



Office of the State Engineer  
Colorado Dam Safety  
Basis and Purpose  
for  
Rules and Regulations for Dam Safety and Dam Construction  
Adopted November 2019

This Statement of Basis and Purpose has been prepared to elaborate upon and clarify the provisions incorporated into revised dam safety and construction Rules to include technical updating, consistency with national dam safety and engineering standards, and clarification of technical requirements for the determination of design standards. Beyond re-structuring the sequence of the rules for efficiency and to avoid redundancy, significant technically driven changes in the rules consisted of incorporating the use of modern meteorological technology based on the CO-NM Regional Extreme Precipitation Study and the incorporation of a more risk-informed approach to inspections and spillway design, and comprehensive evaluation of existing dams.

The specific statutory authority for the Rules are sections 37-87-102 and 37-87-105, C.R.S.; section 37-80-102(1)(k), C.R.S., and section 24-4-103, C.R.S.

**Rule 1. Title.**

These Rules have been referenced by Rules and Regulations for Dam Safety and Dam Construction. The short title is Dam Safety Rules or, as used herein, Rules.

**Rule 2. Authority.**

This rule cites the statutory authority of the State Engineer to promulgate and revise these Rules.

**Rule 3. Scope and Purpose.**

This rule specifically identifies the activities to which these Rules apply and cites the exemptions from the Rules. The overarching purpose of these rules is for the State Engineer to ensure compliance with the statutory requirements associated with dam design, construction, and performance to provide for the public safety and reasonably reduce the potential for the loss of life as a result of dam failure. The Rules also provide for the evaluation of the performance of existing dams.

**Rule 4. Definitions.**

Terms defined in Sections 37-87-102, 37-87-122, and 35-49-103, C.R.S., shall have the identical meanings when used in these Rules. This Rule also defines additional terms used in the Colorado Revised Statutes, the engineering and construction industry, national dam safety agencies, and dam design, construction, maintenance and regulation to ensure that their meanings and usage are clearly understood. The purpose is to clarify and explain the meaning of terms where they are not self-explanatory, technical, administrative, or legal or not commonly used. New definitions were added to define terms used in risk-informed decision making (RIDM) and risk management approaches to dam safety.

**Rule 5. Determination of Safe Storage Level.**

The basis for Rule 5 is Section 37-87-107, C.R.S., which assigns the State Engineer the duty to determine the safe storage level of the reservoirs in the state, as often as he deems necessary, for the purpose of protection of the public.

**Rule 5.1 Authority to Determine Safe Storage Level.**

The purpose of this rule is to allow the State Engineer to carry out his duties under Section 37-87-107, C.R.S, and to specify that the owner of a dam shall be bound by the State Engineer's determination of safe storage level.

**Rule 5.2 Methods to Determine Safe Storage Level.**

**Rule 5.2.1 Safety Inspection.**

The purpose of this rule is to allow the State Engineer to carry out inspections to determine safe storage levels in accordance with Section 37-87-107, C.R.S.

**Rule 5.2.2 Potential Failure Modes Analysis.**

The purpose of this rule is to inform dam owners that dam safety engineers may choose to use the results of a Potential Failure Modes Analysis (PFMA) as a means to set the safe storage level. Previously, only the annual physical inspection, or observed unsafe conditions were utilized. PFMA has recently been recognized by stakeholders within the dam safety industry as a means to detect unobservable latent conditions within a dam. If likelihood is high enough and confidence is strong enough, actions to mitigate latent conditions may be justified. A storage restriction is one such mitigation activity that can be used to allow the conditions to be mitigated so the reservoir is again safe for full storage.

**Rule 5.3 Restriction of Storage.**

The purpose of this rule is to allow the State Engineer to issue restriction orders to enforce his determination of safe storage level in accordance with Section 37-87-107, C.R.S.

**Rule 5.4 Review of Hazard Classification.**

The purpose of this rule is to inform the owner that the State Engineer will review his classifications periodically and will require the dam to meet the requirements of these rules for the present classification. Development often takes place downstream of existing dams, in areas which would be flooded if a failure were to occur. This may require that a dam be reclassified to accurately reflect the effects of its failure in accordance with the definitions of Rule 4.13. By applying the standards of these rules to the new classification, adequate public safety may be maintained. The owner will be given a reasonable amount of time to comply if the new standards are more stringent.

**Rule 6. Design Submittal Requirements.**

The basis for Rule 6 is Section 37-87-105, C.R.S., which states that plans and specifications for a dam must be approved by the State Engineer according to regulations established by the State Engineer. The purpose of this rule is to describe the technical requirements for the design for the construction or enlargement of a dam or reservoir and to provide administrative procedures for the review of the design. The provisions of Rule 6 establish the necessary elements of an application package to ensure adequate information concerning a project is presented for comparison against engineering standards, and to ensure a standardized, durable public record is filed which can be used to update the dams database. Rule 6 provides a standard consistent with the industry for construction drawings/plans to guide construction work.

**Rule 6.1**

This rule establishes the general requirements for a design package submitted for review and approval prior to beginning construction.

**Rule 6.2 Pre Design Meeting.**

This rule addresses an identified problem with communication at the start of dam design projects. Requiring communication at the very beginning of the design process increases the chances for an efficient and timely design, review, and approval and successful construction free from costly and unnecessary missteps or changes in direction.

**Rule 6.3 Application Package.**

This rule sets the requirements for the contents and format of the application materials. These requirements have been updated to comport with current technology.

**Rule 6.3.1 Format.**

This rule establishes consistency and efficiency when using modern technology in a paperless process environment.

**Rule 6.3.2 Content.**

This rule provides a checklist of the documents needed for a successful application package.

**Rule 6.4 Application Form.**

The purpose is the need of the State Engineer to have a summary of information concerning the engineer, owner, and structure which is available for public inquiries, while the remaining project documents are held confidential until approved, to provide a permanent record for the file, and to update the dams database.

**Rule 6.5 Engineer's Qualification Statement and Affidavit.**

This rule addresses an identified problem that resulted in added cost and time to the design review process when unqualified engineers work on dam designs. Establishing an affidavit requirement is intended to discourage unqualified or underqualified engineers from submitting designs or to encourage teaming with qualified engineers and thus reducing the need for extended reviews and expensive rework.

**Rule 6.6 Construction Plans.**

The basis for this rule is Section 37-87-105, C.R.S., and the standard of the industry in that construction drawings/plans are a part of the basic documents used to guide construction work. The purpose of this rule is to provide guidelines and standards for the preparation of plans in sufficient detail to ensure the contractor will understand exactly how the dam is to be built. Additionally, the plans will enable the State Engineer to determine how the dam will be constructed from which a determination may be made concerning the adequacy of the design.

**Rule 6.6.1 Contents.**

The purpose of this rule is to provide information on the plans for inclusion in the State Engineer's filing system and dams database.

**Rule 6.6.1.1**

The seal is required by the Bylaws and Rules of the Board of Licensure Registration for Professional Engineers and Professional Land Surveyors, 4 CCR 730-1.

**Rule 6.6.1.2**

This rule describes required information and content to enable ease of filing documents for use and archival within the state's document management system.

**Rule 6.6.1.3**

This rule requires a list of drawings included in the plans.

**Rule 6.6.1.4**

The purpose of this rule is to establish the requirements to properly title the front or cover sheet of the specifications; to provide standards for the engineer's seal as required by the "Bylaws and Rules of the Board of Licensure Registration for Professional Engineers and Professional Land Surveyors"; to provide the form of the State Engineer's approval statement; and to provide the form of the engineer's certificate of AS-CONSTRUCTED specifications. The AS-CONSTRUCTED statement is necessary for the final filing of the record for future use.

**Rule 6.6.1.5**

This rule describes the physical characteristics of the dam and reservoir to be presented in the construction plans.

**Rule 6.6.1.6**

This rule requires area capacity and stage capacity curves and tables to be provided in a proper format.

**Rule 6.6.1.7**

This rule requires construction plans to identify the vertical and horizontal datum used.

**Rule 6.6.1.8**

This rule requires construction specifications to be shown on specifications documents only to avoid inconsistency between similar information shown on plans and specifications.

**Rule 6.6.2 Format.**

The basis for this rule is section 37-87-105, C.R.S., which requires plans to be filed with the State Engineer. The filing of plans, which has been required since 1925, has served as a valuable resource for the State Engineer to determine the safe storage in existing dams, and as planning information for consulting engineers evaluating the enlargement, modification, or repair of a dam.

**Rule 6.6.2.1**

This rule sets the size requirements of drawings to ensure accurate depiction and interpretation of the design elements.

**Rule 6.6.2.2**

This rule allows for production of legible scaled drawings for the general public use.

**Rule 6.6.2.3**

This rule provides for a space to affix a file number unique to the plans for convenient filing and retrieval.

**Rule 6.6.2.4**

This rule is self-explanatory and allows a user to ensure a set of plans is complete.

**Rule 6.7 Construction Specifications.**

The basis for this rule is Section 37-87-105, C.R.S., and the standard in the dam building industry in that construction specifications are a part of the basic construction documents which define the minimum requirements of quality of material and workmanship of the

construction. The purpose of this rule is to provide guidelines and standards for the preparation of specifications.

**Rule 6.7.1**

The seal is required by the Bylaws and Rules of the Board of Licensure Registration for Professional Engineers and Professional Land Surveyors, 4 CCR 730-1.

**Rule 6.7.2**

The purpose of this rule is to establish the requirements to properly title the cover sheet of the specifications.

**Rule 6.7.3**

This rule provides for consistency of information shown on both the plans and specifications.

**Rule 6.7.4**

The purpose of this rule is to allow easy location of the various parts of the specifications.

**Rule 6.7.5**

This rule provides for a durable record of the construction specifications for immediate and future use and for inclusion in the State Engineer's filing system.

**Rule 6.7.6**

This rule is consistent with Section 37-87-105, C.R.S., which requires approval of plans and specifications by the State Engineer. The purpose is to provide notice to the contractor that material changes require prior written approval of the State Engineer.

**Rule 6.7.6.1**

This rule provides for compliance with Section 37-87-105, C.R.S.

**Rule 6.7.6.2**

This rule provides for compliance with Section 37-87-105, C.R.S.

**Rule 6.7.6.3**

The basis for this rule is the standard in the industry. Adequate plans and specifications define the process and materials required to build a dam. In order to ensure the dam is properly built, there must be adequate monitoring by an experienced engineer. This requirement is the same as the quality of control applied to construction of highways, large buildings, and structures throughout the engineering and construction industry.

**Rule 6.7.7** The purpose of this rule is to outline in general terms the basic elements of a set of specifications.

**Rule 6.7.8**

This rule provides for the exclusion of information not directly associated with the design to enable an efficient and effective design review process.

**Rule 6.8 Design Report.**

The basis for this rule is Section 37-87-105, C.R.S. The information included in the Design Report provides the necessary support for the conclusions reached and presented in the plans and specifications. The presentation of the engineering calculations and assumptions used in

the design will expedite the review process and will reduce the number of questions concerning the design.

#### **Rules 6.8.1 - 6.8.3**

The purpose of these rules is self-explanatory.

#### **Rule 6.8.4 Hazard Classification.**

The purpose of this rule is to ensure that the engineer has properly determined the effects of the dam's failure on downstream property and life and has assigned the appropriate classification for the dam. Also, it describes the need for sufficient and conclusive evidence that the dam is properly classified for the purpose of substantiating the use of lesser design standards than that required of a High Hazard dam.

#### **Rule 6.8.5 Hydrology.**

The purpose of this rule is to ensure the State engineer has the information necessary to review and evaluate the adequacy of the hydrology applicable to the dam.

#### **Rule 6.8.6 Hydraulics.**

The purpose of this rule is to ensure the State engineer has the information necessary to review and evaluate the hydraulics applicable to the dam.

#### **Rule 6.8.7 Geotechnical Design.**

The purpose of this rule is to ensure the State engineer has the information necessary to review and evaluate the geotechnical aspects of the design of the dam.

#### **Rule 6.8.8 Structural Design.**

The purpose of this rule is to ensure the State engineer has the information necessary to review and evaluate the structural aspects of the design of the dam.

#### **Rule 6.8.9 Instrumentation Plan.**

The purpose of this rule is to ensure the State engineer has the information necessary to review and evaluate the adequacy of the instrumentation needed to demonstrate the performance of the dam.

#### **Rule 6.8.10 Mechanical and Electrical Design.**

The purpose of this rule is to ensure the State engineer has the information necessary to review and evaluate the adequacy of the mechanical and electrical facilities needed to operate and monitor the dam.

#### **Rule 6.8.11 River Diversion during Construction.**

The purpose of this rule is to ensure the State engineer has the information necessary for the contractor to adequately protect the dam from extreme rainfall events during construction.

#### **Rule 6.9 Cost Estimate.**

The basis for this rule is Section 37-80-110(1)(e), C.R.S. The purpose of this rule is to ensure the basis of the fee is correct and to compile a record of costs of construction for use by the State Engineer to answer inquiries from other state agencies and the legislature.

**Rule 6.10 Fee.**

The basis for this rule is also Section 37-8-110(1)(e), C.R.S. The rule comports with the statute. The purpose of this rule is to provide this fee requirement within these rules for proper notification to a dam owner.

**Rule 6.11 Design Review Approvals and Limitations.**

The basis for this rule is Section 37-87-105, C.R.S. The purpose for this rule is to provide limitations for the timely resolution of design review comments and for timely dam construction and completion of dams after approval of plans and specifications. The time limitations are necessary to ensure the dam design and construction plans approved are consistent with current industry design and construction standards.

**Rule 6.12 Application and Approval Requirements for Low Hazard and NPH Dams.**

The basis for this rule is Section 37-87-105, C.R.S., which states that plans and specifications for the repair of a dam must first be approved by the State Engineer if such repair would affect the safety of the dam. The purpose of Rules 6.12.1 through 6.12.2.2 is to provide the application and filing requirements for repairs to dams which are of smaller size and of less risk to the loss of life and property damage due to failure. The State Engineer will retain regulatory authority and oversight responsibility, but the majority of the work will be done directly by, or under control of, the owner. The State Engineer will provide technical advice and require quality control by the owner.

**Rule 7 Design Requirements.**

The basis for this rule is Section 37-87-105, C.R.S., and applicable industry dam construction and dam safety standards. The purpose of this rule is to establish minimum standards for design of dams.

**Rule 7.1**

The purpose of this rule is to establish consistent risk profiles for dams in Colorado. Projects that include new dams or those that include alternation, modification, repair or enlargement of existing dams should all be judged against a similar set of risk factors that determine the likelihood of failure and the consequences of failure. Allowing an existing project whose properties result in higher risk or probability of failure based on past design methodologies would result in inconsistent risk. Suitable schedules to address the risk associated with noncompliance of existing project components will be allowed to enable dam owners to complete needed project without excessive economic burdens.

**Rule 7.2 Inflow Design Flood (IDF) for Spillway Sizing.**

The purpose of this rule is to protect against the failure of a dam and reduce the potential for the loss of life due to dam failures as a result of extreme hydro-meteorological events. The application of reasonable standards for the reduction of the potential for the loss of human life is supported by the public, legislature, and industry. If loss of life is expected by failure of a new high hazard dam, the highest standards must be applied. Rule 7.2 is based on the concept of hydrologic hazard, or hazards during an extreme rainfall event. The purpose of this rule is to design spillways for dams based on the risk of failure during a hydrologic event, not on the hazard classification of the dam alone.

**Rule 7.2.1 Prescriptive Method.**

This rule is based on the risk-informed decision making (RIDM) concepts and recognition that there is difference in risk across a given portfolio of high hazard dams. Reasonable

probabilistic standards have been provided to include an accounting of the potential consequences of high hazard dams. If loss of life potential is less than 1, then a lower standard provides the necessary protection level at reduced economic burden. The probabilistic tool recently developed in the CO-NM REPS project allow the risk-based approach to be utilized within the prescriptive framework that is relatively easy for dam engineers to apply.

#### **Rule 7.2.2 Consequence Estimation.**

The basis of loss of life consequence estimates is their tie to the hydrologic hazard and spillway sizing requirements. Loss of life calculations can be conducted by readily available methods produced by agencies such as the U.S. Bureau of Reclamation (USBR). The purpose of the loss of life calculation is to allow the risk-based approach to spillway design.

#### **Rule 7.2.3 Allowable Rainfall Estimates for developing the IDF.**

The purpose of this rule is to describe the allowable rainfall estimates for developing the IDF.

##### **Rule 7.2.3.1**

The purpose of this rule is to allow extreme rainfall (including PMP) estimates to be determined from modern means acceptable to the State Engineer. The state-of-the-practice CO-NM REPS deterministic tools now replace the retired HMR (Hydrometeorological Report) series.

##### **Rule 7.2.3.2**

The purpose of this rule is to utilize the state of the practice probabilistic rainfall estimation tools provided by the state-of-the-practice CO-NM REPS MetPortal Tool. This method is applicable to three levels of hydrologic hazard as shown in Table 7.1.

##### **Rule 7.2.3.3**

The purpose of this rule is to allow a site-specific determination of probable maximum precipitation (SSPMP) for individual dams located in a specific drainage basin.

#### **Rule 7.2.4 Atmospheric Moisture Factor.**

The results of the CO-NM REPS project concluded there is a very high likelihood with strong confidence that Colorado will see an increase in temperature in coming years. The report also establishes the physical relationship of 3.5% moisture increase per degree Fahrenheit of temperature increase. Those scientifically founded conclusions form the basis for Rule 7.2.4. The purpose of the rule is to maintain a high level of public safety by anticipating the climate changes expected in the future. The 50-year period coincides with the useful life of an engineered structure such as a dam.

#### **Rule 7.2.5 Flood Frequency Analysis.**

The basis for this rule is Section 37-87-102, C.R.S., which allows the State Engineer to promulgate rules including factors to be used to predict the frequencies or recurrence interval of floods. The flood frequency analysis methodology provides another basis to protect against the failure of a dam and reduce the potential for the loss of life due to dam failures as a result of an extreme hydro-meteorological event. The application of reasonable standards for the reduction of the potential for the loss of human life is supported by the public, legislature, and industry.



#### **Rule 7.2.6**

The purpose of this rule is to provide the information to be considered by rainfall-runoff modeling.

### **Rule 7.3 Geological and Geotechnical Investigations.**

#### **Rule 7.3.1**

The purpose of this rule is to ensure appropriate expertise when conducting geologic and geotechnical investigations for dams.

#### **Rule 7.3.2 Geological Site Characterization.**

The basis for this rule is found in the standards in the industry which may be found in manuals developed by the US Bureau of Reclamation and the US Army Corps of Engineers and several textbooks prepared by consultants and university professors. The purpose of this rule is to provide sufficient information on the character of the foundation and geological aspects of the dam in order to evaluate the design of the dam. Because loss of life can occur due to the failure of a High Hazard dam, and significant damage can occur from Significant Hazard dams, the threat posed by earthquakes must be evaluated in the design.

#### **Rule 7.3.3 Subsurface Investigation Plans.**

The purpose of this rule is to reduce the potential for damage to existing dams and increase the chances for successful and safe subsurface investigations at dams. The rule is based on methodologies suggested by industry leading agencies such as the US Bureau of Reclamation and US Army Corps of Engineers.

#### **Rule 7.3.4 Subsurface Geotechnical Investigations.**

The basis for this rule is the need to adequately characterize the geologic conditions and collect geotechnical information to aide in the design of a dam or repair or modify the dam.

#### **Rules 7.3.4.1 and 7.3.4.2**

The rule is broken into requirements based on hazard classification with lower requirements for lower hazard classifications. The basis for the different treatment is that lower hazard dams present less of a risk to the loss of life and property damage due to failure.

#### **Rule 7.3.4.3**

The basis for this rule is industry standards. The purpose of this rule is to ensure that adequate information is provided to assess geologic conditions for spillways, outlet works, and appurtenant structures.

#### **Rule 7.3.4.4**

The basis for this rule is that different geologic conditions will have an impact on how underground construction proceeds. The purpose of this rule is to ensure that those different conditions are taken into account, with the assistance of a qualified geologist.

#### **Rule 7.3.4.5**

The purpose of this rule is to ensure that borrow sources are adequate for their uses in dam construction, and that the excavation of borrow sources does not negatively impact dam stability.

#### **Rule 7.3.5 Laboratory Testing.**

The basis for this rule is Section 37-87-105, C.R.S., and the standards in the industry. The purpose is to define the scope required for presenting support for the geotechnical design of a dam. As the consequences of a dam failure become more significant, greater care is required in the investigation and design for High Hazard and Significant Hazard dams. As such, the rule provides different requirements based on the hazard classification or consequences of dam failure.

#### **Rule 7.4 Embankment Dam Design.**

The basis for this rule is section 37-87-105, C.R.S.

##### **Rule 7.4.1 Foundation and Abutment Design.**

The dam foundation and abutment are integral components of the dam and are subjected to similar loading conditions as the dam and thus must be carefully considered in order to design a safe dam. These rules identify potential issues with foundation and abutment materials and provide the detailed evaluation and procedures required for analysis and design including testing and parameters, material considerations, and material compatibility. The rules also indicate the minimum documentation required to demonstrate the adequacy of the design. These requirements are consistent with dam design and construction industry standards.

##### **Rule 7.4.2 Embankment Design Requirements.**

These rules provide minimum standards for the physical configuration of the dam, quality of materials and workmanship to construct the dam, analysis requirements to support the configuration, and requirements for documenting the design of the dam in a design report. The requirements are consistent with dam design and construction industry standards at this time for the reasonable reduction in potential dam failure which could result in the loss of life and property damage.

#### **Rule 7.5 Concrete Dam Design Requirements.**

This rule identifies the requirements for the design documentation and design and construction standards for concrete dams. The requirements are consistent with dam design and construction industry standards. These rules provide specific requirements and standards for arch dams, gravity dams, and roller compacted concrete dams. The design criteria of several federal dam safety agencies are referenced to determine required factors of safety, loading scenarios, and analysis procedures. The requirements are consistent with dam design and construction industry standards at this time for the reasonable reduction in potential dam failure which could result in the loss of life and property damage.

#### **Rule 7.6 Seismic Design Requirements.**

This rule identifies the requirements for the computation of seismic loading scenarios and the analysis of those loads on the stability of the dam. It also identifies scenarios where dam instability due to seismic loading can be considered negligible, thereby eliminating the need for further seismic analysis. The requirements are consistent with dam design and construction industry standards for the reasonable reduction in potential dam failure which could result in the loss of life and property damage.

#### **Rule 7.7 Instrumentation and Monitoring Requirements.**

These rules provide the minimum instrumentation required to monitor the performance of a dam as required by Section 37-87-107, C.R.S., and specify the appropriate level of monitoring of the structural and operational performance of a dam so that potential failure modes are

detected and intervention can be accomplished before they become so advanced as to fail the structure and potentially result in the loss of life.

**Rule 7.7.2.2 Gage Rods.**

The purpose of this rule is to facilitate accurate monitoring of the dam's performance and enforcement of restriction orders. In addition, gage rods are used in the administration of water rights.

**Rule 7.7.2.3 High and Significant Hazard Dams.**

The purpose of this rule is to provide monitoring of High and Significant Hazard dams in order to identify emerging problems, including their specific location. Early detection of dam movement/settlement, changes in seepage patterns, or changes in phreatic level within the dam can indicate developing problems and allow the owner to intervene and take emergency action before the dam fails.

**Rule 7.8 Spillway and Outlet Works Design.**

The purpose of these rules is to provide required design criteria and types of acceptable spillway and outlet configurations consistent with dam design and construction industry standards at this time for the reasonable reduction in potential dam failure which could result in the loss of life and property damage.

**Rule 7.8.1.1**

The purpose of this rule is to set the starting water surface elevation for analysis of spillway adequacy and to allow consideration of starting water surface elevations other than the emergency spillway when situations exist where such consideration is warranted (e.g., dams with service spillways and normally dry flood control dams).

**Rule 7.8.1.2**

The purpose of this rule is to prevent spillway discharges to adjacent basins which could be contrary to water rights administration and to prevent unintended consequences regarding property ownership, including development within spillways which diminishes the required performance of the spillway. This rule is based on past negative, contentious, and difficult to resolve experiences with these situations in Colorado.

**Rule 7.8.1.3**

The purpose of this rule is to help ensure that the spillway structure is not damaged or plugged by debris, thereby reducing capacity and resulting in dam failure.

**Rule 7.8.1.4**

The purpose of this rule is to prevent spillway designs that would be prone to plugging with debris. This is based on experience with pipe spillways plugging and the lower likelihood of plugging provided by open channel spillways.

**Rule 7.8.1.5**

The purpose of this rule is for the design report to include information necessary for the State Engineer's review of the spillway design.

**Rule 7.8.1.6 Overtopping Protection Design.**

The purpose of this rule is to discourage the use of overtopping protection as the primary means of passing the IDF. This is based on experiences of inadequate overtopping designs leading to failure of dams. Overtopping protection may be appropriate for low consequence

dams but would not be allowed for high or significant hazard dams without adequate justification and technical details to support the design.

#### **Rule 7.8.1.6.1**

The purpose of this rule is to prevent designs that include soil cement as a primary defense for overtopping protection. Soil cement does not have the structural capacity to resist overtopping erosive forces and will only be considered on low consequence structures. In those situations, adequate design features would need to be provided for justification.

#### **Rule 7.8.2.1**

The purpose of this rule is to provide for emergency drawdown capability in the event of an incident at a dam that could lead to dam failure and loss of life and property. The basis for this rule is the fact that taking the load off a dam by lowering the reservoir level is the most effective form of intervention during a dam incident or emergency.

#### **Rule 7.8.2.2**

The purpose of this rule is to provide for outlet release capability for the reasons described above for Rule 7.8.2.1 to prevent the situation where the outlet works is connected to a pipeline (typically for water distribution or delivery) and as a result drawdown capability is greatly reduced. The basis for this rule is experience in Colorado where this situation currently exists and is very difficult to rectify either logistically or economically.

#### **Rule 7.8.2.3**

The purpose of this rule is to prevent continuously pressurized outlet pipes which are difficult to inspect and can also lead to high likelihood failure modes. The basis for this rule is case histories of pressurized outlet pipes leading to dam failure and situations where outlet works inspections are delayed or deferred due to access logistics difficulties.

#### **Rule 7.8.2.4**

The purpose of this rule is to ensure reliable outlet works operations over the life of a structure by providing protection of outlet conduits to prevent submerged debris from plugging outlet conduits and reducing outlet release capabilities or capacities. The basis for this rule is case histories and experiences of outlet works operational failures due to unprotected conduit plugging.

#### **Rule 7.8.2.5**

The purpose of this rule is for the design report to include information necessary for the State Engineer's review of the outlet works design.

### **Rule 7.9 Reservoir and Site Requirements.**

This rule provides the necessary reservoir site preparation, ownership and easement requirements, access for emergency response and maintenance, and utility construction standards for the reasonable reduction in potential dam failure which could result in the loss of life and property damage.

#### **Rule 7.9.1**

The purpose of this rule is to prevent excessive floating debris accumulation in a reservoir following construction. The basis for this rule is case histories of floating debris plugging spillways and leading to dam overtopping and failure.

### **Rule 7.9.2**

The purpose of this rule is to provide for access to dams and appurtenant structures for regular inspections, operations and maintenance during normal and emergency situations. The basis for this rule is case histories where intervention of dam emergency and incidents was unsuccessful and led to dam failure because emergency responders could not get the dam or appurtenances to take necessary actions.

### **Rule 7.9.3.1**

The purpose of this rule is to provide for unrestricted access to the dam and appurtenance structures for normal observation, monitoring and maintenance or emergency responses by the dam owner. The basis for this rule is situations in Colorado where access was not provided which lead to unnecessary difficulties in doing required maintenance, construction or emergency operations.

### **Rule 7.9.3.2**

The purpose of this rule is to prevent spillway discharges to adjacent basins which could be contrary to water rights administration and to prevent unintended consequences regarding property ownership, including development within spillways which diminishes the required performance of the spillway. This rule is based on past negative, contentious and difficult to resolve experiences with these situations in Colorado.

### **Rule 7.9.3.3**

The purpose of this rule is to prevent uncontrolled development within the zone between the elevation of normal high waterline of the reservoir and the elevation of reservoir during spillway operations up to and including routing of the IDF. Such development could be negatively impacted by flooding resulting from normal or flood initiated reservoir operations for which the dam is designed. The basis for this rule is Section 37-87-124, C.R.S., and past negative, contentious and difficult to resolve experiences with these situations in Colorado.

### **Rule 7.9.4**

The purpose of this rule is to prevent construction that could result in creating an unintended potential failure mode related to unprotected penetrations through or near the embankment, abutments or foundation. The basis for this rule is case histories of unprotected penetrations or construction leading to dam failure.

## **Rule 8. Construction Requirements.**

The basis for Rule 8 is Section 37-87-105, C.R.S, giving the State Engineer authority to require the material used and the work of construction to be accomplished in accordance with regulations. The requirements for quality control are based upon the hazard classification of the dam. The Rule seeks to balance cost to achieve safety and the risk of failure and its consequences. More stringent requirements are necessary for High Hazard dams than Significant, Low and NPH Hazard dams.

### **Rule 8.1.1 Water Diversion Plan.**

This rule provides the necessary requirements for river and water diversion during construction including the estimation of flow, documentation of the diversion plan, and the supporting engineering required to support the proposed water diversion plan. The requirements are consistent with industry standards to provide a reasonable reduction in potential loss of life and property damage.

### **Rule 8.1.2 Construction Observation Plan.**

The basis for this rule is Section 37-87-105, C.R.S. The purpose for requiring a comprehensive construction observation plan is to ensure that adequate quality control and construction observation, as well as timely inspections by the State Engineer, are provided for dams that have the potential for causing loss of life. The 30 days is necessary in order to allow for time to review the plan and make any revisions to it before the start of construction.

This rule is also based on Section 12-120-201, et seq., C.R.S. The purpose for requiring an engineer to provide the construction observation plan is to protect the public from the construction of hazardous dams by providing a qualified specialist to observe the construction of the dam and ensure that it conforms to the approved plans and specifications. The State Engineer does not have the resources to provide this important function on a full-time basis, but must monitor the performance of the work through checks and review of the engineer's work.

The date of the start of construction is required so that the State Engineer may plan for the administration and inspection of the work. The names and qualifications of the engineer are required to make sure qualified persons are being utilized for the specialized work of dam construction, and the qualifications are a factor in dictating how often, and to what extent, the State Engineer will need to monitor the work. The construction observation schedule is required to ascertain that sufficient inspections will be made to ensure that quality control is provided and to schedule the State Engineer's inspections. The schedule of rock foundation observations by a geologist, or engineering geologist, is required to ascertain that critical aspects of the foundation will be adequately evaluated in regard to the design. A specialist such as a geologist is necessary for High Hazard dams because of the unique features which could affect the safety of the dam (e.g., faults, fractures (and their treatment), and competent rock). The schedule of tests is required to ascertain that an adequate amount of testing will be conducted to ensure the performance of the materials as designed and specified. The materials testing firm is required to ascertain their qualifications and to know who to correspond with.

### **Rule 8.1.3 Pre-Construction Meeting.**

A preconstruction meeting is normally conducted between the engineer and the contractor for major projects. The purpose of this rule is to include the State Engineer in the meeting so that he may ascertain that the work will proceed without delay and problems will be addressed, to establish reporting requirements, and to ensure that the public's safety will not be jeopardized by the water diversion works during flooding. The name of the contractor and its principal employees are needed in order to know who to communicate with if the engineer is not available and are also needed for the record.

## **Rule 8.2 Construction.**

The basis for this rule is Section 37-87-105, C.R.S.

### **Rule 8.2.1 Engineer's Observation.**

The purpose of this rule is to provide sufficient construction observation, to ensure that the work corresponds to the approved plans and specifications, and to discover changed conditions which might jeopardize the safety of the dam as designed.

**Rule 8.2.2 Construction Records.**

The purpose of this rule is to assist in determining when the State Engineer should make construction inspections to evaluate the acceptance of the construction, and to provide a record which can be used to evaluate the future behavior and safe storage level of the dam.

**Rule 8.2.3 Progress Reports.**

The purpose of this rule is for the State Engineer to monitor the progress of the work and schedule inspections. The purpose of the progress reports is to provide a record for future safety inspections of the dam.

**Rule 8.2.4 Notice for Inspection.**

The purpose of this rule is to enable the State Engineer to plan for inspections of critical portions of the construction, which will serve to evaluate the contractor's performance and serve as part of the basis for acceptance of the work.

**Rule 8.2.5 Design Change Order.**

Any significant change in the plans which could affect the safety of the dam must be approved by the State Engineer in order to maintain the validity of the original approval. The State Engineer will review the change orders promptly to not unduly delay the contractor's work.

**Rule 8.2.6 Final Inspection.**

The purpose of this rule is to enable the State Engineer to plan for and make a final inspection of the work before preparing the written acceptance.

**Rule 8.3 Acceptance of Construction.**

The basis for this rule is Section 37-87-105, C.R.S., which states that no work shall be deemed complete until the State Engineer furnishes to the owner a written acceptance of the work.

**Rule 8.3.1 Construction Completion Documents.**

The purpose of this rule is to enable the State Engineer to respond to the written notification of construction completion within the 60-day limit as required by Section 37-87-105, C.R.S. Other purposes are to document the basis for the acceptance and to provide a record for evaluating the future performance of the dam and its safe storage level.

The purpose for requiring the engineer to ascertain the completion of the work is because they are the best qualified to do it. The record must contain this assurance to validate the safe storage level of the dam.

The first filling of a reservoir is the most critical phase of the safety of a dam's performance. Although every effort has been made to ensure the safe design and construction of the dam, unforeseen conditions could exist which could jeopardize the safety of the dam during the initial filling of the reservoir. The purpose of requiring a schedule for the first filling of the reservoir is to control the filling and to monitor the performance of the dam, and to enable the discovery of any problems and remedy them before the dam could fail.

As-constructed plans are required to create an accurate record of the dam's construction and to evaluate future performance and safe storage level, as well to provide a public record for future use.

The construction completion report is required to create a record for evaluation of the future performance of the dam. If problems occur with the dam, these records will be invaluable in the analysis of the problem and may save the large expense of exploration of the cause of the problem.

Location of movement monuments is required to have a basis to determine any possible shifting and/or settlement of the dam.

The dam observation and monitoring plan is required to ensure that the instrumentation is monitored and the data analyzed on a regular basis.

A new or updated Emergency Action Plan is required to ensure the owner has an updated Emergency Action Plan in place prior to putting the dam into service after construction.

#### **Rule 8.3.2 Engineer Review of Monitoring Data.**

Rule 6 contains the requirements for instrumentation for each class of dam. The purpose of Rule 8.3.2 is to ensure that the instrumentation is monitored and the data analyzed by the Engineer for this 5-year period for new and enlarged dams. The data and analysis supplements the safety evaluation of a dam by early detection of movements, stress, or trends which are abnormal in relation to the expected performance of the dam. It is important that the data be analyzed (graphed) and compared with design expectations for new dams and past performance of enlarged dams for detection of trends (expected, normal or abnormal). The history of performance is an important part of the safety evaluation of a dam. This 5-year period is critical for new dams and enlargements to confirm expected performance. The analysis must be sent to the State Engineer for review and filing to enable him to evaluate the safe storage level and maintenance of the record in the dam safety files.

#### **Rule 8.3.3 Temporary Approval.**

The purpose for temporary approval is to maximize the beneficial use of water by allowing temporary storage if a project is substantially complete in the judgment of the State Engineer. Some approvals may also require contingencies for full storage or even partial storage (e.g., controlled filling, monitoring, completion by a certain date) to ensure the safety of the dam. A written request is needed in order to document the basis for the decision of the State Engineer.

#### **Rule 9. Requirements for Removing or Breaching an Existing Dam.**

The basis for this rule is Section 37-87-105, C.R.S., because a breach is considered an alteration to a dam. The purpose of this rule is to require careful breaching of the dam storing water because breaching is a dangerous activity which, if uncontrolled, could cause loss of life and property damage. This rule is also intended to ensure the safe removal of a dam, and that the dam, as breached, will remain stable and not be a future threat to public safety.

#### **Rule 9.1 Breach Plan and Application.**

The purpose of this rule is to set the minimum standards for submittal of a breach plan and application. The basis for the rules is to provide for a well-thought-out and properly permitted release of stored reservoir contents (water and silt). In addition, the rules set out minimum standards to ensure the stability of the final ground surfaces that remain after the breach has been accomplished. The requirements are based on best management practices (BMP) necessary to prevent environmental or economic damages to land or landowners downstream of the breach.



### **Rule 9.1.1**

The purpose of this rule is to ensure downstream land owners are aware of the breaching activities.

### **Rule 9.1.2**

The purpose of this rule is to alert the dam owner of other permits that might be necessary to accomplish the work.

### **Rule 9.1.3**

The propose of this rule is to ensure adequate thought has been given to the actual steps involved in breaching a dam and to avoid unintended short or long term consequences as a result of the dam breach. The basis of the rules is best practices for dam engineering and stream and watershed protection.

### **Rule 9.1.3.6**

The basis for this rule is related to the higher consequences of high and significant hazard dams and the need, therefore, for greater planning efforts and attention to detail in those situations.

## **Rule 10. Construction, Modification, Alteration, Repair, and Breach of Non-jurisdictional Size Dams**

The bases for this rule are Sections 37-87-105, 37-87-107, 37-87-109, and 37-87-125, C.R.S.

### **Rule 10.1 Notice of Construction.**

The basis for Rule 10.1 is Section 37-87-125, C.R.S., which states that any person proposing to construct a reservoir that is non-jurisdictional shall submit notice to the State Engineer prior to beginning any construction. The purpose of requiring the notice to be submitted on a form is to standardize the format of the notice, which facilitates the administration and filing. The purpose for the 45-day notice is to allow the State Engineer time to evaluate the notice and ensure the proposed structure is non-jurisdictional, to assess its effect on public safety downstream of the dam, and to ensure it meets the requirements for administration of water rights. The form is submitted to the Division Engineer because these structures do not typically impact public safety, and the Division Engineer is in the best position to determine whether the proposed structure will affect other water rights.

### **Rule 10.2 Modification or Alteration of Non-Jurisdictional Size Dams.**

The purpose of this rule is to provide minimum standards for the safety of non-jurisdictional dams. These standards may vary based on the hazard classification (consequences of failure) of the structure in question. The basis for the rule is Section 37-87-105, C.R.S., requiring the approval of alterations to a dam by the State Engineer.

### **Rule 10.3 Repair or Breaching of Non-Jurisdictional Dams.**

The purpose of this rule is to provide minimum standards for the repair or breaching of existing non-jurisdictional dams found to be unsafe. The basis for the rule is Section 37-87-105, C.R.S., and Sections 37-87-107, C.R.S. and 37-87-109, C.R.S. "Complaints on the safety of a dam," are the primary ways the State Engineer may learn of unsafe conditions of non-jurisdictional dams.

#### **Rule 10.4 Spillway Requirements.**

The basis for this rule is Section 37-87-105, C.R.S., and standards of other states and dam safety organizations. The purpose of this rule is to establish minimum standards for protection of reservoir dams with the objective of avoiding loss of dams by overtopping as much as possible. The spillways will also prevent the dams from diverting the floodwaters to adjacent property and causing damage. The spillways will also protect against the loss of the dam and loss to the owner.

#### **Rule 10.5 Enlargement of Non-Jurisdictional Size Dams.**

The purpose of this rule is to ensure that design and construction of an enlargement of an existing non-jurisdictional size dam to a jurisdictional-size structure complies with the appropriate sections of the rules.

### **Rule 11. General Maintenance, Ordinary Repairs, and Emergency Actions**

#### **Rule 11.1**

The basis for this rule is Section 37-87-105(1) and (4), C.R.S., which excludes "[g]eneral maintenance, ordinary repairs, or emergency actions not impairing safety" from the requirement of prior approval of plans by the State Engineer. The activities described in this rule are based on the experience of the State Engineer in making the determination of safe storage level for the reservoirs in this state. The purpose of this rule is to allow a distinction to be made by the State Engineer between those actions which are believed to impair the safety of the dam, and those actions that do not impair the safety of the dam and can be done by the owner to improve the condition of the dam without approved plans.

#### **Rule 11.1.1**

The basis for not requiring approved plans for this work is that removal of brush or tall weeds is usually accomplished by repeated cutting, spraying foliage with herbicides, digging or grubbing, cabling, burning, or grinding. Each of these methods has only a surficial effect on the structure-and does not impair the safety of the dam.

#### **Rule 11.1.2**

The basis for not requiring approved plans for this work is that cutting of trees and removal of slash from the dam is usually accomplished with chainsaws or light excavating equipment. In general, this work is expected to have only a surficial effect on the dam and is not expected to impair the safety of the dam.

#### **Rule 11.1.3**

The basis for not requiring approved plans for this work is that rodent control is usually carried out by removing the rodents and then backfilling the rodent holes. In general, this work is carried out by hand tools and has only a surficial effect on the dam. This work is not expected to impair the safety of the dam.

#### **Rule 11.1.4**

The basis for not requiring approved plans for this work is that repair of erosion gullies is usually carried out by first removing vegetation and unsuitable earthen material and then backfilling the affected area with competent material. In general, this work is carried out with hand tools or light excavating equipment and has only a surficial effect on the dam. This work is not expected to impair the safety of the dam.

**Rule 11.1.5**

The basis for not requiring approved plans for this work is that surface grading is usually carried out by use of hand tools or a grader. The effect is usually only surficial and is not expected to impair the safety of the dam.

**Rule 11.1.6**

The basis for not requiring approved plans for this work is that placement of additional riprap and bedding in the case of minor damage usually involves only shallow dressing of the earthen embankment, then placement of additional erosion-resistant materials. This work has only a surficial effect on the dam and is not expected to impair the safety of the dam.

**Rule 11.1.7**

The basis for not requiring approved plans for this work is that painting, caulking, or lubricating of metal structures is usually carried out with hand tools and affects only the exterior surfaces of the part addressed. This work is not expected to impair the safety of the dam.

**Rule 11.1.8**

The basis for not requiring approved plans for this work is that patching or caulking spalled or cracked concrete is appropriate in areas where the concrete has not suffered structural damage. This work is preventative in nature and is usually carried out with hand tools and affects only the surface being treated. This work is not expected to impair the safety of the dam.

**Rule 11.1.9**

The basis for not requiring approved plans for this work is that removing accumulated materials from the outlet conduit or outlet or spillway channel generally involves only removal of materials that are not a part of the structure in order to restore designed hydraulic capacities. This work is not expected to impair the safety of the dam.

**Rule 11.1.10**

The basis for not requiring approved plans for this work is that this patching work is done to restore wearing surfaces and does not involve structurally significant portions of the dam. This work is usually carried out with hand tools and has only a surficial effect and is not expected to impair the safety of the dam.

**Rule 11.1.11**

The basis for not requiring approved plans for this work is that replacement of mechanical parts of the outlet system which will restore the valves and controls to a satisfactory condition usually involves replacement of components that do not affect structural integrity. This work is not expected to impair the safety of the dam.

**Rule 11.1.12**

The basis for not requiring approved plans for this work is that repair or replacement of fences usually requires digging post holes or otherwise providing for the anchoring of the fence posts. This work has only a surficial effect on the dam and is not expected to impair the safety of the dam.

**Rule 11.1.13**

The purpose of this rule is to exclude landscaping, including the planting of trees and large vegetation near the dam, from being considered "general maintenance". The basis for not

allowing these activities is to prevent the potentially detrimental impacts of these activities on dams.

#### **Rule 11.2 Emergency Action.**

The basis for this rule is Section 37-87-105(1) and (4), C.R.S., and the experience of the State Engineer. The purpose of this rule is to differentiate between those emergency actions that do impair the safety of the dam and those emergency actions that do not impair the safety of the dam. This rule identifies those actions that are not expected to impair the safety of the dam and may be taken in emergency situations.

##### **A.**

The basis for not requiring prior approval of the State Engineer is that materials are usually stockpiled near or on the dam in a location where they cannot affect its structural integrity or interfere with operation of the dam. This activity is not expected to impair the safety of the dam.

##### **B.**

The basis for this rule is Sections 37-87-103, 37-87-105, and 37-87-108, C.R.S. The purpose for not requiring prior approval of the State Engineer is that lowering of the water level is required to lessen the hydrostatic pressure acting on all portions of the dam located below the water surface elevation. Generally, this activity is not expected to impair the safety of the dam; however, when large releases are going to be made the Division Engineer, Dam Safety Engineer and Local Emergency Manager shall be notified to allow for proper notifications and emergency response to provide for protection downstream persons in low-lying areas within the floodplain below the dam. There have been cases in Colorado where releases well within the operating capacity of the dam have caused dangerous conditions below the dam. .

##### **C.**

The basis for not requiring prior approval of the State Engineer is that armoring eroded areas can prevent further damage to the affected areas, without adversely affecting the dam's integrity.

##### **D.**

The basis for not requiring prior approval of the State Engineer is that plugging leakage entrances usually involves replacing eroded material, or adding material at the upstream surface of the dam. This activity is not expected to impair the safety of the dam since it reduces the erosion causing flows through the dam.

##### **E.**

The basis for not requiring prior approval of the State Engineer is that placing sandbags or temporary earthfill on the crest of the dam or on spillway walls in order to restore freeboard and prevent an overtopping failure is not expected to impair the safety of the dam because the additional loading placed on the structure will have no significant effect on structural stability.

##### **F.**

The basis for not requiring prior approval of the State Engineer is that diverting water away from the reservoir basin does not directly affect the dam structure.

**G.**

The basis for not requiring prior approval of the State Engineer is that training berms constructed to control flood waters are usually adjacent to, not built on, the dam, and may abut against the structure. Construction of these berms is not expected to impair the safety of the dam.

**H.**

The basis for not requiring prior approval of the State Engineer is that the placing of ring dikes does not impose any additional stress on the dam. These ring dikes can regulate piping flows and reduce erosion in order to prevent failure of the dam.

**I.**

The basis for not requiring prior approval of the State Engineer is that removing accumulated materials from the outlet conduit or outlet and spillway channel generally involves only removal of materials that are not a part of the structure in order to restore designed hydraulic capacities to increase outflows in order to prevent failure of the dam.

**Rule 11.3 Emergency Excavation.**

The purpose of this rule is to avoid the catastrophic consequences of a dam failure. In the instance when failure is imminent and the water level cannot be lowered by any other means, it is reasonable to allow persons attempting to save the dam to lower the spillway or create a controlled breach because failure through the spillway or controlled breach is not expected to create as large a flood as failure of the dam.

**Rule 11.4 Emergency Notification.**

The purpose for this rule is so that the State Engineer can determine if everything is being done to create as safe of a situation as possible and provide the subsequent notification to emergency response teams.

**Rule 11.5 Emergency Action Plan.**

The basis for this rule is the standard of the dam safety and emergency response communities. The purpose for requiring emergency action plans is to lessen loss of life and property damage in the event of a dam failure. Emergency action plans are required for dams whose failure is expected to cause loss of life or significant property damage. The plan must be implemented in emergency situations in order to reduce the likelihood of a dam failure and lessen the potential for loss of life and property damage.

**Rule 12. Safety Inspections Performed by the Owner's Engineer**

The basis for Rule 12 is Section 37-87-107, C.R.S., which requires the State Engineer to determine the safe storage level for dams in the state. Although the State Engineer's staff will normally conduct the safety inspections necessary to make this determination, there may be instances where the dam owner wishes to hire his own engineer for that purpose. This rule specifies requirements which must be met before the State Engineer will accept the inspection performed by the owner's engineer as a replacement for an inspection which would have otherwise been conducted by members of the State Engineer's staff. (Note: These formal engineering inspections should not be confused with the informal observations carried out by the owner or his caretaker under Rule 13.4.)

**Rule 12.1 Owner Safety Inspection.**

The purpose of this rule is to establish owner engineer qualification requirements, set the expectation for uses of owner provided inspection reports, and establish notification protocols when owners intend to utilize their own engineers for inspections.

**Rule 12.2 Scope of Inspection.**

The purpose of this rule is to provide the owner's engineer with information necessary to allow the State Engineer to utilize the inspection report provided by the owner's engineer to make the determination of the safe storage level of the reservoir. The procedures of this Rule are followed by field engineers on the State Engineer's staff.

**Rule 12.3 State Engineer Acceptance.**

The purpose of this rule is to provide the dam owner with a notice of acceptance of the inspection conducted by the owner's engineer and to notify the owner of required actions and the determined safe storage level.

**Rule 13. Owner's Responsibilities.**

**Rule 13.1 Liability.**

The basis for this rule is Sections 37-87-104 and 37-87-107, C.R.S., which specify that the owner (which, under Section 37-87-104.5, C.R.S., and as defined under Rule 4.21, includes persons in control of the dam) may be liable for personal injury or property damage resulting from the failure or partial failure of the dam if caused by the owner's negligence and that it is unlawful for the owner to store water in excess of the safe storage level set by the State Engineer. The purpose of this rule is to inform dam owners of the responsibilities and liabilities of dam ownership.

**Rule 13.2 Change in Ownership.**

The basis for this rule is Section 37-87-104.5, C.R.S., which requires notification of changes in dam ownership. The purpose is for the State Engineer to have an up-to-date list of dam owners across the state.

**Rule 13.3 Site Security.**

The basis for this rule is that dams can be intentionally misoperated or damaged to cause harm to the public. The purpose of the rule is to prevent intentional misoperation or damage by requiring dam owners to maintain reasonable security measures.

**Rule 13.4 Dam Observation and Monitoring Plans.**

The basis for this rule is the standard of practice for dam owners to regularly observe their dams and to utilize instrumentation and observations therefrom. The purpose of this rule is to require owners to develop a site specific plan for regular observations and instrumentation readings and to regularly assess of the condition and performance of their dams. This type of regular program will enable early detection of progressive problems so as to make corrective actions to ensure public safety. Monitoring data collected is also essential when evaluating dam performance during comprehensive dam safety evaluations and potential failure modes analysis.

**Rule 13.4.1 Owner Observations.**

The purpose of this rule is to ensure frequent, informal observations of dams based on their risk (hazard classification) so that serious developing problems can be quickly detected.

These informal observations are intended to provide a cost effective way to identify serious safety problems, and allow emergency corrective action, before the dam fails.

The required frequency of owner observations is based upon the State Engineer's experience concerning how rapidly serious problems can develop, and upon the consequences of failure of the dam. The requirement to observe High Hazard and Significant Hazard dams twice a month when the reservoir level is greater than half the full storage capacity is reasonable when the devastating consequences of failure for these structures are considered. The required frequency of owner observations of Low Hazard dams is only once every three months, since the consequences of failure of these dams is not as severe.

The State Engineer's "Dam Safety Manual", 2002, and other resources provided by agencies such as FEMA and the Association of State Dam Safety official (ASDSO) describe inspection methods and provide many and varied resources to assist the dam owner in identifying safety problems.

#### **Rule 13.4.2 Monitoring Instrumentation.**

The basis for this rule is Section 37-87-107, C.R.S., which requires the State Engineer to determine the safe storage level of a reservoir. Appropriate instrumentation is judged to be the most cost effective for the early detection of serious problems which could lead to the failure of the dam.

Monuments to allow monitoring of horizontal and vertical movement are also required on dams which would be expected to cause loss of life if they were to fail (High Hazard). By surveying the monuments, it is possible to detect subtle movements and to then take action to avoid full failure of the dam. Dams with the greatest potential for causing serious damage or loss of life must be monitored more closely. In view of the disastrous effect of the failure of a High Hazard dam, this minimum instrumentation is reasonable and warranted.

#### **Rule 13.5 Outlet Inspections.**

The basis for this rule is that outlet works, including outlet valves and conduits, are key safety features and also key risk factors at any dam. The purpose of the rule is to ensure dam owners maintain their outlet works in operational conditions so water administration and emergency releases can be made. The rule sets timelines and expectations for inspections based on the risk of a given dam (by hazard classification) and includes a notice requirement to seize opportunities for inspections when reservoirs are drained.

#### **Rule 13.6 Responsibility for Maintenance.**

The purpose of this rule is to ensure that minor deterioration does not develop into serious problems which threaten the safety of the dam. As a practical matter, it is usually more cost effective in the long run for the dam owner to keep his structure in good repair. Routine maintenance and minor repairs can usually be done by the dam owner or his representative at low cost using equipment and materials on hand. However, repair of problems which have been allowed to become serious enough to threaten the safety of the dam will require an engineering design approved by the State Engineer.

#### **Rule 13.7 Emergency Preparedness.**

The purpose of emergency preparedness activities is to reduce the consequences of dam failures and outlet works and spillway releases.

#### **Rule 13.7.1 Emergency Action Plans (EAP).**

The basis for this rule is the standard of the dam safety and emergency response industry and continued collaborative work with state and local emergency managers in Colorado. The purpose of this rule is for High and Significant hazard dams to have current EAPs. Low and NPH dams are not required to have EAPs. This rule contains the key elements of EAPs, which are common to dam safety and emergency management organizations in the country and state of Colorado. An EAP template is provided to dam owners at no cost, in a format readily accessible to dam owners. The Colorado EAP template has been reviewed by state and local emergency managers in Colorado and comments have been used to develop a template that meets their needs.

Inundation mapping is also a key element of an EAP and is the basis for evacuation planning in dam emergencies. Colorado uses FEMA and CWCB funding to assist dam owners with development and updating inundation mapping.

#### **Rule 13.7.2 Termination.**

This rule is based on the industry standard process of providing positive termination of an EAP activation. The purpose is to notify all members of the emergency response team that the emergency is over and they can stand down.

#### **Rule 13.7.3 EAP Distribution.**

The basis for this rule is the standard of practice in the dam safety and emergency response communities. The purpose is to ensure distribution of EAPs to those who have roles and responsibilities in a dam safety emergency.

#### **Rule 13.7.4 EAP Updates.**

The basis for this rule is the standard of practice in the dam safety and emergency response communities. The purpose of the rule is to keep the plans current so they are valid and useable when an emergency occurs, which can be at any time during the life of the dam, and to ensure the updated EAPs are provided to those who have roles and responsibilities in a dam safety emergency.

#### **Rule 13.7.5 EAP Testing.**

The basis for this rule is the standard of practice in the dam safety and emergency response communities. The purpose is to require regular testing of EAPs through phone drills, EAP orientations, and tabletop and functional exercises in order to ensure the EAP will be effective in an emergency and that lessons learned during the exercises can be applied in an emergency.

### **Rule 14 Exempt Structures**

The basis for this rule is Section 37-87-114.5, C.R.S., which exempts certain structures from the provisions of Section 37-87-105 through Section 37-87-114, C.R.S., and Sections 35-49-101, et seq., and 37-87-122, C.R.S.

#### **14.1 Exempt Structures.**

The rule is consistent with the applicable statute and is repeated here to add clarification but to also avoid undo conflicts between the rules and statutes.

#### **14.2 Livestock Water Tanks.**

The rule is consistent with Section 35-49-104, C.R.S., which exempts Livestock Water Tanks from the provisions of Section 37-87-101 through 108 and 114 through 115, C.R.S.



### **14.3 Erosion Control Dams.**

The Rule is consistent with Section 37-87-122, C.R.S., which exempts Erosion Control Dams from the provisions of Sections 37-87-101 through 108, C.R.S.

### **14.4**

In some situations, multiple agencies have regulatory responsibilities over the same structure. The purpose of this rule is to recognize that such situations may exist and to avoid redundancy of efforts.

### **Rule 15. Restriction of Recreational Facilities within Reservoirs.**

The basis for this rule is Section 37-87-124, C.R.S. The rule is consistent with the statute. The purpose is to prevent the construction of recreational facilities within reservoirs that would sustain significant damage during operation of the reservoir. Boat rams, docks, and marinas are excluded from the notice and approval requirements, as they typically meet the requirements of Rule 15.1, and thus do not require further review by the State Engineer.

### **Rule 16. Waiver or Delay of Enforcement of Rules by the State Engineer.**

The purpose of this rule is to recognize that under the facts of any particular case, a strict and literal application of these rules may work an unreasonable hardship on the dam owner or unreasonably interfere with the beneficial use of water without significantly affecting dam safety. In such situations, the State Engineer should be able to prevent such unreasonable hardships and limitations on beneficial use of water.

### **Rule 17. Appeal of Requirements or Approval.**

The basis for this rule is rule 10(4)(c) of the Division of Water Resources Procedural Regulations, 2 CCR 402-5. The purpose is to give a person directly impacted by a decision of the State Engineer a method of recourse.

### **Rule 18. Rules by Reference**

The basis for this rule is section 24-4-103(12.5), C.R.S.

### **Rules 19 through 22 Severability, Revision, Statement of Basis and Purpose Incorporated by Reference, and Effective Date.**

The basis and purpose for these rules are self-explanatory.