STATE ENGINEER'S SEVENTEENTH ANNUAL REPORT TO THE COLORADO GENERAL ASSEMBLY ON DAM SAFETY FOR FY 00-01

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COLORADO DIVISION OF WATER RESOURCES
OFFICE OF THE STATE ENGINEER

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INTRODUCTION

The mission of Colorado's Dam Safety Program is to prevent loss of life and property damage and protect the state's water supplies from the failure of dams within the resources available to this office. The program provides for a safe environment related to the design, construction, and operation of dams and reservoirs through working with dam owners and designers to achieve compliance with state law. The program includes the enforcement of a comprehensive set of regulations, policies, and procedures for the construction and maintenance of dams, the safe operation of reservoirs, and emergency preparedness. In the event a dam is found to be unsafe, the public safety is improved by restricting the storage in the reservoir to a safe level. The safe storage levels are determined by the review and approval of engineered plans for the construction and repair of dams, and regular safety evaluations of existing dams and reservoirs by professional engineers.

The program is managed by the State Engineer in accordance with Title 37, Article 87, of C.R.S. (2000 Supp.), and the Livestock Water Tank Act, Title 35, Article 49, of C.R.S. (2000 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.

PURPOSE

This report is submitted in compliance with Section 37-87-114.4, C.R.S. (2000 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. (2000 Supp.).

EFFECTIVENESS OF PROGRAM

The effectiveness of a program can be demonstrated by producing a result or accomplishment. For fiscal year 2000 - 2001, the dam safety program achieved the majority of its goals and objectives in the design review and inspection of dams. We continue, however, to experience incidents at dams. Because of our dam safety program, the incidents resulted in reduced consequences. This is attributed to the increased awareness of the dam owners to be responsible for their dams, including emergency preparedness; and to the enforcement of the regulations, policies, and procedures by our office.

At the end of the reporting period, there were 198 dams restricted from full storage due to various structural problems such as serious leakage, cracking and sliding of embankments, and

inadequate spillways. Total storage restricted is 132,115 acre-feet. The restrictions provide risk reduction for the public and environment until the problems are corrected. The owners are responsible for following the restricted operating levels, and the restrictions are enforced by the Division Engineers. See Appendix G for a list of restricted dams. In the event conditions of any dam or reservoir are so unsafe as to not permit the time to issue or enforce a restriction, or a dam is threatened by a large flood, the State Engineer may immediately employ remedial measures to protect the public safety. An emergency dam repair cash fund is provided under the Colorado Water Conservation Board's construction fund per Section 37-87-122.5 (2000 Supp.)

Seven dams experienced serious problems during the period. Following is a short description of the incidents:

- Matheson, a Significant Hazard (Class 2) dam near Kremmling in Grand County, has been experiencing significant leakage over the years subsequently developing large sinkholes in the right abutment. The sinkholes are growing in number and progressing towards the dam. The reservoir is restricted to a level below the sinkholes.
- Martin Cull dam, a Low Hazard (Class 3) structure near Craig in Moffat County had a large slip on the upstream slope which damaged the outlet works. The damage resulted in the reservoir draining and partially filling the outlet conduit with silt.
- Rifle Gap, a High Hazard (Class 1) dam near Rifle in Garfield County, experienced a sinkhole in the parking lot at the right abutment of the dam. Investigation by the US Bureau of Reclamation found shrinkage cracks in the underlying foundation which the overlying cohesionless material was able to pipe into. The remaining voids were grouted. The reservoir was at a low level at the time of the incident.
- Wahatoya Lake, a High Hazard (Class 1) dam near LaVeta in Huerfano County, suddenly began leaking in a broad band at the downstream toe near the Northeast corner of the dam. The downstream slope was saturated one-fourth the way up, and a crack appeared on the crest of the dam. The reservoir was spilling at the time. Emergency repairs were done by clearing the extensive brush off of the slope, and installing a weighted filter and drains on the downstream slope.
- Lake Henry, a Significant Hazard (Class 2) dam near Ordway in Crowley County, suffered severe overtopping of the crest of the East embankment by waves due to high winds. The water saturated the downstream slope causing a slide. Emergency repairs were made to fix the slide.
- Fruita No.1 dam, a Significant Hazard (Class 2) structure near Glade Park in Mesa County, experienced another significant slide on the dowstream slope. Plans have been approved to stabilize the slope and the reservoir is restricted to 20 feet below the crest of the dam.
- Oasis, a Low Hazard (Class 3) dam near Austin in Delta County, suffered erosion damage due to wave action on the left end of the main dam, which reduced the crest width. The reservoir is being lowered pending repairs.

With the passage of the National Dam Safety Program Act (NDSP), PL 104-303, and its subsequent funding, Colorado has applied for and received assistance grants in 1998 ($25,162), 1999 ($49,230) and 2000 ($85,400) to improve the effectiveness of its program. An additional grant was approved for $85,400 for year 2001. These funds are being used to provide advanced training to the staff in the field of dam safety and risk analysis. See Page 12 for more information on our Failure Mode and Consequence Evaluations pilot project, and our Risk Based Profiling

System plans. Additional training will also be provided under the Technical Seminar training provisions of the Act. The grant funds will also be used to acquire emergency communication equipment; upgraded computers; engineering computer programs; and digital cameras. Future grants may be available each year under the Act, until the year 2002, subject to appropriations.

The following sections of this report cover the activities of the program during the period.

DAM SAFETY PROGRAM

Organization

The Dam Safety Program is implemented by the State Engineer through the Dam Safety Branch and the Division Engineers' offices. The branch is partially decentralized, with Dam Safety Engineers working under the general supervision of the Division Engineers in the several divisions throughout the state. The Dam Safety Engineers and the divisions are responsible for the Program for their geographic area, including enforcement of reservoir level restrictions. The Principal Engineer of the Branch, who is located in Denver, has program-wide responsibilities such as: communication, training, coordination, formulating the goals of the program, recommending policies for implementation of the regulations, preparing procedures for carrying out the policies, and providing technical guidelines for conduct of the work. The Principal Engineer also supervises the Design Review and Construction Inspection activities. (See Appendix A for tables and charts of the personnel and organization of the Branch.)

The Dam Safety Engineers' principal duties are to respond to emergency situations, conduct safety inspections of existing dams, review the adequacy of spillways under the rules, enforce the requirement for emergency planning, assist dam owners in developing their Emergency Preparedness Plans (EPP), provide design review and construction inspection of repairs and alterations when necessary, and investigate complaints on the safety of dams. They also investigate the construction of dams in violation of Section 37-87-105(1) and (4), C.R.S. (1999 Supp.), and conduct training on the inspection of dams for division personnel, dam owners, interested agencies, engineers, and the public. In addition, they review and approve Livestock Watertank and Erosion Control Dam applications, and do other related work as assigned.

Interagency coordination occurs as necessary. For example, we provide the U.S. Forest Service copies of our inspection reports and orders for repair for privately owned dams, so they can administer their use permits on national forest lands. We also coordinate the reviews of plans with the forest service for permitted dams. An updated MOU is pending. An MOU was also executed with the US Bureau of Land Management to coordinate our dam safety activities. MOUs are pending with the US Army Corps of Engineers and the Federal Energy Regulatory Commission. See page 7 for more information on the safety of federal dams.

A Memorandum of Understanding has been executed with the Division of Wildlife (DOW) regarding the responsibilities of each agency in carrying out the safety inspection of their dams. DOW is making safety inspections of their Low Hazard (Class 3) dams.

The Design Review Engineers' 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. (2000 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 engineers assist 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, provides technical assistance to the Division Engineers' offices on dam safety, and performs other related work as assigned.

The Colorado Water Conservation Board makes its Construction Fund available to assist owners with the repair of their dams. We coordinate the review and approval and the final acceptance of these dams with them.

Goals and Objectives of the Program

The program concentrates on "jurisdictional" dams and reservoirs as defined in Section 37-87-105, C.R.S. (2000 Supp.), which are greater than ten feet high at the spillway; or twenty acres in surface area, or 100 acre-feet in capacity at the high water line. Particular attention is placed on inspecting Class 1 (High Hazard) dams annually, Class 2 (Significant Hazard) dams every two years, and Class 3 (Low Hazard) dams are inspected at least every six years. Because of their non-hazardous location, Class 4 (No Hazard) dams are not inspected regularly, but observed for changes in hazard class periodically. See SAFETY INSPECTIONS AND CONSTRUCTION OBSERVATIONS, page 9 for more information.

The Dam Safety Branch developed the following goals and objectives for the Dam Safety Program.

1. **In order to protect the public safety, the Dam Safety Branch shall determine the amount of water, which is safe to impound in the several reservoirs in the state.** All of the objectives were accomplished for the period. See page 10 for more details on the number of inspections conducted.

2. **In order to protect the public from the failure of dams, the Dam Safety Branch shall review and recommend approval of plans and specifications for the construction, modification, and repairs of dams, in accordance with the Regulations for Dam Safety and Dam Construction, September 30, 1988.** All of the objectives for this goal were also accomplished, including the Design Review Unit completing the review of plans and specifications within the 180-day limit. See page 8 for more details on the number of plans reviewed and approved.

3. **In order to improve the public safety from the failures of dams, the Dam Safety Branch shall implement the Rules and Regulations for Dam Safety and Dam Construction in a reasonable time.**

   Emphasis has been placed during the period on improving the number and quality of Emergency Preparedness Plans for High and Significant hazard dams, especially getting existing plans updated. Moderate success is being realized due to the efforts of our Dam Safety Engineers, in some cases assisting the owners by providing the forms and data they need.

4. **To improve the communications of the Dam Safety Branch, the Principal Engineer of the branch and the Division Engineers shall coordinate their activities closely.** Communications are maintained through the use of e-mail and sending monthly activity reports to the Divisions by the Principal Engineer of the branch.

The Assistant State Engineer, Jack Byers, schedules frequent meetings with the Division Engineer's offices and annual meetings with the branch.

5. **In order to improve the functions of the Branch, and to meet the public information needs, the Dam Safety Branch shall maintain a data information system.** The maintenance of the DAMS database has been very successful. See page 12 for more information about this and the NATDAM program.

6. **In order to improve the technical proficiency of the Branch, the Division of Water Resources shall provide training and professional development of the personnel.** The Dam Safety Branch submitted a training plan as part of an application to the Federal Emergency Management Agency (FEMA) under the National Dam Safety Program Act (NDSP) to provide the staff with advanced training in technical subjects. During the period the staff have taken part in Technical Seminars offered by the Association of State Dam Safety Officials (ASDSO) and others as follows:

   US Committee on Large Dams annual conference and special session on risk assessment. The Principal Engineer of the Branch attended.

   Association of State Dam Safety Officials Annual Conference and Technical Seminar on Slope Stability. Four members of the branch attended. Out-of-state travel limitations prevented additional dam safety engineers attending.

   FEMA/ASDSO workshop on enforcement of dam safety actions. One member of the branch attended.

   In house training on Risk Assessment. All members of the branch attended.

   ASDSO Western Region Conference and Technical Seminar on Dam Failure Analysis. Two members of the branch attended.

   FEMA/ASDSO workshop on HEC-RAS. One member of the branch attended.

   Workshop on Roller Compacted Concrete. One member of the branch attended.

   Administrative leave is also provided for continuing education and participation on task groups and committees.

7. **In order to improve our dam safety program, and to participate in the development of national policies on dam safety, and to take advantage of the continuing education and information available, the State shall be a full voting member of the Association of State Dam Safety Officials (ASDSO).** Under Goal 7, the Principal Engineer of the Branch is the designated state representative to ASDSO. He has served on task groups, committees, and the Board of Directors, and was an officer. All of the personnel in the Branch have had an opportunity to attend ASDSO conferences and technical seminars over the years. Their Associate Member dues are paid for from operating funds.

Safety of Federal Dams

A Memorandum of Understanding (MOU) has been executed with the U.S. Bureau of Reclamation (BOR), the Bureau of Land Management (BLM), and the Air Force Academy (AFA) relating to dam safety activities in Colorado. They provide for the exchange of safety related information of dams under each agency's jurisdiction. An MOU is also being updated with the U.S. Forest Service, Rocky Mountain Region, to provide coordination of our mutual responsibilities for dam safety, and their Travel Management Plan for the National Forests. This is necessary to provide access to private dams located on the forests. MOUs are being pursued with the other federal agencies such as the Army Corp of Engineers and the Federal Energy Regulatory Commission to assure that the dams under their jurisdiction are being maintained in safe condition and to coordinate our activities and exchange of information and data.

Safety evaluations are done in accordance with the "Federal Guidelines for Dam Safety". We monitor the activities of these federal agencies to assure they are following their guidelines.

We have curtailed participating in routine inspections of federal dams in accordance with a legislative audit recommendation. The Branch however, will participate in the evaluation of the safety of some federal dams for special issues and performance problem evaluations, in accordance with the procedure for obtaining approval to participate in these inspections. Ninety-three (93) hours were spent participating in these safety inspections at a cost of $3906.

Federal Energy Regulatory Commission Licensed Dams

The Branch makes safety inspections of dams, which are also regulated by the Federal Energy Regulatory Commission (FERC). In accordance with an agreement with them, they notify us of their schedules, and invite us to participate in their inspections. They also furnish us copies of their reports for our records. We notify the FERC of any safety problems that we have identified based on our safety inspections, when requested by them. We have also curtailed our participation in FERC regulated dams in accordance with the audit, but in accordance with the procedures for approval spent 18 hours on inspections to evaluate specific performance or maintenance issues, at a cost of $756.

Tables of Jurisdictional Dams

See page 15 for a table showing the distribution of dams by ownership. Table 1 shows the ownership of jurisdictional dams in divisions by hazard class and type of owner.

APPROVAL OF PLANS AND SPECIFICATIONS FOR CONSTRUCTION OF DAMS AND RESERVOIRS

During FY 00-01, the State Engineer's Office received plans for five new dams, and thirty-four plans for alteration, modification, repair, or enlargement. Six separate hydrology studies were also submitted for determination of the inflow design flood for spillway design. The estimated cost of construction for the submitted plans was $22,300,173. Forty-five thousand nine hundred and twenty-eight dollars ($45,928) was collected for the examination and filing of the submitted plans.

Thirty-six sets of plans and specifications for construction, and six hydrology studies were approved by the State Engineer during FY 00-01. (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.

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. (2000 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. (2000 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

Scope

The statutes specify 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. Construction inspections also need to be maintained at a high level. Construction inspections are important to assure that the approved plans are being followed and to assure changed conditions during construction does not jeopardize the safety of the design. 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 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 has been postponed on dams located above 7500 feet in elevation, pending the completion of a study of extreme precipitation by the State Engineer and the Water Conservation Board, (See page 11 for more information.).

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. An order is prepared for the State Engineer's signature, restricting storage in the reservoir until the problem is corrected. 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.

Procedures have been implemented to begin reporting incidents, and the findings of safety inspections where orders have been issued to make modifications for safety reasons, to the Center for the Performance of Dams at Stanford University, Palo Alto, California. This is a national program that has been developed by the Association of State Dam Safety Officials and the Federal Emergency Management Agency for accumulating data for the improvement of design and safety evaluations of dams nationwide. Dam incident reports were submitted for seven dams during the period.

Orders to repair or maintain the dam usually require the re-inspection of the dam in order to verify that the work has been done in an acceptable 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 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.

Scheduling

The Dam Safety Engineers collectively conduct about 600 to 800 safety and construction inspections each year. Jurisdictional dams identified for inspection in accordance with the policies of the State Engineer are assigned to the Dam Safety Engineers in each Division. The number of inspections required to be scheduled is related to the number of dams in each division and their hazard class. Included in these numbers has been the annual inspection of all Class 1 dams, one-half of the Class 2 hazard dams, and about one-sixth of the Class 3 hazard dams. Inspection of federal dams for nonroutine inspections are integrated with these schedules. Subsequent follow-up and problem solving meetings with dam owners results in additional inspections each year. In order to implement a pilot project on Failure Mode and Consequences Evaluations, and to assist with inspections in Divisions 5 and 6 due to employee injuries, the Dam Safety Engineers were directed to identify dams they could postpone safety inspections of. This reduced the number of safety inspections during the period.

In order to track potential problems which could develop at Class 3 dams, the Dam Safety Engineers assign dams to be observed to the Divisions' Water Commissioners, and they file an observation report. The report is reviewed, and then furnished to the owner for their information, and to implement any recommendations for repair and maintenance. A copy of the WATER COMMISSIONER DAM OBSERVATION REPORT form is in Appendix C.

Number of Inspections

During FY 00-01, a total of 519 safety inspections and 163 construction inspections were conducted for a total of 682. In addition, 141 follow-up inspections were made. The safety inspections included 214 Class 1 (High) hazard dams, 172 Class 2 (Significant) hazard dams, 127 Class 3 (Low) hazard dams, and 51inspections of Class 4 (No Hazard) dams (includes Federal dams which are inspected at three year intervals and which we participated). Fewer low hazard inspections were done due to a vacancy in Divisions 3 and 7, and injuries to two of the Dam Safety Engineers For inspections of federally owned dams and FERC regulated dams in which we don't participate, we receive and review their reports and findings.

DAM SAFETY PROJECTS

Extreme Precipitation Study

The State Engineer and the Colorado Water Conservation Board (CWCB) continued the process during the period to study extreme precipitation in the mountainous areas of Colorado. See Proposal for Evaluating Extreme Precipitation for the Mountainous Areas of Colorado in Appendix E. A volunteer committee of meteorologists, hydrologists, engineers, federal and state agencies, and private entities prepared the proposal. The Department of Atmospheric Science, CSU (State Climatologist) was engaged for doing Phase I of the study, which is the collection and verification of data. A workshop was held to provide a forum for professionals in the field to determine which modeling technology should be used during Phase II of the plan. The Phase I report was completed in May 1997. It contains a list of recommended extreme storms that will be used for modeling research, and can be used for site specific analysis of extreme events for project studies. The CWCB approved $300,000 for doing the Phase II study. They also approved the use of $100,000 for updating the 100-year frequency atlas for Colorado. The National Weather Service, NOAA, will be requested to update the atlas, however they are behind schedule and no work is expected to get done until 2002.

A Memorandum of Understanding was approved on March 5, 1999 with Colorado State University (CSU) Department of Atmospheric Science, Ft. Collins, Colorado to develop new methodologies for determining extreme precipitation. This will be about a two plus year (February 1999 – June 2001) research project using the RAMS model at CSU to simulate extreme precipitation of historic events, and to create a graphical user interface (GUI) with the RAMS model to develop extreme precipitation estimates in Colorado. A Technical Review Group is assisting us in reviewing the progress of the research. The members of the group are Mr. Jimy Dudhia, National Center for Atmospheric Research; Mr. Louis Schreiner and Mr. David Mathews, US Bureau of Reclamation; and Mr Stephen Spann, Consultant. These new criteria should save millions of dollars in the construction of spillways for dams. CSU has requested, and has been granted, a six-month extension of time to complete their research by December 2001.

Emergency Preparedness Plans

Emergency preparedness for incidents at dams that jeopardize the public safety, including the failure of dams, has become an integral part of dam safety programs. All the federal dam owning/regulating agencies, and most states require that plans be formulated in order 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 Emergency Preparedness Plans (EPP) be prepared for High and Significant Hazard dams as part of the regulations for dam safety adopted in September 1988. Although all high hazard dams have a plan, much work is still needed, however, to update, maintain, and exercise the plans annually.

The Dam Safety Engineers in the Divisions continue to assist dam owners in the preparation of their EPPs. Approximately 98 percent of the Significant Hazard dams have plans on file. The others who do not have a plan, have been notified of the requirement to prepare them. In some cases, we have prepared the plans for the owners. This will continue to be enforced during the

following year of inspections. We also participate in a variety of emergency exercises in coordination with federal, state, and local emergency managers.

Dam Safety Database Management System

The dams database (DAMS) is maintained on a personal computer system (PC) using dBASE IV as the data management program. While the main database is kept on a PC in Denver, the several dam safety engineers maintain the data for their Divisions on their 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 and analyze dams was enhanced by the receipt of computer hardware and software for the Denver office and the Division offices under the auspices of the National Dam Safety Program Assistance Grants. The addition of e-mail and Internet Services has improved our ability to maintain and share our databases materially. This system is used to update the National Inventory of Dams (NATDAM or NID) periodically when requested by the US Army Corps of Engineers.

Publications/Internet

As a service to dam owners, the Dam Safety Branch makes available, at no charge, a brochure on the construction and operation of dams in Colorado (January 1999). 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. Guidelines for preparing EPPs and a Project Review Guide for submitting plans for approval also are provided at no cost.

In addition, the Regulations, Project Review Guide, application forms, sample plans, Livestock and Erosion Control Dam Permits, and Notice to Construct a Nonjurisdictional Impoundment Structure are available on the Dam Safety Web Page.

Failure Modes and Consequence Evaluations

Colorado has relied on an inspection/standards based program for the past several years to assure the safety of dams. While inspection activities are necessary, and provide a basis for dam inventories, evaluation of hazard classifications, and site conditions at dams, we are still experiencing too many serious incidents and even failures of dams in Colorado. After attending an ASDSO workshop on Risk Assessment in 1999, we decided to explore ways to include risk assessment in our dam safety program as a tool for identifying potential failure modes at existing dams, and to focus our resources at the dams having the greatest risk of failure and significant consequences.

We implemented a pilot project to train our staff and evaluate Failure Modes and Consequence Evaluations (FMCE). We simultaneously began an evaluation of the US Bureau of Reclamation's Risk Based Profiling System (RBPS). It is a an indexing method for ranking dams in accordance with weighted failure modes and consequences. RBPS could be used to create a list of dams to do FMCE on.

FMCE is a subset of risk analysis, but is simplified by qualitatively, rather than quantitatively, estimating the likelihood of adverse consequences from loads on dams, (hydrologic, static, and seismic). It includes a comprehensive review of the engineering data, operation, performance history, and record of design and construction, as well as information related to the consequences of failure and planned emergency procedures, by a team of experts in dam safety. The teams use an "expert elicitation" process to develop an understanding of the most significant failure modes, consequences, and any risk reductions that can be implemented, with respect to a dam. One session has been conducted in Division 1 for the period, with three more planned in Divisions 2, 4, and 5 in the next year. The session in Division 1 was very successful, and the process shows promise for implementation in our program.

Draft modifications have been made by the staff to the RBPS module. Several of the Dam Safety Engineers have ranked their dams using the module, and believe that the results should assist in selecting dams that should receive more attention in our program. We will need to decide if we should hire the Bureau to modify the program for our use.

ASSOCIATION OF STATE DAM SAFETY OFFICIALS

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, presenting papers and serving on task groups and committees. 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. Alan Pearson, Principal Engineer of the Dam Safety Branch, is the state's representative for the Association. Mr. Pearson also is a member of the Peer Review Committee and the Executive Committee for the National Center for Performance of Dams (NPDP). The Peer Review Program provides member states with an opportunity to have their dam safety programs reviewed to ensure that they are accomplishing their objectives, and to receive recommendations for improving their programs. Colorado has taken advantage of this opportunity for a review in 1991. Several of the recommendations have been implemented to date. The NPDP's mission is to be the leading source of information on the operational and structural performance of dams. The Center and the data will provide an important research tool in the improvement of dam safety in the United States. The Branch executed an MOA with the Association for submitting incidents to the National Center for Performance of Dams; agreeing to include the submittal of incident data to the Center on a routine basis.

USE OF APPROPRIATED FUNDS

Dam safety personal service expenditures for the fiscal year 2000-01 were $1,068,117. Total operating and travel expenditures were approximately $25,000.

$65,000 of the National Dam Safety Program Act assistance grant for 2000-01 has been expended to date, for training and purchase of equipment and software. These expenditures were made in accordance with the plan that was submitted to FEMA for improving Colorado's Dam Safety Program.

RECEIPTS GENERATED FOR COSTS OF FILING PLANS

Fees collected by the State Engineer and deposited in the General Fund for dam safety amounted to $45,928 for filing plans and specifications during the period.

ENFORCEMENT ORDERS AND PROCEEDINGS

No enforcement orders on dam safety were issued during the period.

LEGISLATION

No legislation affecting dam safety was enacted during the period.

TABLE 1

DISTRIBUTION OF DAMS BY IRRIGATION DIVISION/CLASS

HAZARD RATING	DIVISION	NONFEDERAL	FEDERAL	TOTAL
Class 1	1	130	14	144
Class 2	1	123	8	131
Class 3	1	425	11	436
Class 4	1	34	9	43
Class 1	2	39	6	45
Class 2	2	50	3	53
Class 3	2	102	11	113
Class 4	2	98	4	102
Class 1	3	9	1	10
Class 2	3	13	0	13
Class 3	3	30	4	34
Class 4	3	15	0	15
Class 1	4	30	10	40
Class 2	4	37	0	37
Class 3	4	148	6	154
Class 4	4	4	3	7
Class 1	5	35	5	40
Class 2	5	37	0	37
Class 3	5	121	10	131
Class 4	5	16	0	16
Class 1	6	12	0	12
Class 2	6	13	1	14
Class 3	6	107	9	116
Class 4	6	11	0	11
Class 1	7	12	4	16
Class 2	7	20	1	21
Class 3	7	40	1	41
Class 4	7	6	0	6
TOTALS		**1717**	**121**	**1838**

Class 1 - Loss of human life is expected in the event of failure of the dam, while the reservoir is at the high water line.

Class 2 - 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 3 - 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 4 - 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.

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APPENDIX A

DAM SAFETY BRANCH

ASSISTANT STATE ENGINEER
ENGINEERING, TECHNOLOGY, AND INVESTIGATIONS

DAM SAFETY PROGRAM

Professional Engineer III

DIVISION ENGINEERS OFFICES

DIVISION 1
4 - Professional Engineer II

DIVISION 2
2 - Professional Engineer II

DIVISION 3-7
Professional Engineer II

DIVISION 4
Professional Engineer II

DIVISION 5
Professional Engineer II

DIVISION 6
Professional Engineer II

DESIGN REVIEW AND CONSTRUCTION INSPECTION UNIT

1 - Professional Engineer II

APPENDIX A

PERSONNEL
DAM SAFETY BRANCH

TITLE	NAME	AREA OF RESPONSIBILITY
	Denver Office	
Professional Engineer III	Alan Pearson	Principal Engineer, Dam Safety Program
Professional Engineer II	Mark Haynes	Design Review/Const. Inspection
	Resident, Division Offices	
Professional Engineer II	Dennis Miller	Dam Safety Engineer, Division 1
Professional Engineer II	Michael Cola	Dam Safety Engineer, Division 1
Professional Engineer II	James Dubler	Dam Safety Engineer, Division 1
Professional Engineer II	Gregory Hammer	Dam Safety Engineer, Division 1
Professional Engineer II	Michael Graber	Dam Safety Engineer, Division 2
Professional Engineer II	Garrett Jackson	Dam Safety Engineer, Division 2[1]
Professional Engineer II	Brett Nordby	Dam Safety Engineer, Divs. 3&7
Professional Engineer II	James Norfleet	Dam Safety Engineer, Division 4
Professional Engineer II	John Blair	Dam Safety Engineer, Division 5
Professional Engineer II	Sally Lewis	Dam Safety Engineer, Division 6[2]

[1] One-half time Field Engineer, one-half time Design Review Engineer
[2] One-half time Field Engineer, one-half time Asst. Division Engineer

APPENDIX B

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

NAME	DAMID	C-NO(1)	DATE	USE
HUGHES	380114	C-335C	07/27/2000	RECREATION
RIST BENSON	040208	C-252D	09/07/2000	IRRIGATION
WOODMOOR LAKE	100311	C-1199C	09/11/2000	POWER
FOOTHILLS	050124	C-66B	09/19/2000	DOMESTIC
WINSLOW RESERVOIR	530137	C-1246X	09/19/2000	IRRIGATION
NEEDLE CREEK	280106	C-0984B	09/22/2000	IRRIGATION
COAL RIDGE WASTE	020118	C-0689A	09/25/2000	IRRIGATION
EAST	075309	C-1299C	09/25/2000	IRRIGATION
FOX ACRES NO.3	030412	C-1443A	09/25/2000	RECREATION
FRUITA #1	420116	LTR.	09/25/2000	DOMESTIC
G.H. AND S. #2	420119	LTR.	09/25/2000	RECREATION
GRANBY #5-11	400307	LTR	10/16/2000	IRRIGATION
LOWER SPRING CREEK	580303	LTR	10/27/2000	BREACH PLAN
FISHER CANON	100121	C-0228A	11/03/2000	IRRIGATION
PANAMA NO.1 - EAST DAM	060206	C1469BX	11/03/2000	IRRIGATION
IDAHO SPRINGS	070111	C1514BX	11/09/2000	DOMESTIC
MONUMENT LAKE	100214	C-0274B	01/11/2001	RECREATION
POOSE CREEK	440202	C-0606C	01/11/2001	RECREATION
LEYDEN	070209	C-0317A	02/05/2001	IRRIGATION
BIJOU NO.2	010115	C-423A	02/14/2001	IRRIGATION
BIG BATTLEMENT	400112	C-519A	03/22/2001	IRRIGATION
INDIAN CREEK	030210	C-0462A	03/28/2001	IRRIGATION
LOUISVILLE NO. 1	060134	C-1699A	04/02/2001	DOMESTIC
ELDER	030131	C-1640A	04/12/2001	IRRIGATION
RYAN GULCH	040211	C-1716B	04/30/2001	IRRIGATION
J.O.HILL	080213	C-1038B	05/07/2001	RECREATION
GROSS	060211	C-569B	05/21/2001	DOMESTIC

[1] Filing system for approved plans (C-569B). Letter at end denotes revisions/additions.

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

NAME	DAMID	C-NO(2)	DATE	USE
EVANS GULCH	110106	C-1796	07/24/2000	DOMESTIC
BLUE LAKE NO.1	600105	C-1805	09/11/2000	POWER
DIAMOND	050315	C-1814	09/28/2000	POWER
ROCKY RIDGE	030316	C-1792	11/03/2000	IRRIGATION
PICKLE JAR RESERVOIR	07____	C-1804	11/03/2000	DOMESTIC
DAVIS NO.1	060111	C-1806	01/11/2001	DOMESTIC
TRUSTEES PUEBLO WW #1	140126	C-1808	02/22/2001	DOMESTIC
SLESINGER	290108	C-1810	05/04/2001	IRRIGATION
VICTOR NO.2	120218	C-1809	06/07/2001	DOMESTIC

[2] Filing system for approved plans (C-1809). Assigned to plans for new dams, and alterations and repairs to existing dams that weren't previously approved.

APPENDIX C

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

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.

		Conditions Observed		
		GOOD	ACCEPTABLE	POOR
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 _____			
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 OUTFALLS 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 NOT OPERATED DURING INSPECTION 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 ☐ (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 _____			

See Guidelines on Back of this Sheet

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

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 ☐ ☐ **FIELD DIMENSIONS SHOWN ON BACK**

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 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.

'86 JTS

OBSERVATION BY WATER COMMISSIONER _____ DATE

APPENDIX 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			

DC185a-85

DAM 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

The State Engineer, by providing this dam safety inspection report, does not assume responsibility for any unsafe condition of the subject dam. The sole responsibility for the safety of this dam rests with the reservoir owner or operator, who should take every step necessary to prevent damage 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
_____ _____

REASON FOR RESTRICTION: _____

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

Engineer's Signature _____ INSPECTED BY

Owner's Signature _____ OWNER/OWNER'S REPRESENTATIVE DATE: ___/___/___

DC-22-2649a-86

pp

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.

APPENDIX E

PROPOSAL FOR EVALUATING EXTREME PRECIPITATION FOR THE MOUNTAINOUS AREAS OF COLORADO

INTRODUCTION

The state engineer's Regulations for Dam Safety and Dam Construction require that spillways for dams be adequate to handle floods based upon Probable Maximum Precipitation (PMP). PMP is the theoretically greatest depth of precipitation for a given duration, that is physically possible over a drainage basin at any specific time of year. This is essentially a no risk standard that is in accord with the national standards for dam safety, and Colorado case law, where failure of a dam could be catastrophic to the public health and welfare.

PROBLEM

The sources of extreme rainfall (PMP)[1] data for the mountainous areas of Colorado are presently the National Weather Service.[2] Recent studies by the US Geological Survey (Jarrett-Costa), reveal a difference in quantity between the level of flooding predicted by the weather service publications, and runoff observations for areas above 7500 feet in Colorado. Also, studies presently being done (December 1993) by the Denver Water Board for their Williams Fork Dam appear to support that the extreme rainfall for this basin is significantly less than predicted by the weather service. Another study, of the Grizzly Creek watershed near Aspen (1992), provided a conservative reduction of about 20 % in the PMP in relation to the weather service.

PROPOSAL

Because of these apparent differences, and the significant cost associated with designing/constructing spillways to handle floods caused by extreme precipitation (EP), the state engineer is proposing that the Colorado Water Conservation Board fund a study of the extreme precipitation problem in the mountainous areas of Colorado.

# of dams affected.	**81 Class I, 69 Class II**	**Total = 150**
# of owners affected.	**81**	
Volume of storage affected.	**3,379,000 Acre Feet**	

According to a thesis by David Chagnon, Colorado State University, Department of Atmospheric Science (1986), the total economic effect of estimating EP magnitude ranges from $10 -$16 Million per inch of change in rainfall, for about 150 dams in the area affected by HMR 55A. (1996 costs at 3% inflation for 10 years are $13.5 - $22 Million per inch of change in rainfall.) A 20% reduction in estimates of about 3 inches (conservative analysis) could result in a total savings of $40 - $60 million dollars (1996 dollars).

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[1]Hydrometeorological Reports No. 55A (June 1988) for areas east of the continental divide; and No. 49 (1984) for areas west of the divide.

[2]US Department of Commerce, National Oceanic and Atmosphere Administration (NOAA)

PLAN

This proposal was developed by a volunteer committee of meteorologists, hydrologists, and engineers from universities, consulting firms, dam owners, and state and federal agencies. The proposal contains the following components, which will be executed in three phases:

Phase I	1.	Data collection (Extreme precipitation data/studies).
	2.	Development of EP Database (Verification)
	3.	Modeling Workshops (Forum for professionals in field to reach consensus on which technology would be applicable for predicting an EP atmosphere in the mountains of Colorado.)
Phase II	4.	Research/Development of "Model/s" for use.
Phase III	5.	Creation of data for isohyetal maps and depth-duration data of EP. Correlation of data with hydrologic records (including paleo-hydrologic.).
	6.	Peer review and endorsement by other agencies.
	7.	Documentation, development of the procedures for use by practitioners.

Phase I is expected to be accomplished in about one-years time. The State Climatologist's Office (SCO) will do the inventory, and develop the EP database. The SCO will also organize and conduct a workshop on modeling of EP at Colorado State University. Additional workshops may be organized for other components. The estimated cost of these Phase I components are $50,000 - $75,000 for the inventory, and $20,000 - $25,000 for the workshops (primarily for reimbursement of travel expenses of participants). Total cost estimate is $70,000 - $100,000.

The research/development component of Phase II is necessary to understand the physical mechanisms of extreme precipitation with elevation, and to develop a modeling program for analyzing/defining extreme precipitation. (The scope of this component is expected to be defined by the workshops.) The time period could be from 3 to 5 years as presently estimated. The cost shall also be defined by the workshops. After the EP analyses and modeling program are developed, the EP data will be produced and correlated with historic records for verification during Phase III. The generated EP data can then be used to develop (after peer review) procedures for use by practitioners. Geographical Information Systems (GIS) technology is available to do this. The time period for this is estimated to be 1 - 2 years. The cost will be defined by the scope of the project and requests for proposals from the industry.

Total estimated time for completion of all phases is 5 to 8 years. The benefits expected from this proposal are:

Significant reduced costs for the design of new dams, and for upgrading spillways at existing dams, to the standards contained in the regulations.

Increased conservation pools in reservoirs.

Increased head available for power generation.

APPENDIX F

Restriction List

FOR DIVISION 1

DAMID	HAZ	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
010104	3	ADAMS & BUNKER #3	6.0 CREST	INADEQUATE FREEBOARD, SEEPAGE	0.0	05/22/1975	C	150
010115	2	BIJOU #2 (DIKE #1) (WEST DAM)	GH 16 FT.	SCARPING OF U/S FACE, NO EMER SPWY, SEEPAGE	16.0	06/01/1993	C	1700
010132	3	J. B. COOKE	3.0 CREST	FREEBOARD	0.0	05/06/1998	R	0
010138	3	DOVER	10.0 FT. CREST	POOR CONDITION	0.0	06/27/1996	I	60
010210	1	EMPIRE (EAST EMBANKMENT)	GH 29 FT.	ABSENCE OF SPILLWAY	29.0	03/07/1985	R	2779
010419	3	D.A.LORD NO 4	2.0 SPILLWAY	INADEQUATE SPILLWAY	0.0	09/19/1980	C	400
010505	2	PROSPECT	GH 35.5.	QUESTIONABLE SLOPE STABILITY	35.5	08/31/1988	C	600
010506	1	RIVERSIDE	GH 33.55 FT.	PREVENT OVERFILLING OF RESERVOIR	33.5	05/09/1984	I	2500
010611	3	BRAMKAMP	9.0 CREST	SCARPING/EROSION OF U/S SLOPE	0.0	12/05/1990	I	320
010612	3	NO NAME 1-1, #1	10 FT. CREST	SCOUR OF D/S SLOPE DUE TO FAILURE OF OUTLET	0.0	11/02/2000	I	100
010709	3	JOLLY JOHN	NO STORAGE	SCOUR HOLE FROM OUTLET	0.0	10/27/2000	I	297
010716	3	HOWARDS LAKE	3.0 FT. SPILLWAY	EROSION OF DAM AND CREST	0.0	06/03/1998	I	50
020109	3	BRIGHT VIEW #1	7.0 CREST	INOP. OUTLET, INADEQUATE FREEBOARD	0.0	09/30/1985	I	17
020113	3	CARLIN	5.0 CREST	NO SPILLWAY	0.0	07/29/1986	C	0
020115	3	LOWER CHURCH LAKE	3.0 FT CREST	INADEQUATE SPILLWAY	0.0	06/22/1999	I	0
020119	3	COLE	NO STORAGE	POOR CONDITION	0.0	06/30/1994	I	95
020123	2	EASTLAKE #1	NO STORAGE	INADEQUATE SPILLWAY, POOR CONDITION	0.0	03/19/1992	I	125
020125	2	EASTLAKE #2	NO STORAGE	POOR CONDITION	0.0	03/19/1992	I	198
020314	3	NORTH STAR	3.0 CREST		0.0	10/17/1991	I	30
020322	2	SIGNAL #1	5.0 CREST	CONCENTRATD SPG AREAS&QUESTNBLE COND OF OUTLET	0.0	06/21/1993	R	60
020325	2	SMITH IRRIGATION	NO STORAGE	PREVENT STORAGE	0.0	09/21/2000	I	264
020327	2	RANKIN RESERVOIR	NO STORAGE	POOR CONDITION	0.0	07/12/1995	I	44
020330	3	TALBOT	5.0 FT.CREST	NO SPILLWAY	0.0	06/05/1997	I	0
020333	3	THOMPSON	5.0 CREST	INADEQUATE FREEBOARD, GENERALLY POOR CONDITION	0.0	10/07/1987	R	30
020411	2	NISSEN NO.2	1.75 SPILLWAY	LACK OF FREEBOARD	0.0	09/11/1995	I	50
020615	3	HAVANA STREET DAM	NO STORAGE	NO SPILLWAY	0.0	06/17/1987	C	0
020634	3	VOGEL POND	3.0 FT. CREST	NO SPILLWAY	0.0	11/04/1996	I	0
030107	1	BLACK HOLLOW DAM	4.2 FT. SPILLWAY	INADEQUATE SPILLWAY	31.0	10/22/1997	I	999
030108	3	BOX ELDER #2	3.0 FT. SPILLWAY	EXCESSIVE SEEPAGE	6.5	08/08/1989	I	49
030122	2	CURTIS LAKE	GH 10 FT.	CREST, SLOPE, EXT. SEEP. AREA BELOW D/S TOE	10.0	07/02/1985	I	397
030128	3	DRY CREEK	GH 11.5 FT.	OUTLET DETERIORATION,SEEPAGE, INAD SW	11.5	01/17/1996	R	150
030131	1	ELDER	2.0 FT. SPILLWAY	SINKHOLES	0.0	04/26/1999	I	500
030138	2	GRAY NO.3	NO STORAGE	SINKHOLE OVER OUTLET	0.0	05/27/1997	I	100
030214	3	LAW, JOHN	3.0 CREST	INADEQUATE SPILLWAY AND FREEBOARD	11.0	06/22/1987	C	45
030220	3	MATTINGLY DAM	2.0 FT. SPILLWAY	EROSION/3-5 FT. SCARP ON U/S FACE	0.0	10/23/1997	I	99
030225	3	MOUNTAIN SUPPLY NO.1	10 FT. CREST	POOR CONDITION	5.0	11/05/1997	I	500
030226	3	MOUNTAIN SUPPLY NO.2	10 FT. CREST	POOR CONDITION	5.0	11/05/1997	I	300

FOR DIVISION 1

030227	3	MOUNTAIN SUPPLY #6	3.0 CREST	NO SPILLWAY	0.0	10/19/2000	C	120
030229	3	MOUNTAIN SUPPLY #8	NO STORAGE	POOR CONDITION	0.0	10/03/1978	I	643
030236	2	NORTH POUDRE # 1	7.0 CREST	SEEP. @ HIGHER STGE. LEVELS/COND. OF UP SLOPE	9.0	10/17/1988	R	365
030301	2	NORTH POUDRE # 4	GH 17 FT.	POOR U/S FACE, GENERAL CONDITION	17.0	04/17/1984	R	562
030509	3	GEIST	5.0 CREST	INADEQUATE SPILLWAY	6.7	06/18/1998	C	58
030512	3	RIST CANYON	3.0 CREST	SEEPAGE, INADEQUATE SPILLWAY	0.0	04/19/1983	I	33
040123	2	FAIRPORT	6.0 SPILLWAY	POOR CONDITION	8.0	06/22/1987	R	30
040208	1	RIST-BENSON		LEAKAGE/RODENT HOLE	9.7	08/02/1999	I	300
040209	2	GEORGE RIST		DILAPIDATED CONDITION, NO SPILLWAY	6.5	06/07/1995	R	300
040211	2	RYAN GULCH		INADEQUATE SPILLWAY, LEAKAGE	27.6	02/12/1997	R	40
040213	2	SOUTH SIDE	8.0 CREST	DAM UNSAFE FOR ORIG. STOR. AMT.	8.0	07/07/1978	I	105
040237	3	WESTERDOLL	8.5 CREST	POOR CONDITION	0.0	03/30/1992	I	9
045234	3	IDE AND STARBIRD #1	3.0 CREST	POOR MN, ERODED U/S FACE, QUES. SPILLWAY	0.0	07/03/1985	I	0
050101	2	AKERS & TARR	7.0 CREST OCT. 1 - APRIL 1	SLIDE ON D/S SLOPE, SPGE. IN AREA OF ABAND OTL	0.0	03/23/1989	R	34
050124	1	FOOTHILLS	GH 41 FT.	SEEPAGE	41.0	05/20/1986	I	450
050132	3	HIGHLAND	3.0 BELOW TOP OF CONCRETE WALL AT OUTLET	NO SPILLWAY	0.0	11/26/1990	R	0
050206	3	KNOTH	NO STORAGE	NEVER COMPLETED DAM	0.0	12/24/1985	I	204
050212	3	LITTLE GEM	10.0 CREST	EROSION ON U/S SLOPE & CRST,TREES ON U/S SLOPE	0.0	10/11/1985	I	60
050230	2	OLIGARCHY NO.1		RODENT HOLES	26.0	05/20/1999	I	500
050301	3	STEELE BROTHERS #1	4.0 SPILLWAY	SAT. EMBKMT.;INOP. O'S.;INAD. FBD.;SPWY.REPAIR	0.0	12/01/1987	I	34
050302	3	STEELE BROTHERS #2	3.0 SPILLWAY	TOTAL REHABILITATION REQUIRED	0.0	11/23/1987	I	14
050304	3	SWEDE	5.0 CREST	EMBANKMENT SEEPAGE & INADEQUATE FREEBOARD	0.0	11/14/1986	I	75
050308	2	UNION	GH 28 FT.	EMERG. SPLWY NOT BUILT TO PLAN	28.0	12/06/1977	I	0
060115	2	ERIE	3.0 CREST	INSUFFICIENT FREEBOARD	12.0	06/02/1986	I	29
060122	4	GREEN LAKE #1	3.0 CREST	SEEPAGE, NO SPILLWAY	0.0	10/12/1984	I	30
060124	4	GREEN LAKE #3	3.0 CREST	LEAKS, INADEQUATE SPILLWAY FREEBOARD	0.0	10/08/1984	I	60
060134	2	LOUISVILLE #1	GH 92 FT.(10/1 - 4/30), GH 94 FT.	EXCESSIVE SEEPAGE	92.0	06/28/1985	I	32
060202	3	MCKAY LAKE	GH 11 FT.	INAD. FREEBOARD, SEEPAGE	11.0	09/11/1995	I	90
060204	3	MESA	NO STORAGE	POOR COND	0.0	06/28/2000	I	100
060208	3	PRINCE NO.1	7.25 CREST	LEAKAGE	4.0	07/07/1994	I	32
060212	3	SECTION 19	4.0 CREST	NO SPILLWAY	0.0	07/24/1984	I	10
060306	3	VARSITY POND	1 FT. SPILLWAY	SEEPAGE/SPILLWAY	0.0	08/31/1999	I	1
060314	3	HODGSON-HARRIS	6.0 CREST	POOR CONDITION	0.0	11/14/1995	I	60
070111	1	IDAHO SPRINGS	9.0 CREST	SEEPAGE, SETTLEMENT & REPAIRS REQD. ON SPWY.	0.0	07/23/1996	R	69
070113	3	LOWER CHINNS		SINKHOLES	110.0	11/24/1999	I	60
070126	2	DEWEY #1	3.0 CREST(NW)	POOR CONDITION	0.0	11/19/1990	I	15
070201	1	KALCEVIC	11.0 CREST	ERODED UPSTREAM SLOPE	0.0	02/10/1983	I	43
070202	3	KELLY	3.0 CREST	NO SPILLWAY,	0.0	12/05/1986	I	30
070209	1	LEYDEN	GH 24 FT./NO REFILL AFTER RELEASE	INADEQUATE SPILLWAY, LOW AREAS IN CREST	24.0	05/04/1998	R	750

FOR DIVISION 1

			FOR IRR.					
075309	1	EAST	1.0 FT. SPILLWAY	SAND BOILS IN SPILLWAY FLOOR	0.0	06/08/1999	I	26
075311	1	SMITH	1.0 SPILLWAY	SEEPAGE	0.0	01/26/2000	R	100
080101	3	ALLIS	15.0 CREST	SLOUGHING, SEEPAGE	0.0	08/25/1992	R	50
080105	3	BAIRD #1	7.0 CREST	SEVERE BEAVER ACTIVITY, PLUGGED OUTLET	0.0	01/08/1990	I	25
080110	4	CANTRILL	NO STORAGE	NO SPILLWAY, INOPERABLE OUTLET	0.0	10/22/1987	I	37
080218	3	LAMBERT	8.0 CREST	COMPLETELY REHABILITATE THE DAM	0.0	07/09/1984	I	50
080306	3	WAKEMAN	NO STORAGE	SPILLWAY EROSION	0.0	10/17/1994	I	110
080321	4	QUICK	NO STORAGE	NO SPILLWAY, INOPERABLE OUTLET	0.0	10/22/1987	I	64
080327	1	SKEEL DAM	2.0 FT. SPILLWAY	POOR CONDITION	0.0	04/02/1997	R	10
080422	3	RAINBOW FALLS #5	9.0 CREST	INADEQUATE SPILLWAY	0.0	09/11/1985	I	25
080424	3	GERLITS	NO STORAGE	DAM PARTIALLY BREACHED DUE TO OVERTOPPING.	0.0	11/13/1984	I	10
090104	1	BERGEN EAST		INADEQUATE SPILLWAY CAPACITY	0.0	05/03/2000	L	0
090115	2	HARRIMAN	GH 19 FT.	EXCESSIVE SEEPAGE	19.0	11/12/1992	R	300
090138	4	HAYSTACK #1	NO STORAGE	SPILLWAY UNDERMINED	0.0	05/08/1987	I	3
090204	1	WILLOW SPRINGS NO.1	1.0 SPILLWAY	EROSION OF US FACE	13.5	09/14/2000	R	10
095223	2	BEERS SISTERS	5.0 CREST	NO SPILLWAY	0.0	01/08/1999	I	0
230102	1	ANTERO	GH 18 FT.	STAB. BERM CONST. & NEW INSTR. MONITORING	18.0	02/04/1986	R	5100
230308	3	MOUNTAIN	4.0 CREST	INSUFFICIENT FREEBOARD, SEEPAGE AT TOE	0.0	11/06/1985	I	3
230310	3	STOCKING POND	NO STORAGE	INADEQUATE SPILLWAY	0.0	06/13/1988	I	10
230311	3	SUN	5.0 CREST	SEEPAGE-RESTRICT O 8' BELOW CREST	0.0	12/31/1984	R	6
230312	3	WIND	5.5 CREST	SATURATED D/S SLOPE	0.0	09/20/1985	C	3
480101	3	JOHNSON	4.0 CREST(3.0 CREST IRR. SEASON)	EROS. ON U/S FACE, IMPROPER FB., SEEP/D/S TOE	0.0	07/18/1994	C	68
640104	1	JULESBURG	GH 24 FT. FOR 90 DAYS, THEN GH 23 FT.	CONDITION OF OUTLET, EXCESSIVE SEEPAGE	24.0	05/02/1995	R	6964
640108	1	PREWITT	GH 26.5 FT.	NO SPWY & EXCESSIVE SEEPAGE	26.5	08/23/1990	I	2531
650121	3	DUCK	4.0 SPILLWAY	NARROW CREST, STEEP SLOPES	0.0	03/23/1987	I	15
650123	3	HANSHAW	5.0 CREST	SEEPAGE, SLIDE	0.0	07/07/1987	I	20

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 1 = 33895 AF TOTAL NUMBER OF DAMS AFFECTED = 102 DAMS

FOR DIVISION 2

DAMID	HAZ	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
100123	3	A. MCCRAY DAM	5.0 FT SPILLWAY	INSTABILITY	0.0	04/13/1998	I	10
100128	1	FOUNTAIN VALLEY NO.2	1.5 FEET SPILLWAY	HYDROLOGIC INADEQUATE SPILLWAY	0.0	06/11/2001	I	345
100131	3	GARDEN OF THE GODS GOLF COURSE	3.0 CREST	NO SPILLWAY	0.0	05/31/1988	I	0
100205	3	KEETON	10.0 FT. SPILLWAY	EROSION OF SPILLWAY, LEAKAGE, PIPING	0.0	08/08/1997	I	10
100214	2	MONUMENT LAKE	3.0 SPILLWAY	UNSAT. SPILLWAY CONDITION	0.0	03/22/2001	C	150
100215	N	MODERN WOODMEN OF AMER.	NO STORAGE	INADEQUATE SPILLWAY, POOR REPAIR	0.0	08/12/1983	R	85
100235	2	PROSPECT LAKE	3.5 CREST	NO SPWY., OTLT OPERABILITY QUESTIONABLE	0.0	05/31/1988	I	0
100309	3	VALLEY NO. 1	15.0 CREST	INOPERABLE OUTLET & BLOCKED SPILLWAY	0.0	12/27/1984	I	50
100311	1	WOODMOOR LAKE		HYDROLOGIC INADEQUACY	0.0	03/22/2001	L	0
100402	2	VALLEY RESERVOIR NO. 2	NO STORAGE	INOPERABLE OUTLET, POOR CONDITION	0.0	07/14/1999	C	185
100402	2	VALLEY NO.2	NO STORAGE	INOPERABLE OUTLET, OBSTRUCTED SPILLWAY	0.0	09/21/2000	I	185
110106	3	EVANS GULCH	3.0 CREST	INSUFFICIENT FREEBOARD	0.0	02/02/1985	R	2
120136	3	PARK CENTER L & W #2	8.8 CREST	SLIDE ON DOWNSTREAM SLOPE	0.0	01/04/1989	R	11
120202	3	PARK CENTER L & W #10	GH 7 FT.	EXTENSIVE CRACKING ON THE CREST	7.0	10/02/1974	I	48
120218	2	VICTOR #2	8.0 CREST	EXTENSIVE CRACKING ALONG EMBANKMENT	23.0	06/11/1984	I	17
150116	3	OCCHIATO NO.1	10 FEET CREST	SLIDE	0.0	09/16/1999	I	3
160108	1	CUCHARAS #5	GH 100 FT.	POOR OVERALL CON. EMBKMT. HISTY. MVMNT.	100.0	07/21/1988	R	33000
160112	1	HORSESHOE LAKE		EXTENSIVE LEAKAGE, PIPING AT OUTLET	0.0	04/06/2000	L	0
160135	4	CLARK #1	8.0 CREST	ERODED UPSTREAM SLOPE	0.0	02/16/1994	R	80
160218	1	MARTIN LAKE	5.0 CREST	NO SPILLWAY	0.0	02/18/1983	I	1200
170118	3	CUDAHY #1	5.0 FT. BELOW DAM CREST	INADEQUATE FREEBOARD AND INOPERABLE OUTLET	0.0	07/15/1985	I	900
170217	3	SWINK #1	5.0 CREST	IN DISREPAIR, ABANDONED	0.0	04/24/1986	I	500
170218	3	SWINK #2	5.0 CREST	IN DISREPAIR, ABANDONED	0.0	04/24/1986	I	600
170219	3	SWINK #5	5.0 CREST	IN DISREPAIR, ABANDONED	0.0	04/24/1986	I	750
170220	3	SWINK #6	5.0 CREST	IN DISREPAIR, ABANDONED	0.0	04/24/1986	I	650
170222	3	TIMPAS #3	10.0 CREST	IN DISREPAIR, ABANDONED	0.0	04/21/1986	I	500
180206	2	APISHIPA DAM	22.0 CREST	SPILLWAY, OUTLET SILTED IN	0.0	02/18/1994	I	260
180207	3	SEVEN LAKES	7.0 CREST	DILAPIDATED CONDITION OF DAM	0.0	05/06/1987	I	1200
190114	3	MODEL	3.0 FT SPILLWAY	POOR COND	0.0	06/28/2000	I	1000
670218	2	NEE-NOSHE		SAND BOILS IN OUTLET CHANNEL	23.5	06/22/1999	R	6392
670236	1	TWO BUTTES	GH 20 FT.	HYDRAULICALLY INADEQUATE SPILWAY	20.0	01/24/1983	I	31465

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 2 = 79598 AF TOTAL NUMBER OF DAMS AFFECTED = 31 DAMS

FOR DIVISION 3

DAMID	H A Z	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
200110	1	CONTINENTAL DAM	GH 64.5	LEAKAGE	64.5	08/01/1995	R	7679
200221	3	WEE RUBY	5.0 CREST	CORRODED OUTLET, INADEQUATE FREEBOARD	0.0	01/18/1991	I	60
210102	1	TERRACE	7.0 SPILLWAY	DETERIORATED SPILLWAY	117.0	07/18/1984	I	2000

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 3 = 9739 AF TOTAL NUMBER OF DAMS AFFECTED = 3 DAMS

FOR DIVISION 4

DAMID	HAZ	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
400103	3	ARCH SLOUGH	DAM WAS ABANDONED,BUT CAN STILL HOLD WATER	POOR CONDITION	0.0	12/12/1985	I	66
400112	2	BIG BATTLEMENT	GH 8 FT.	SINKHOLES ON EMBANKMENT	8.0	09/24/1991	R	750
400135	1	CEDAR MESA	10.0 FT. SPILLWAY	SEEPAGE	24.5	07/14/1999	I	380
400212	3	CYPHER #1	4.0 CREST	INADEQUATE FREEBOARD, OUTLET INOPERABLE	0.0	10/13/1988	I	10
400306	2	GRANBY #12	GH 17 FT.	D/S FACE SLIDE DUE TO SEEPAGE	17.0	10/15/1987	R	0
400307	2	GRANBY #5-11	5.0 SPILLWAY (PROVISIONAL DURING WINTER)	SEEPAGE	18.0	03/01/2001	R	500
400318	1	HOTEL LAKE	5.0 FEET SPILLWAY	SLOPE INSTABILITY, INCREASED SEEPAGE	0.0	09/07/2000	I	200
400330	3	KNOX	FULL STORAGE FROM 4/1 TO 8/15 IF MONITORED	EXCESSIVE SEEPAGE AT TOE AND ON EMBANKMENT	17.0	01/08/1988	R	0
400405	3	LONE STAR #1	30.0 CREST	CRACKS ON CREST, UNAPPROVED PLANS, POOR CONSTR	0.0	07/31/1996	R	0
400411	3	MILITARY PARK		PIPING	10.0	09/07/2000	I	150
400413	2	MONUMENT	10.0 SPILLWAY, FILL/MONITORING PLAN IN PLACE	CRACKS ON DAM AND LEFT ABUTMENT SLIDE	33.5	04/29/1993	I	175
400434	3	PITCAIRN NO.1	5.5 FT. SPILLWAY	BEAVER DENS ON US FACE	0.0	08/02/2000	I	50
400522	3	TODD	10.0 CREST	6' ELEVATION DIFF ALONG CREST WITH NO SPLLWAY	0.0	10/19/1984	I	112
400524	3	TRIO	8.0 SPILLWAY	SLIDE ON DOWNSTREAM SLOPE	14.0	01/11/1989	I	75
400601	3	HARRY WHITE #2	5.0 CREST	POOR OUTLET VALVE,LACK OF FREEBOARD,MAINTENANC	0.0	08/09/1991	I	30
400619	3	LONE STAR #2	10.0 CREST	CONSTRUCTION WITHOUT APPROVED PLANS & SPECS	0.0	06/02/1988	C	0
400705	3	WEBSTER #1	NO STORAGE	POORLY CONSTRUCTED	0.0	05/06/1987	C	15
400707	3	WEBSTER #3	NO STORAGE	POORLY CONSTRUCTED	0.0	05/06/1987	C	15
410201	3	COFFEY RESERVOIR	NO STORAGE	GENERAL POOR CONDITION,CONST. WO/APP. PLANS	0.0	07/21/1988	C	90
410202	3	MOCK #1	9.0 CREST(AFTER 60 DAYS FULL)	BUILT WITHOUT APPROVED PLANS & SEEPAGE	0.0	04/26/1989	R	0
420116	2	FRUITA NO.1	20 FT. CREST	SLIDE ON DOWNSTREAM SLOPE	0.0	08/12/1998	I	100
420119	3	G.H. AND S. #2	NO STORAGE	NARROW CREST, STEEP SLOPES, POOR OUTLET	0.0	08/26/1992	R	29
420120	3	GRAND MESA #1	3.0 CREST	INADEQUATE FREEBOARD	0.0	01/27/1988	R	48
420120	3	GRAND MESA NO.1	8 FT. SPILLWAY	OUTLET WORKS FAILURE	12.0	12/21/2000	I	300
420123	3	GRAND MESA NO.9	3.4 FT SPILLWAY	OUTLET WORKS PROBLEMS	8.0	12/21/2000	I	100
420135	3	REEDER	8.0 CREST	SEEP. ON D/S SURFACE,NUMEROUS LARGE TREES	0.0	08/26/1985	R	96
590113	2	MERIDIAN LAKE PARK #1	2.0 SPILLWAY (PRIN SPWY LOWERED)	SEVERE EROSION OF THE EMERGENCY SPILLWAY	0.0	06/04/1987	I	10
600118	3	PAXTON	2.5 SPILLWAY	SEEPAGE	0.0	08/08/1988	R	100
600126	3	CUSHMAN	6.0 CREST	OUTLET-INOP. SPWY-INAD. EMB. SEEPS	0.0	07/29/1975	I	36
600127	1	PRIEST	3.0 CREST	INSUFFICIENT FREEBOARD	0.0	09/16/1985	I	25

FOR DIVISION 5

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 4 = 3462 AF TOTAL NUMBER OF DAMS AFFECTED = 30 DAMS

FOR DIVISION 5

DAMID	HAZ	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
370116	3	LOWER G.G.	4.0 CREST	INADEQ FRBD., STABILITY OF DOWNSTREAM SLOPE	0.0	12/14/1992	R	6
370205	3	FORIER NO.3	NO STORAGE	ILLEGAL DAM /INADEQUATE SPILLWAY	0.0	11/09/1995	I	2
380207	2	WARREN LAKE NO.3	NO STORAGE	INADEQUATE SPILLWAY	0.0	11/01/1995	I	27
450101	3	BATTLEMENT NO. 2	NO STORAGE	INADEQUATE SPILLWAY	0.0	09/18/1995	I	23
450102	3	BATTLEMENT #1	NO STORAGE	POOR CONDITION OF OUTLET	0.0	10/01/1990	C	70
500113	2	MATHESON	ELEVATION OF SINKHOLES	SINKHOLES	0.0	09/26/2000	I	500
500126	3	MILK CREEK	15.0 CREST (AUG 1 THRU MAY 1)	EXCESSIVE LEAKAGE	0.0	05/10/1991	R	56
510104	3	DALE	ORDER TO BREACH BY 01/15/97	OUTLET DISTRESS, SLOUGHING AT OUTLET	0.0	12/20/1996	R	39
510114	2	LITTLE KING RANCH AKA KING MTN RANCH	10.0 SPILLWAY	EXCESSIVE SEEPAGE	41.0	03/07/1978	C	439
510125	1	SYLVAN	14.0 CREST	SLIDE ON DOWNSTREAM SLOPE	0.0	07/08/1998	R	650
510129	N	ROCK CREEK	NO STORAGE	DAM BREACHED BY OWNER BUT WANTS TO REPAIR	0.0	06/28/1989	C	66
530119	3	KELLY	5.0 CREST	SPILLWAY EROSION	0.0	09/20/1985	C	0
530125	3	NEWTON GULCH	20.0 CREST	EXCESSIVE SEEPAGE THROUGH ABUTMENTS	17.0	07/20/1990	I	465
530129	3	STERNER	RELAX 5/1-8/15, 3.0 SPILLWAY	UNCONTROLLED LEAKAGE	0.0	08/02/1995	R	71
530137	3	WINSLOW		SEEPAGE,UNAPPROVED PLANS	0.0	04/16/2001	L	0
720117	3	CARPENTER RESERVOIR	NO STORAGE	PIPING HOLE	0.0	08/23/1994	I	27
720126	3	CURRIER NO.2	5.0 SPILLWAY	SLIDE ON HILL ABOVE SPILLWAY, BACKCUTTING	0.0	05/24/1995	I	100
720410	3	PALISADE #3	5.0 SPILLWAY	UNSTABLE D/S SLOPE & NARROW CREST	0.0	07/05/1990	I	9

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 5 = 2550 AF TOTAL NUMBER OF DAMS AFFECTED = 18 DAMS

FOR DIVISION 6

DAMID	HAZ	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
430205	3	BAXTER DAM	5.0 FT. SPILLWAY	SEEPAGE, EROSION OF U/S FACE	0.0	11/13/1997	I	30
430212	3	WILSON #3	3.0 SPILLWAY	INOPERABLE OUTLET, INAD SPWY	3.0	09/30/1989	I	10
440106	3	BISKUP	5.0 SPILLWAY	DILAPIDATED CONDITION	0.0	08/19/1987	C	55
440120	3	DRESCHER	8.0 SPILLWAY	SEEPAGE & INSTABILITY	8.0	08/01/1988	R	159
440124	3	ELLGEN #2	NO STORAGE	POOR OUTLET CONDITION	0.0	05/30/1986	I	60
440213	3	FLATTOP	5.0 FT CREST MAIN DAM	BREACHED, BEAVER DAMS, FREEBOARD	0.0	08/02/1999	I	50
470210	2	POLE MOUNTAIN		UPSTREAM SLOPE FAILURE	25.0	07/11/2000	R	100
540103	3	MARTIN CULL	NO STORAGE	U/S SLOPE FAILURE	0.0	10/25/2000	I	250
570114	3	LAKE EMRICH	15.0 CREST	SLIDES ON DOWNSTREAM SLOPE	0.0	08/30/1988	C	330
580118	1	LONG LAKE DAM	NO STORAGE BY MARCH 31, 1996	SLIDES ON DOWNSTREAM SLOPE	0.0	02/05/1996	R	396
580304	2	LOWER SPRING CREEK	5.0 FT SPILLWAY	SEEPAGE, INADEQUATE SPILLWAY,EROSION	0.0	07/14/1999	I	10

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 6 = 1450 AF TOTAL NUMBER OF DAMS AFFECTED = 11 DAMS

FOR DIVISION 7

DAMID	HAZ	DAM NAME	RESTRICTED RESERVOIR LEVEL	REASON FOR RESTRICTION	GAGE HGT	ACTDATE	ACT TYPE	VOLUME LOST
290103	3	HARRIS BROTHERS & BOONE NO.2	NO STORAGE	POOR CONDITION	0.0	07/08/1996	I	206
340101	2	BAUER LAKE #1	3.0 SPILLWAY	SATURATION HIGH ON EMBANKMENT	0.0	08/27/1984	R	144
340106	3	HURST	NO STORAGE	OUTLET FAILURE	0.0	03/29/1999	I	35
340119	3	J.O. SPENCER	NO STORAGE	INOPERABLE OUTLET	0.0	05/08/2000	I	16
340203	1	SUMMIT	NOT TO EXCEED 1.1' BELOW SPILL FOR > 3 WEEKS	EXCESSIVE SEEPAGE	23.6	06/03/1998	R	579
770103	2	SPENCE	NO STORAGE	OUTLET PIPE FAILURE	0.0	06/19/2001	I	441

VOLUME OF STORAGE LOST DUE TO RESTRICTION FOR DIVISION 7 = 1421 AF TOTAL NUMBER OF DAMS AFFECTED = 6 DAMS