAPSED ☐ (47) JOINTS DISPLACED
☐ (48) VALVE LEAKAGE ☐ (49) OTHER _____

SPILLWAY

PROBLEMS NOTED: ☐ (50) NONE ☐ (51) NO EMERGENCY SPILLWAY FOUND ☐ (52) EROSION-WITH BACKCUTTING
☐ (53) CRACK - WITH DISPLACEMENT ☐ (54) APPEARS TO BE STRUCTURALLY INADEQUATE ☐ (55) APPEARS TOO SMALL
☐ (56) INADEQUATE FREEBOARD
☐ (57) FLOW OBSTRUCTED ☐ (58) CONCRETE DETERIORATED/UNDERMINED ☐ (59) OTHER _____

MAINTENANCE

PROBLEMS NOTED: ☐ (60) NONE ☐ (61) ACCESS ROAD NEEDS MAINTENANCE ☐ (62) CATTLE DAMAGE
☐ (63) BRUSH ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☐ (64) TREES ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE
☐ (67) GATE AND OPERATING MECHANISM NEED MAINTENANCE ☐ (68) OTHER _____

Conditions Observed

	GOOD	ACCEPTABLE	POOR
UPSTREAM SLOPE			
CREST			
DOWNSTREAM SLOPE			
SEEPAGE			
OUTLET			
SPILLWAY			
MAINTENANCE			

See Guidelines on Back of this Sheet

DIRECTIONS: ENTER PROBLEM NUMBER ( ) THEN LOCATION DIMENSIONS, DEGREE.

LOCATION OF PROBLEMS & COMMENTS. _____

MAINTENANCE – MINOR REPAIR – MONITORING – ACTION REQUIRED OF OWNER TO IMPROVE THE SAFETY OF THE DAM.

☐ (80) PROVIDE ADDITIONAL RIPRAP _____
☐ (81) LUBRICATE AND OPERATE OUTLET GATES THROUGH FULL CYCLE. _____
☐ (82) CLEAR TREES AND/OR BRUSH FROM _____
☐ (83) INITIATE RODENT CONTROL PROGRAM AND PROPERLY BACKFILL EXISTING HOLES _____
☐ (84) GRADE CREST TO A UNIFORM ELEVATION WITH DRAINAGE TO THE UPSTREAM SLOPE _____
☐ (85) PROVIDE SURFACE DRAINAGE FOR _____
☐ (86) MONITOR _____
☐ (88) OTHER _____
☐ (89) OTHER _____

DAM REQUIRES INSPECTION BY A FIELD ENGINEER _____

The State Engineer, by providing this dam safety observation report, does not assume responsibility for any unsafe condition of the subject dam. The sole responsibility for the safety of the dam rests with the reservoir owner or operator, who should take every step necessary to prevent damages caused by leakage or overflow of waters from the reservoir or floods resulting from a failure of the dam.

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, OUTLET, SPILLWA

GOOD	ACCEPTABLE	POOR
In general, this part of the structure has a near new appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. conditions in this area do not currently appear to threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD	ACCEPTABLE	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in seepage. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Seepage conditions observed appear to threaten the safety of the dam. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment, i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	POOR
Owner has a plan for annual maintenance. Dam consistently receives effective on-going maintenance and repair.	Dam receives maintenance in accordance with a plan, but some maintenance items need to be addressed. No major repairs are required.	No annual maintenance plan in effect. Dam does not appear to receive adequate maintenance. One or more items needing maintenance or repair have begun to threaten the safety of the dam. Lack of maintenance prevents thorough inspection.

CLASSIFICATION OF DAMS

Class 1 - Loss of human life is expected in the event of failure of the dam.

Class 2 - Significant damage is expected in the event of failure of the dam, but no loss of human life is expected.

Class 3 - A small amount of damage is expected. Loss of human life and significant damage are not expected.

Class 4 - No loss of human life is expected and damage will occur only to the dam owner's property.

ATTACHMENT D

ENGINEERS INSPECTION REPORT

OFFICE OF THE STATE ENGINEER-DIVISION OF WATER RESOURCES - DAM SAFETY BRANCH
1313 Sherman Street, Room 818, Denver, CO 80203, (303) 866-3581

DAM NAME _____ W. DIV. _____ W. DIST. _____ DATE OF INSPECTION ___/___/___

DAM ID _____ FILE NO. C- _____ FOREST I.D. _____ DATE OF LAST INSPECTION ___/___/___

OWNER NAME _____ OWNER PHONE _____

ADDRESS _____ ZIP CODE _____

CONTACT NAME _____ CONTACT PHONE _____

CLASS _____ CAPACITY _____ AF SURFACE AREA _____ AC. HEIGHT _____ FT. CREST LENGTH _____ FT CREST WIDTH _____ FT.

CURRENT RESTRICTION ☐ (NO) ☐ (YES) LEVEL _____ EPP ON FILE ☐ (NO) ☐ (YES) SPWY WIDTH _____ FT, FBD. _____ FT, Z _____

INSPECTION PARTY _____ REPRESENTING _____

DIRECTIONS: MARK AN X FOR CONDITIONS FOUND AND UNDERLINE WORDS THAT APPLY. GIVE LOCATION AND EXTENT WITH NUMBER REFERENCE I.E. (25) ALL ALONG SLOPE, OR SHOW IT ON SKETCH.

FIELD CONDITIONS OBSERVED

WATER LEVEL - BELOW DAM CREST _____ FT., BELOW SPILLWAY _____ FT., GAGE ROD _____

GROUND MOISTURE CONDITION: DRY _____ WET _____ SNOWCOVER _____ OTHER _____

UPSTREAM SLOPE

PROBLEMS NOTED: ☐ (0) NONE ☐ (1) RIPRAP - MISSING, SPARSE, DISPLACED, WEATHERED ☐ (2) WAVE EROSION-WITH SCARPS
☐ (3) CRACKS-WITH DISPLACEMENT ☐ (4) SINKHOLE ☐ (5) APPEARS TOO STEEP ☐ (6) DEPRESSIONS OR BULGES ☐ (7) SLIDES
☐ (8) CONCRETE FACING-HOLES, CRACKS, DISPLACED, UNDERMINED ☐ (9) OTHER _____
Comments: _____

CREST

PROBLEMS NOTED: ☐ (10) NONE ☐ (11) RUTS OR PUDDLES ☐ (12) EROSION ☐ (13) CRACKS - WITH DISPLACEMENT ☐ (14) SINKHOLES
☐ (15) NOT WIDE ENOUGH ☐ (16) LOW AREA ☐ (17) MISALIGNMENT ☐ (18) INADEQUATE SURFACE DRAINAGE
☐ (19) OTHER _____
Comments: _____

DOWNSTREAM SLOPE

PROBLEMS NOTED: ☐ (20) NONE ☐ (21) LIVESTOCK DAMAGE ☐ (22) EROSION OR GULLIES ☐ (23) CRACKS - WITH DISPLACEMENT ☐ (24) SINKHOLE
☐ (25) APPEARS TOO STEEP ☐ (26) DEPRESSION OR BULGES ☐ (27) SLIDE ☐ (28) SOFT AREAS ☐ (29) OTHER _____
Comments: _____

SEEPAGE

PROBLEMS NOTED: ☐ (30) NONE ☐ (31) SATURATED EMBANKMENT AREA ☐ (32) SEEPAGE EXITS ON EMBANKMENT
☐ (33) SEEPAGE EXITS AT POINT SOURCE ☐ (34) SEEPAGE AREA AT TOE ☐ (35) FLOW ADJACENT TO OUTLET ☐ (36) SEEPAGE INCREASED/MUDDY
DRAIN OUTFALLS SEEN ___No ___Yes ☐ (37) FLOW INCREASED/MUDDY ☐ (38) DRAIN DRY/OBSTRUCTED
☐ (39) OTHER _____ Show location of drains on sketch and indicate amount and quality of discharge.
Comments: _____

OUTLET

PROBLEMS NOTED: ☐ (40) NONE ☐ (41) NO OUTLET FOUND ☐ (42) POOR OPERATING ACCESS ☐ (43) INOPERABLE
☐ (44)UPSTREAM OR DOWNSTREAM STRUCTURE DETERIORATED ☐ (45) OUTLET NOT OPERATED DURING INSPECTION
INTERIOR INSPECTED ☐ (120) NO ☐ (121) YES ☐ (46) CONDUIT DETERIORATED OR COLLAPSED ☐ (47) JOINTS DISPLACED ☐ (48) VALVE LEAKAGE
☐ (49) OTHER _____
Comments: _____

SPILLWAY

PROBLEMS NOTED: ☐ (50) NONE ☐ (51) NO EMERGENCY SPILLWAY FOUND ☐ (52) EROSION-WITH BACKCUTTING ☐ (53) CRACK - WITH DISPLACEMENT
☐ (54) APPEARS TO BE STRUCTURALLY INADEQUATE ☐ (55) APPEARS TOO SMALL ☐ (56) INADEQUATE FREEBOARD ☐ (57) FLOW OBSTRUCTED
☐ (58) CONCRETE DETERIORATED/UNDERMINED ☐ (59) OTHER _____
Comments: _____

See Guidelines on Back of this Sheet

Conditions Observed	GOOD	ACCEPTABLE	POOR
UPSTREAM SLOPE			
CREST			
DOWNSTREAM SLOPE			
SEEPAGE			
OUTLET			
SPILLWAY	GOOD	ACCEPTABLE	POOR

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, OUTLET, SPILLWAY

GOOD	ACCEPTABLE	POOR
In general, this part of the structure has a near new appearance, and conditions observed in this area do not appear to threaten the safety of the dam.	Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.	Conditions observed in this area appear to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD	ACCEPTABLE	POOR
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.	Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in seepage. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.	Seepage conditions observed appear to threaten the safety of the dam. Examples: 1) Designed drain or seepage flows have increased without increase in reservoir level. 2) Drain or seepage flows contain sediment, i.e., muddy water or particles in jar samples. 3) Widespread seepage, concentrated seepage or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MONITORING

GOOD	ACCEPTABLE	POOR
Monitoring includes movement surveys and leakage measurements for all dams, and piezometer readings for Class I dams. Instrumentation is in reliable, working condition. A plan for monitoring the instrumentation and analyzing results by the owner's engineer is in effect. Periodic inspections by owner's engineer.	Monitoring includes movement surveys and leakage measurements for Class I & II dams; leakage measurements for Class III dams. Instrumentation is in serviceable condition. A plan for monitoring instrumentation is in effect by owner. Periodic inspections by owner or representative. OR, NO MONITORING REQUIRED.	All instrumentation and monitoring described under "ACCEPTABLE" here for each class of dam, are not provided, or required periodic readings are not being made, or unexplained changes in readings are not reacted to by the owner.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD	ACCEPTABLE	POOR
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.	Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are required.	Dam does not appear to receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam.

OVERALL CONDITIONS

SATISFACTORY	CONDITIONALLY SATISFACTORY	UNSATISFACTORY
The safety inspection indicates no conditions that appear to threaten the safety of the dam, and the dam is expected to perform satisfactorily under all design loading conditions. Most of the required monitoring is being performed.	The safety inspection indicates symptoms of *possible* structural distress (seepage, evidence of minor displacements, etc.), which, if conditions worsen, *could* lead to the failure of the dam. Essential monitoring, inspection, and maintenance must be performed as a requirement for continued full or reduced storage in the reservoir.	The safety inspection indicates *definite* signs of structural distress (excessive seepage, cracks, slides, sinkholes, severe deterioration, etc.), which *could* lead to the failure of the dam if the reservoir is used to full capacity. The dam is judged unsafe for full storage of water.

SAFE STORAGE LEVEL

FULL STORAGE	CONDITIONAL FULL STORAGE	RESTRICTION
Dam may be used to full capacity with no conditions attached.	Dam may be used to full storage if certain monitoring, maintenance, or operational conditions are met.	Dam may not be used to full capacity, but must be operated at some reduced level in the interest of public safety.

CLASSIFICATION OF DAMS

CLASS I	CLASS II	CLASS III
Class I - Loss of human life is expected in the event of failure of the dam, while the reservoir is at the high water line.	Class II - Significant damage to improved property is expected in the event of failure of the dam while the reservoir is at the high water line, but no loss of human life is expected.	Class III - Loss of human life is not expected, and damage to improved property is expected to be small, in the event of failure of the dam while the reservoir is at high water line.

NAME: _____ DAM I.D.: _____ DATE ___/___/___

MONITORING

EXISTING INSTRUMENTATION FOUND ☐ (110) NONE ☐ (111) GAGE ROD ☐ (112) PIEZOMETERS ☐ (113) SEEPAGE WEIRS/FLUMES
☐ (114) SURVEY MONUMENTS ☐ (115) OTHER _____
MONITORING OF INSTRUMENTATION: ☐ (116) NO ☐ (117) YES PERIODIC INSPECTIONS BY: ☐ (118) OWNER ☐ (119) ENGINEER
Comments: _____

GOOD ☐ ACCEPTABLE ☐ POOR ☐

MAINTENANCE AND REPAIR

PROBLEMS NOTED: ☐ (60) NONE ☐ (61) ACCESS ROAD NEEDS MAINTENANCE ☐ (62) CATTLE DAMAGE
☐ (63) BRUSH ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☐ (64) TREES ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE
☐ (65) RODENT ACTIVITY ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☐ (66) DETERIORATED CONCRETE-FACING, OUTLET, SPILLWAY
☐ (67) GATE AND OPERATING MECHANISM NEED MAINTENANCE ☐ (68) OTHER _____
Comments: _____

GOOD ☐ ACCEPTABLE ☐ POOR ☐

OVERALL CONDITIONS

REMARKS: _____

Based on this Safety Inspection and recent file review, the overall condition is determined to be:

☐ 71 SATISFACTORY ☐ 72 CONDITIONALLY SATISFACTORY ☐ 73 UNSATISFACTORY

RESPONSIBILITY

The responsibility for the safety of this dam rests with the reservoir owner or operator, who should take every step necessary to prevent damages caused by leakage or overflow of waters from the reservoir or floods resulting from a failure of the dam.

ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

MAINTENANCE - MINOR REPAIR - MONITORING

☐ (80) PROVIDE ADDITIONAL RIPRAP: _____
☐ (81) LUBRICATE AND OPERATE OUTLET GATES THROUGH FULL CYCLE: _____
☐ (82) CLEAR TREES AND/OR BRUSH FROM: _____
☐ (83) INITIATE RODENT CONTROL PROGRAM AND PROPERLY BACKFILL EXISTING HOLES: _____
☐ (84) GRADE CREST TO A UNIFORM ELEVATION WITH DRAINAGE TO THE UPSTREAM SLOPE: _____
☐ (85) PROVIDE SURFACE DRAINAGE FOR: _____
☐ (86) MONITOR: _____
☐ (87) DEVELOP AND SUBMIT AN EMERGENCY PREPAREDNESS PLAN. _____
☐ (88) OTHER: _____
☐ (89) OTHER: _____

ENGINEERING - EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO: (Plans & Specification must be approved by State Engineer prior to construction.)

☐ (90) PREPARE PLANS AND SPECIFICATIONS FOR THE REHABILITATION OF THE DAM: _____
☐ (91) PREPARE AS-BUILT DRAWINGS OF: _____
☐ (92) PERFORM A GEOTECHNICAL INVESTIGATION TO EVALUATE THE STABILITY OF THE DAM: _____
☐ (93) PERFORM A HYDROLOGIC STUDY TO DETERMINE REQUIRED SPILLWAY SIZE: _____
☐ (94) PREPARE PLANS AND SPECIFICATIONS FOR AN ADEQUATE SPILLWAY: _____
☐ (95) SET UP A MONITORING SYSTEM INCLUDING WORK SHEETS, REDUCED DATA AND GRAPHED RESULTS: _____
☐ (96) PERFORM AN INTERNAL INSPECTION OF THE OUTLET: _____
☐ (97) OTHER: _____
☐ (98) OTHER: _____
☐ (99) OTHER: _____

SAFE STORAGE LEVEL RECOMMENDED AS A RESULT OF THIS INSPECTION

☐ (101) FULL STORAGE
☐ (102) CONDITIONAL FULL STORAGE
☐ (103) RECOMMENDED RESTRICTION — RESTRICTED LEVEL OFFICIAL ORDER TO FOLLOW →
- _____ FT. BELOW DAMS CREST
- _____ FT. BELOW SPILLWAY CREST
- _____ FT. GAGE HEIGHT
- _____ NO STORAGE-MAINTAIN OUTLET FULLY OPEN
- _____ _____

SON FOR RESTRICTION: _____

ONS REQUIRED FOR CONDITIONAL FULL STORAGE OR CONTINUED STORAGE AT THE RESTRICTED LEVEL: _____

eer's ture _____ INSPECTED BY Owner's Signature _____ OWNER/OWNER'S REPRESENTATIVE DATE: ___/___/___

2-2649a-86