E.38. Puerto Rico
Law Núm. 207 of year 2002

of C. 2483), 2002, law 207

In order to amend Arts. 4 and 8 of the Law Núm. 133 of 1986: Committee of Supervision and Evaluation of the State Program of Inspection and Regulation of Prey and Dams

LAW NUM. 207 OF 28 OF AUGUST OF 2002

In order to amend Articles 4 and 8 of the Law Núm. 133 of 15 of 1986 July, in order to arrange that the Committee of Supervision and Evaluation of the State Program of Inspection and Regulation of Prey and Dams can be integrated by representatives of the respective agencies, to those who the faculty has been delegated him to act to name of the respective agencies, and to establish a new way to calculate the contribution that corresponds to pay to the Authority of Electrical Energy each organization or person to him owner of a dam or prey, and to other aims.

EXHIBITION OF REASONS

In Puerto Rico several prey and dams with multiple uses exist to give service to the citizenship. Some of these uses consist of the energy generation, irrigation of the agricultural fields, aqueducts, conservation, recreation, fishes and control of floods. The government of the Associated Free State of Puerto Rico, never has scrimped before his responsibility to adopt those measures that he considers necessary or pertinent to protect the life and the security of the citizens, especially, that one that is related to the storage of the water which we consumed.

The State Program of Inspection and Regulation of Prey and Dams was created by means of the Law Núm. 133 of 15 of 1986 July, in order to maintain, to conserve, to inspect and to guard by the security of the prey and dams in Puerto Rico. According to Article 2 of the Law Núm. 133, supra, the program before mentioned is administered by the Authority of Electrical Energy through the Unit of Inspection and Regulation for the Security of Prey and Dams.

Article 4 of the Law Núm. 133, supra, have the constitution a Committee to the supervision and evaluation of the mentioned Program, which is integrated by the President of the Meeting of Planning, the Executive Director of the Authority of Electrical Energy, the Director of Operations of the Authority of Aqueducts and Sewage systems, the Secretary of the Department of Natural and Environmental Resources and three citizens in representation of the public interest, named by the Governor. It is of general knowledge, that these officials government count on agendas of work extremely loaded. However, this Law nothing arranged to authorize these civil servants to delegate its responsibilities in representatives specifically designated by them to such effects. It brings, consequence, delay in the works of the Committee when, for some reason, three (3) of the civil servants to those who it was designated to them to comprise of the same, cannot attend the meetings properly summoned by the Committee.

In addition, according to Article 8 of the mentioned Law, the created unit is authorized to invoice
to name of the Authority, proportionally, to each agency, person or organization following the number of dams or dams that it owns, independent of the size, the capacity or the structural complexity and the maintenance that the wall requires that dams the water of the same.

The effect of the application of the established formula is unjust. Some prey and dams have needed very little effort and services of the Unit, whereas others have required that the Authority carries out extraordinary inspection and carries out expensive works, complex and continuous in relation to the same. The Legislative Assembly of Puerto Rico understands that it is not reasonable that those facilities that most of receive the services or whose walls of dam are in worse S-state are subsidized by the owners of prey and dams that require minor attention and effort or whose walls are in good state. For example, Represa de Carraízo, that has a capacity of dam of 23,500 acre-feet, has needed extraordinary and complex works, besides a continuous service. Their costs of inspection and maintenance as well as those of conservation of their walls exceed those all the other dams and dams in Puerto Rico, are public and private. He is not reasonable that the costs of operation of the Unit are divided in equal proportion between all the prey and dams, when we considered situations as the one of Represa Carraízo and we compared with Represa the Bronze, that inspects once every three years and has a dam of only 843 acre-feet.

Given the situation that we have indicated, the Government of the Free State Associated of Puerto Rico esteem that this Law, is necessary so that the distribution of expenses between the owners of the prey and dams, is more equitable and suitable, considering, among others factors, the size, material, the age and the conditions in which is the wall that dams the water. In addition, it turns out own to arrange that the civil servants appointed by law to form the Committee for the supervision and evaluation of the State Program of Inspection and Regulation of Prey and Dams, can delegate their responsibilities in representatives specifically designated to act to their name.

**IT WOULD DECREE BY THE LEGISLATIVE ASSEMBLY OF PUERTO RICO:**
Section 1. - Article 4 of the Law N úm reforms. 133 of 15 of 1986 July, so that it reads as it follows:

“Article 4. -

One forms a Committee for the supervision and evaluation of the Program, which will be integrated by the President of the Meeting of Planning, the Executive Director of the Authority of Electrical Energy, the Director of Operations of the Authority of Aqueducts and Sewage systems, the Secretary of the Department of Natural and Environmental Resources or his respective representatives in those who the faculty has been delegated to act to name of these, and three (3) citizens in representation of the public interest named by the Governor of the Associated Free State of Puerto Rico. The Executive Director of the Authority of Electrical Energy or his authorized representative to act in his name will be the President of the Committee. The first three (3) representing members of the public interest will be named one (1) by three (3) years and two (2) by four (4) years. When expiring the term of each, the subsequent appointments will become all by a term of four (4) years and until their successors are appointed and take possession from the position. In case of happening a vacancy between the members of the Committee in representation of the public interest, the Governor of the Associated Free State of Puerto Rico will send a new appointment by the term nonfulfilled del that caused the vacancy.

Five (5) members of the Committee will constitute quorum.”

Section 2. - Article 6 of the Law N úm reformed. 133 of 15 of 1986 July, so that it reads as it follows:

“Article 6. -

When the Unit determines that a prey or dams of an agency or public instrumentality offers danger to the life and property of the citizens of the area in which it is, therefore it will notify the Executive Director of the Authority of Electrical Energy. The Director, as well, will notify the Committee, that in consultation with the Office of Management and Budget and the head or director of the agency or instrumentality owner of the prey or dam will adopt a plan of measures to take, with specification of the necessary bottoms, if some, to carry out them. The Unit will establish the term that will have the organization to correct the indicated deficiencies, of not correcting itself, within the ruled time, the Executive Director of the Authority of Electrical Energy will notify the Secretary of Justice of the breach, for its evaluation and later proceeding according to the Law. The Committee will notify in writing to the Governing one on the situation.”

Section 3. - Article 8 of the Law N úm reformed. 133 of 15 of 1986 July, so that it reads as it follows:

“Article 8. -

Annually, the Unit, with the approval of the Committee, will invoice to each public agency, person or private organization that own a prey or a participant dam in the Program, the cost incurred across the Program during every year and the received thing will collect to him to the Authority of Electrical Energy.

The Committee will promulgate a regulation to establish the duties and the obligations of
the possessors of prey and dams that its conservation guarantees, and to determine the 
way in that the contribution will calculate that corresponds to each public agency, person or 
deprived organization, taking as it bases the costs incurred across the Program and the size, 
material, age and conditions in which is the wall of retention in each one of the prey and dams 
that receive the services that the Unit offers."

Section 4. - This Law will begin to prevail immediately after its approval.

Important note: This law is copy of the original law when it was approved, does not include later amendments to this.

It presses Here to return to the previous Menu and to select another law.

WARNING

This document constitutes a document of the laws of the Associated Free State of P.R 
that is subject to the changes and corrections of the process of compilation and 
official publication of the laws of Puerto Rico. Its electronic distribution becomes like 
a public service the community. It always looks for later laws for possible 
amendments this law.

LexJuris of Puerto Rico always is under construction.
**Purpose** - The Program's purpose is to provide for a safe design, construction, operation and maintenance of the dams to protect public safety.


**Puerto Rico Dam**

¿**Which dams are subject to the law?** All dams in Puerto Rico are subject to the Dam Safety Act.

"Any artificial barrier, including appurtenant works, which impounds or diverts water, and which:
1) Is 25’ or more in height from the natural bed of the watercourse, measured at the downstream toe, or

2) Has an impounding capacity at the maximum water storage elevation of 50 acre-feet or more.”

**National Inventory of Dams**  
**Dams Under State Regulation**

<table>
<thead>
<tr>
<th>National Inventory of Dams</th>
<th>Dams Under State Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

The height of a dam is defined as the vertical distance from the streambed at the downstream toe to the top of the dam.

The capacity of a dam is defined as the volume capable of being impounded at the top of the dam.

**Hazard Classification of Dams** - Dams are classified with a hazard potential depending upon the downstream losses anticipated in event of failure. Hazard potential is not related to the structural integrity of a dam but strictly to the potential for adverse downstream effects if the dam were to fail.

<table>
<thead>
<tr>
<th>Hazard Classification</th>
<th>Property Damage</th>
<th>Potential Loss of Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>Minimal</td>
<td>None</td>
</tr>
<tr>
<td>SIGNIFICANT</td>
<td>Appreciable</td>
<td>Unlikely</td>
</tr>
<tr>
<td>HIGH</td>
<td>Excessive</td>
<td>Likely</td>
</tr>
</tbody>
</table>

Dams are classified by the hazard they represent to downstream life and property, if they were to fail. The classification does not indicate the state of disrepair or the likelihood of failure.
E.39. Rhode Island
AUTHORITY: These regulations are adopted pursuant to Chapters 42-17.1, 42-17.6, 42-35, and 46-19 of the Rhode Island General Laws of 1956, as amended.
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RULE 1. PURPOSE
The purpose of these Rules and Regulations is to implement the provisions of Chapter 46-19, “Inspection of Dams and Reservoirs” of Rhode Island General Laws (R.I. Gen. Laws) of 1956, as amended and to provide for the safety of dams to protect the public, real property and natural resources by establishing reasonable standards and to create a public record for reviewing the performance of dams.

RULE 2. AUTHORITY

RULE 3. ADMINISTRATIVE FINDINGS
The following administrative findings are made as a basis for these Rules and Regulations:

(A) Rhode Island has approximately 674 dams of varying age, size and state of repair;

(B) Failure or misoperation of high hazard dams or significant hazard dams (both of which represent approximately 30 percent of all dams in the state) will result in a probable loss of human life or cause major economic loss, disruption of lifeline facilities or impact other concerns;

(C) Investigations of dam failures have found that approximately 60 percent were caused by lack of maintenance, resulting in piping, surface erosion, slope protection damage or deterioration of outlet pipes;

(D) Many of these dams, both public and private, have not been properly maintained through the years and pose a significant threat to public safety, real property and natural resources;

(E) Since dam related laws were adopted, the threat to public safety, real property and natural resources has increased due to deterioration of dams and development in downstream areas over which dam owners do not necessarily have control.

(F) It is in the best interest of the state, the cities and towns of the state, and the citizen's thereof, to maintain a safe dam infrastructure; and

(G) In order to maintain a safe dam infrastructure, a collaborative effort is required by state and municipal officials, private dam owners and elected officials.
RULE 4. RESPONSIBILITY OF DAM OWNERS

(A) All owners of high hazard dams and significant hazard dams shall keep their dams and appurtenant works in a safe condition.

(B) All owners or precedent owners are responsible for liability for damage to property of others or injury to persons, including but not limited to loss of life, resulting by the following of the pond raised by the dam, by the stopping or raising of the water either above or below the dam, by the backing of water or by the flowing out of any fall of water by means of the dam.

(C) These regulations shall not be interpreted as relieving any owner or person maintaining or having control of a dam from responsibility, or lessening such responsibility, for any damages to persons or property caused by defects, inappropriate operation or inadequate maintenance or as creating liability on the part of the Department or the Director.

(D) Compliance with these Rules and Regulations does not relieve an owner or person maintaining or having control of a dam of any obligation to comply with any other applicable laws or regulations administered by, through or for the Department or any other government entity.

RULE 5. APPLICATION

(A) The terms and provisions of these Rules and Regulations shall be liberally construed to permit the Department to effectuate the purposes of state law, goals and policies.

(B) Nothing in these Rules and Regulations shall be deemed to prohibit a dam owner or person maintaining or having control of a dam, from seeking assistance from a municipality or prohibit a municipality from assisting a dam owner in complying with these Rules and Regulations.

RULE 6. DEFINITIONS

For the purposes of these Rules and Regulations, the following terms shall have the following meanings:

(A) “Appurtenant works” means any ancillary feature of a dam including such structures as dikes, training walls, spillways, either in the dam or separate there from, low level outlet works, and water conduits such as tunnels, channels, pipelines or penstocks, either through the dam or its abutments.

(B) “Dam” means any barrier made by humans, including appurtenant works, that impounds or diverts water.

(C) “Department” means the Department of Environmental Management and may be used interchangeably with Director.

(D) “Department dam engineer” means an individual employed by the Department who possesses a Bachelor of Science degree in engineering and has demonstrated, through a combination of education, experience, and/or training, that he/she is qualified to perform visual inspections.

(E) “Detailed investigation” means all studies, investigations and analyses appropriate to evaluate the structural safety and hydraulic capacity of a dam or reservoir and appurtenant works.
(F) “Director” means the Director of the Department of Environmental Management, or his or her
designee and may be used interchangeably with Department.

(G) “Embankment” means the fill material, including but not limited to rock or earth, placed to
provide a permanent barrier that impounds water.

(H) “Freshwater wetlands” means those areas as defined in Section 2-1-18, et. seq. of the R.I. Gen.
Laws of 1956, as amended, and the Wetlands Regulations.

(I) “Hazard classification” means a rating for a dam that relates to the probable consequences of
failure or misoperation of the dam, which is a determination made by the Director based on an
assessment of loss of human life, damages to properties or structures located downstream of the
reservoir, or loss of use as a drinking water supply. This rating has no relationship to the current
condition of the dam. A higher hazard dam does not imply that it is more likely to fail or be
misoperated than a lower hazard dam.

(J) “Height” means the vertical distance from the elevation of the uppermost surface of a dam to the
lowest point of natural ground, including any stream channel, along the downstream toe of the dam.

(K) “High hazard dam” means a dam where failure or misoperation will result in a probable loss of
human life.

(L) “Hydraulic” means the behavior of water relative to the dam. It is the manner in which water in
the reservoir is passed over or through the dam, via an outlet such as a spillway or low level outlet.

(M) “Hydrologic” means the volume and speed at which precipitation flows along the earth, combines
into streams and discharges into a reservoir.

(N) “Lifeline facilities” means essential facilities, the loss of which can result in indirect threats to life.
Lifeline facilities may include hospitals, transportation links (highways, bridges, airports, rail lines,
waterways, ports and harbor facilities and emergency evacuation routes), and utility systems
(electric power plants, gas and liquid fuel pipelines, telecommunication systems, water supply and
waste water treatment facilities).

(O) “Low hazard dam” means a dam where failure or misoperation results in no probable loss of
human life and low economic losses.

(P) “Maintenance” means minor work on a dam necessary to maintain the dam in proper working
order, including activities such as filling minor erosion areas, mowing or clearing vegetation
provided that it does not affect the integrity of the dam, lubricating and exercising equipment and
re-pointing masonry areas. Maintenance does not include repair of a dam or substantial alteration
of a dam

(Q) “Owner” means the person or persons, including any individual, firm, partnership, association,
syndicate, company, trust, corporation, municipality, agency, political or administrative subdivision
of the state or any legal entity of any kind holding legal title to a dam.
“Person maintaining or having control of a dam” means the person or persons, including any individual, firm, partnership, association, syndicate, company, trust, corporation, municipality, agency, political or administrative subdivision of the state or any legal entity of any kind having authority to operate or maintain a dam.

“Piping” means the progressive development of internal erosion by seepage through the dam. Piping appears downstream as a hole or a discharging flow of water that includes soil particles from the dam embankment or foundation.

“Probable loss of human life” means loss of human life that is likely to occur, or reasonably or realistically expected. This definition does not include persons who are only incidentally in the potential inundation area downstream of a dam. Examples include walking on the dam, driving on lightly traveled roads on or downstream of the dam and recreating downstream of the dam provided the area is not an established recreational area.

“Qualified engineer” means a professional engineer fully registered in the State of Rhode Island, who is experienced with dam inspection, design, construction and repair.

“Registered owner” means a dam owner who has been issued a certificate of registration by the Department.

“Regulated dam” means a low hazard dam that is six (6) feet or more in height or has fifteen (15) acre-feet or more of storage capacity; or a high hazard dam; or a significant hazard dam. An acre-foot is a unit of volume equal to 43,560 cubic feet or 325,830 gallons (a measure that would cover one acre to a depth of one foot).

“Removal” means the destruction or breaching of a dam to the extent that the dam no longer impounds or diverts water.

“Repair” means any work performed at a dam that may affect the integrity of the dam, including certain cutting or removal of trees where the resulting decomposition of the tree root system could jeopardize the integrity of the dam, work requiring excavation into the embankment fill or foundation of a dam, work requiring reinforcement of the embankment or work requiring removal or replacement of major structural components of a dam; or any related, new, temporary or permanent access way(s) that may be required within freshwater wetlands.

“Reservoir” means the body of water that is impounded or diverted by a dam.

“Significant hazard dam” means a dam where failure or misoperation results in no probable loss of human life but can cause major economic loss, disruption of lifeline facilities or impact other concerns detrimental to the public’s health, safety or welfare. Examples of major economic loss include but are not limited to washout of a state or federal highway, washout of two or more municipal roads, loss of vehicular access to residences, (e.g. a dead end road whereby emergency personnel could no longer access residences beyond the washout area) or damage to a few structures.

“Spillway” means a structure, a low area in natural grade or any part of the dam which has been designed or relied upon to allow normal flow or major flood flow to pass over or through while being discharged from a reservoir.
(AC) “Substantial alteration” means any physical modification to a dam that results in a permanent change in the water elevation of the reservoir or in water flow downstream of the dam.

(AD) “Unsafe dam” means the condition of a regulated dam, as determined by the Director, is such that an unreasonable risk of failure exists that will result in a probable loss of human life or major economic loss. Among the conditions that would result in this determination are: excessive vegetation that does not allow the Director to perform a complete visual inspection of a dam, excessive seepage or piping, significant erosion problems, inadequate spillway capacity, inadequate capacity and/or condition of control structure(s) or serious structural deficiencies, including movement of the structure or major cracking.

(AE) “Visual inspection” means a visual, technical evaluation of the physical conditions of a dam that affect performance of the structure.

(AF) “Wetlands Regulations” means the “Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act”.

RULE 7. PROHIBITIONS

(A) No repair of a high hazard dam or significant hazard dam shall occur until plans and specifications of the proposed work have been filed with and approved by the Director in accordance with these Rules and Regulations.

(B) No repair of a low hazard dam shall occur without approval of the Director in accordance with the Wetlands Regulations unless specifically exempted under the Wetlands Regulations.

(C) No maintenance of a high hazard dam or significant hazard dam shall occur without approval of the Director unless specifically exempted under these Rules and Regulations.

(D) No maintenance of a low hazard dam shall occur without approval of the Director in accordance with the Wetlands Regulations unless specifically exempted under the Wetlands Regulations.

(E) No new construction, substantial alteration, or removal of a dam shall occur without approval of the Director.

RULE 8. REGISTRATION AND NOTIFICATION

(A) The owner of a regulated dam shall file with the Department, within sixty (60) days of promulgation of these Rules and Regulations, a fully completed registration form to be provided by the Director.

(B) The owner of a regulated dam shall notify the Director and the local municipality’s emergency management authority having jurisdiction, of the transfer of legal title of such dam or a change in the mailing address, telephone number or emergency contact person not later than thirty (30) days after the date of such transfer or change and provide to the Director the new owner, mailing address, telephone number, or emergency contact person.
(C) The Director, following receipt of a fully completed registration form, shall issue a certificate of registration to the owner of a regulated dam identifying the proper name, registration number and current hazard classification of the dam.

(D) The owner of a regulated dam, upon written request from the Department, shall make available to the Director, all the existing surveys, plans, drawings and reports related to the dam, in possession of or available to the owner, that may be required by the Director for the purposes of dam safety.

(E) The owner of a regulated dam, upon written request from the Department, shall prepare all the necessary surveys, plans, drawings and reports related to the dam that may be required by the Director for the purposes of dam safety.

RULE 9. HAZARD CLASSIFICATION

(A) The Department shall classify each regulated dam in the State as a high hazard dam, significant hazard dam or low hazard dam. The Director shall send a notice of the proposed classification to the registered owner of a dam. The dam owner may contest the proposed classification pursuant to Rule 15 of these Rules and Regulations. The Director shall maintain a list of all classified dams and shall make the list available to the public.

(B) The Director shall examine each regulated dam as often as he or she shall deem necessary to assess whether the dam warrants reclassification.

(C) Any person may petition the Director for reclassification of a dam. The petition must be in writing and must include a written report prepared by a qualified engineer that details the findings and analyses that support the engineer’s opinion that the dam should be reclassified.

RULE 10. APPROVALS

(A) MAINTENANCE OF A HIGH OR SIGNIFICANT HAZARD DAM

(1) Maintenance of a high hazard dam or significant hazard dam, except for certain cutting or removal of trees, does not require an approval from the Department. To be exempt from Department approval, the cutting or removal of trees must be limited to those trees with a diameter less than 6 inches (measured 2 feet above the ground level) or that do not affect the integrity of the dam. If trees have a diameter greater than 6 inches (measured 2 feet above the ground level) then the dam owner shall first consult with a qualified engineer who will determine if the cutting or removal could jeopardize the integrity of the dam. The owner shall obtain a written report from the qualified engineer, if the qualified engineer determines that the cutting or removal is not a threat to the integrity of the dam, and keep a copy of the report on file. The report does not have to be filed with the Department. The owner shall file an application for repair of the dam in accordance with these Rules and Regulations if the qualified engineer determines that the cutting or removal is a threat to the integrity of the dam.
Mowing or cutting of vegetation may be performed without an approval from the Department provided it is limited to areas on the dam and adjacent to the dam such that an area does not exceed fifteen (15) feet from the embankment, spillway or low level control structure. All other mowing or cutting of vegetation within freshwater wetlands will require a permit from the Director unless specifically exempted under the Wetlands Regulations. Areas exceeding fifteen (15) feet from the embankment, spillway or low level control structure that have been historically mowed and maintained are specifically exempted under the Wetlands Regulations. These areas can continue to be mowed without a permit from the Director.

(2) All maintenance activities shall comply with the following:

(a) Best management practices for erosion and sediment controls must be used. All controls must be maintained in effective operating condition during the activity, and all exposed soil and other fills must be permanently stabilized at the earliest possible date. (For guidance see Rhode Island Soil Erosion and Sediment Control Handbook and Rhode Island Stormwater Design and Installation Standards Manual);

(b) All equipment used for maintenance activities shall be removed from any freshwater wetland upon completion of the maintenance project; and

(c) All maintenance activities shall be protective of water quality and freshwater wetland functions and values so as to prevent pollutants, sediment, direct discharge of stormwater runoff, or any material foreign to waters of the State including freshwater wetlands, or hazardous to life, from entering any waters of the State including freshwater wetlands.

(B) REPAIR OF A HIGH OR SIGNIFICANT HAZARD DAM

The dam owner must submit an application for repair of a high hazard dam or significant hazard dam directly to the Department’s Dam Safety Program. Applications shall be in writing and on a form prescribed by the Director and shall contain such documentation and information as the Director may require, which may include but not be limited to the following:

(1) A locus map indicating the location of the dam in relation to other fixed infrastructure in the community such as roads, etc.;

(2) Written justification explaining the need for the work;

(3) Three (3) sets of plans and specifications for the proposed work, prepared and stamped by a qualified engineer. The Department reserves the right to request additional copies for coordination with other State or federal permitting agencies;

(4) Plans drawn in sufficient detail to clearly indicate the extent and complexity of the work, including plan, profile and cross section views, along with any new, temporary or permanent access ways;

(5) Written description of the method of construction;

(6) Supporting computations and field measurements for all assumptions and design work (hydrologic, hydraulic, structural, geotechnical);

(7) Criteria and basis for selection of the design;
(8) Specifications of all material to be used in the repair;

(9) Estimated construction schedule including commencement and completion of the repairs;

(10) Amount (estimated vertical, horizontal and areal) and schedule of reservoir drawdown and schedule of reservoir recovery;

(11) If a temporary water by-pass or diversion is proposed, the dam owner shall provide plans, details and calculations for such by-pass or diversion. The design of the by-pass or diversion shall be capable of accommodating peak flows from a minimum of 95% of all storm events that may be expected to occur within the proposed construction period and contain a contingency provision to safely accommodate a 100-year, 24 hour duration Type III storm event. The design of the by-pass or diversion shall be capable of accommodating, at a minimum, peak flows in accordance with the following table.

<table>
<thead>
<tr>
<th>Construction Duration</th>
<th>Required Design Storm</th>
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<tbody>
<tr>
<td>up to 3 months</td>
<td>5 year</td>
</tr>
<tr>
<td>3 months to 6 months</td>
<td>10 year</td>
</tr>
<tr>
<td>6 months to 1 year</td>
<td>20 year</td>
</tr>
<tr>
<td>1 year to 2 years</td>
<td>50 year</td>
</tr>
</tbody>
</table>

(12) Supporting documentation to demonstrate that there is no practicable alternative to the proposed repair that would have less adverse impact on freshwater wetlands, that addresses the impact avoidance and minimization criteria specified in Appendix I. A practicable alternative is defined as one that is “available and capable of being done after taking into consideration cost, existing technology and logistics in light of the overall project purposes”;

(13) Contact name and telephone number of person(s) responsible for repair; and

(14) Statement that a record drawing, certified by the qualified engineer responsible for design that the dam was repaired in conformance with the plan approved by the Director, will be provided to the Director upon completion of the work.

The Director shall provide dam owners with written notice for any additional information the Director requires.

(C) EMERGENCY REPAIR OF A HIGH OR SIGNIFICANT HAZARD DAM

The Director may grant verbal approval of an emergency repair consistent with the following requirements:

(1) Verbal or written request for permission to proceed with an emergency repair must be made by the owner or person maintaining or having control of a dam;

(2) The request must inform the Department of at least the following:

   (a) An explanation of the problem necessitating an emergency repair;
(b) The reason why the problem represents an imminent threat to public safety or real property;

(c) The location of the dam on which the repair is required;

(d) The proposed actions necessary to correct the problem and complete the repair;

(e) The person responsible for overseeing the repair, including means of contact; and

(f) The means proposed to restore any wetland areas following the emergency repair that may be required by the Director.

(3) Any emergency repair undertaken shall not result in a significant alteration of any wetland unless authorized by a permit issued by the Director.

(4) Alteration of wetlands shall not exceed work beyond that necessary to abate the emergency;

(5) Unless otherwise informed by the Director, the dam owner must submit a report, a record drawing and a permit application to the Department no later than thirty (30) days following the emergency repair. The report must explain the emergency repair undertaken, and the short-term and long-term effects that the emergency repair had on abating the emergency, any wetlands affected, any permanent, significant alteration which resulted from the activity, and all restoration activities undertaken, or which may still be required;

(6) The time limitation for performance of an emergency repair shall not exceed ten (10) days following initial approval by the Department unless written approval for an extension is obtained from the Department; and

(7) Following submission of the record drawing required above, the applicant is required to comply with any additional activities necessary to prevent significant wetland alterations or to obtain a permit as detailed in writing by the Department.

An emergency repair may be taken by the owner or person maintaining or having control of a dam without prior Department approval in accordance with Rule 12 of these Rules and Regulations. The Department will evaluate the emergency repair to determine if it is consistent with Rule 10(C) of these Rules and Regulations. The Department will consider good faith efforts made by the owner or person maintaining or having control of the dam to obtain prior approval from the Department for the emergency repair.

(D) PROCEDURES FOR REVIEW OF APPLICATIONS

(1) In consideration of the application, the Department may use, but is not limited to, the criteria, manuals and procedures used by the following agencies:

The United States Army Corps of Engineers;
The United States Department of Agriculture, Natural Resources Conservation Services;
The United States Department of Energy, Federal Energy Regulatory Commission;
The United States Department of Homeland Security, Federal Emergency Management Agency; and
The United States Department of the Interior, Bureau of Reclamation.
(2) At any time during the review, the Director may:

(a) Require that the dam owner provide such information as the Director deems necessary for the review of the application;

(b) Issue an approval requiring such terms, conditions, management practices and operation and maintenance requirements as deemed necessary to comply with the requirements of applicable state laws; or

(c) Deny the application for failure to satisfy the requirements of applicable laws and advise the dam owner of the right to appeal under Rule 15 of these Rules and Regulations. A denial may be based on, but is not limited to, any of the following:

(i) Failure to submit any information required by the department; or

(ii) Failure to provide clear and convincing documentation demonstrating, to the satisfaction of the Director, that the project will not violate these Rules and Regulations.

(E) PUBLIC NOTICE
The Director may require the applicant to provide written notice of the planned repair to abutters of the dam and reservoir and to the municipality(s) in which the dam and reservoir are located. In general, an abutter will be limited to a property owner with frontage on the reservoir. The Director may prescribe a form or a format for such notice.

(F) EFFECT OF APPROVAL

(1) The issuance of an approval mandates compliance with all terms, conditions, management practices and operation and maintenance requirements set forth in the approval.

(2) The issuance of an approval does not relieve any person of the continuing responsibility to comply with any other applicable federal, state or local law or regulation.

(3) The issuance of an approval does not relieve any person of the responsibility for obtaining any other necessary permits or approvals from any federal, state, regional, or local agency.

(4) The issuance of an approval does not authorize any injury to persons or property or invasion of other private rights, or any infringement of federal, state or local law or regulations.

(G) MODIFICATION, SUSPENSION OR REVOCATION OF APPROVAL

(1) The Director may modify, suspend, or revoke, in whole or in part, an approval for cause, including, but not limited to, the following:

(a) Information indicating that the project will result in an unsafe condition of the dam;
(b) The existence of a factor or factors which, if properly and timely brought to the attention of the Director, would have justified the application of more or less stringent conditions than required by these regulations, but only if such factor(s) arose after the approval was issued;

(c) Where circumstances on which the approval was based have materially and substantially changed since the approval was issued, including but not limited to pertinent amendment of these rules and regulations;

(d) The information or data submitted by the dam owner either on the form required or in any other material in support of the application is found to be false, misleading or erroneous; or

(e) The project is not undertaken in strict compliance with the conditions or provisions of any approval issued by the Department.

(2) A notice of revocation/suspension of an approval will be in the form of a certified letter notifying the dam owner of the revocation or suspension and the reasons why the approval is being revoked or suspended. Such notice shall be in conformance with the Administrative Procedures Act, R.I. Gen. Laws Sections 42-35-9(b) and 42-35-14, as amended.

(3) The dam owner issued a notice of revocation/suspension of an approval may request an adjudicatory hearing to contest the revocation as set forth in the provisions of Rule 15 of these Rules and Regulations. A notice of revocation/suspension of an approval automatically becomes a final order of the Director enforceable in Superior Court upon failure to request said adjudicatory hearing.

(4) Modification of an approval shall be in accordance with Rule 10(B) of these Rules and Regulations.

RULE 11. INSPECTIONS

(A) SCHEDULED INSPECTIONS

(1) Regulated dams shall be inspected in accordance with the following schedule. These time periods are the maximum time between inspections and more frequent inspections may be performed at the discretion of the Director.

<table>
<thead>
<tr>
<th>Hazard Classification</th>
<th>Minimum Inspection Frequency</th>
<th>Type of Inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>2 years</td>
<td>Visual</td>
</tr>
<tr>
<td>Significant</td>
<td>5 years</td>
<td>Visual</td>
</tr>
<tr>
<td>Low</td>
<td>5 years</td>
<td>Hazard Classification Assessment</td>
</tr>
</tbody>
</table>
(2) The Director shall periodically perform or require the owner to perform a visual inspection of all high hazard dams and significant hazard dams. The Director will notify the owner by certified letter in the event that the Department will require the owner to perform a visual inspection of the dam. The owner must then retain a qualified engineer to perform a visual inspection of the dam. Visual inspection by a qualified engineer must be completed within sixty (60) days following receipt of notification from the Director.

(3) At any time, the owner may elect to employ the services of a qualified engineer to perform a visual inspection of his or her dam.

(4) Whenever the findings of the visual inspection reveal, in the opinion of the Director, that the dam may be unsafe, the owner shall be required to retain a qualified engineer to perform a detailed investigation of the dam and to provide a schedule by which any work needed shall be accomplished. The owner shall be responsible for completing all work required by the Director and in a reasonable time frame required by the Director.

(5) Evaluations of regulated, low hazard dams shall be conducted by the Director at least every five (5) years to determine whether conditions have changed over time that warrant raising the hazard classification to significant or high. If the Director determines the classification of a low hazard dam should be raised to significant or high, the owner shall be informed of the classification change in accordance with Rule 9(A) of these Rules and Regulations.

(B) UNSCHEDULED INSPECTIONS

(1) Any person who has cause to believe that an unsafe dam exists may make a request to the Director to inspect the dam. If in the opinion of the Director, the failure of the dam will result in a probable loss of human life or cause major economic loss, disruption of lifeline facilities or impact other concerns detrimental to the public’s health, safety or welfare, then the Director shall perform a visual inspection, or cause a visual inspection to be performed, of the dam to determine if the dam is unsafe.

(2) The Director shall, whenever he or she has cause to believe that an unsafe dam exists, perform a visual inspection, or cause a visual inspection to be performed, of the dam to determine if the dam is unsafe.

(C) INSPECTIONS

(1) Visual Inspections
A qualified engineer or a Department dam engineer must perform a visual inspection. The visual inspection shall include an assessment of the condition of the major components of the dam subjectively rated as *good*, *fair* or *poor*. The major components of a dam are the embankment(s), the spillway(s) and the low level control structure(s). *Good* is defined as meeting minimum guidelines, where no irregularities are observed and the component appears to be maintained properly. *Fair* is defined as a component that requires maintenance. *Poor* is defined as a component that has deteriorated beyond a maintenance issue and requires repair; the component no longer functions as it was originally intended.
(2) Detailed Investigations
A qualified engineer must perform a detailed investigation. A detailed investigation may include soil analysis, concrete or earth stability analysis, materials testing, foundation explorations, hydraulic and hydrologic analysis, including basin studies, flood potential, and an analysis of the dam’s ability to pass flood waters.

(D) INSPECTION REPORTS
A report must be prepared for each visual inspection or detailed investigation. If deficiencies are found, the report must identify the specific deficiencies and, when warranted, specify further investigation or corrective measures. The report, completed by a qualified engineer retained by a dam owner, must provide a recommended schedule to complete any work identified as necessary to correct the deficiencies noted in the report. Such reports must be provided to the dam owner and the Director within thirty (30) days of the date of the visual inspection or within sixty (60) days of the date of the detailed investigation.

RULE 12. UNSAFE DAMS

(A) Whenever the Director determines that a dam is unsafe the Director shall determine whether the water in the reservoir shall be drawn off in whole or in part, and the actions necessary to make the dam safe.

(B) The Director shall notify the owner or person maintaining or having control of the dam, by certified mail, that the dam is unsafe, the actions necessary to make the dam safe and a schedule to complete the actions.

(C) The Director may notify the owner or person maintaining or having control of the dam, by certified mail, that the dam is unsafe after completing his/her own inspection or after receiving an inspection report completed by a qualified engineer.

(D) The Director may, pursuant to R.I. Gen. Laws Section 42-17.1-2(u), issue an immediate compliance order stating the existence of the unsafe condition and the action deemed necessary to correct the unsafe condition. The Director may order the water in the reservoir to be drawn off, in whole or in part. The immediate compliance order shall become effective immediately upon service or within such time as is specified by the Director in such order.

(E) Any emergency action taken by the owner or person maintaining or having control of a dam shall immediately be reported by the dam owner to the Director and the municipality(s) in which the dam and reservoir lies. The owner or person maintaining or having control of a dam shall also report, by telephone within twenty-four (24) hours and in writing within three (3) days, the emergency action taken.

(F) If water has been drawn off or the dam has been altered pursuant to an order by the Director, the reservoir shall not be refilled without approval of the Director.

(G) If the owner or person maintaining or having control of a dam fails to comply with an order of the Director, the Director may also, by summons and complaint, seek to enforce the order in a court of competent jurisdiction.
RULE 13. ACCESS
The Director shall conduct all inspections in accordance with the “Administrative Inspection Guidelines”, adopted on January 23, 2003, and any amendments thereto.

RULE 14. ENFORCEMENT ACTIONS
As set forth in R.I. Gen. Laws Chapter 42-17.1, et seq. and Section 42-17.6-1 et seq., the Director shall have the power to issue enforcement notices, orders, administrative penalties or other requirements to ensure compliance with these Rules and Regulations. The Director may also provide written or verbal warning of his/her intent to undertake enforcement action, but is not required to do so. Nothing in these Rules and Regulations shall limit the authority of the attorney general to prosecute offenders as required by law. The Department shall forward a copy of the enforcement notices and/or orders to recognized watershed councils in accordance with the Rules and Regulations of the Rhode Island Rivers Council for Watershed Council Grants and Notification of Proposed Actions to Watershed Councils and the municipality wherein the dam is located.

RULE 15. APPEALS

(A) The procedures for appeal of Departmental decisions pursuant to the provisions of Chapter 42-35 of the R.I. Gen. Laws are contained in the "Administrative Rules of Practice and Procedure for the Department of Environmental Management Administrative Adjudication Division for Environmental Matters".

(B) Within thirty (30) days of the receipt of a decision from the Department regarding an application for repair of a dam or hazard classification of a dam, the owner may request an adjudicatory hearing to appeal the decision, or portions thereof. The request for an adjudicatory hearing must be in writing, must comply in form and content for such requests as required by the “Administrative Rules of Practice and Procedure for the Administrative Adjudication Division for Environmental Matters”, and must be filed directly with the Administrative Adjudication Division (AAD) of the Department. A copy of such request must also be forwarded to the Dam Safety Program. A request for an adjudicatory hearing automatically stays any contested approval issued for repair of a dam. It shall be the dam owner’s burden to demonstrate by a preponderance of the evidence that the application as proposed or hazard classification is consistent with the purposes of the law, complies with these Rules and Regulations and protects the public, real property and natural resources.

(C) Any person who has received a Notice of Violation (NOV) alleging violation of these Rules and Regulations, or whose approval has been suspended or revoked, may appeal to the Director for review of the decision on which the NOV, suspension or revocation is based by filing an appeal with AAD.

(1) Filing of Appeal - All appeals shall be in writing and shall be filed with and received by AAD within twenty (20) days after the date of receipt of the subject NOV, or within thirty (30) days after receipt of the revocation or suspension.

(2) Contents of Appeal - Every appeal shall contain a detailed basis upon which the appeal is taken.
RULE 16. SEVERABILITY
If any provision of these Rules and Regulations, or the application thereof to any person or circumstance, is held invalid by a court of competent jurisdiction, the validity of the remainder of the Rules and Regulations shall not be affected thereby.

RULE 17. EFFECTIVE DATE
The foregoing Rules and Regulations for Dam Safety, after due notice, are hereby adopted and filed with the Secretary of State this _________ day of _______________, 2007 to become effective twenty (20) days thereafter, in accordance with the provisions of Chapters 46-19, 42-35, 42-17.1, and 42-17.6 of the General Laws of Rhode Island of 1956, as amended.

_____________________________________
W. Michael Sullivan, Director
Department of Environmental Management

Notice Given on:  July 23, 2007
Public Hearing held:  August 23, 2007
Filing Date:
Effective Date:
APPENDIX I: IMPACT AVOIDANCE AND MINIMIZATION
Rhode Island’s Freshwater Wetlands Act (R.I. Gen. Laws Section 2-1-18 et seq.) and Water Pollution Act (R.I. Gen. Laws Section 46-12-1 et seq.) require the Director to protect freshwater wetland values and water quality, respectively. It is important for the dam owner to recognize the Director’s responsibilities under these laws and to plan his/her repair projects to minimize any negative impacts to freshwater wetlands and water quality values. In particular, the dam owner must:

(A) Minimize the impacts from lowering the water elevation in a reservoir during a repair project, such as by installing a temporary cofferdam. This is necessary to reduce detrimental impacts to fish and wildlife associated with the wetland environment and to reduce loss of aquatic vegetation that serves as wildlife habitat. In the event that a dam owner is unable to install controls to maintain water in the reservoir to assist in protecting fish and wildlife habitat, the dam owner must specifically inform the Director of this situation and document in writing why water is not proposed to be maintained upstream of the dam during the repair activity. Efforts must be made to avoid drawdowns between April 15 to July 1, and to avoid significant drawdowns between October 15 and March 15.

(B) Use best management practices regarding the installation of sediment and erosion controls to prevent sediment from entering adjacent waters of the state.

(C) Minimize construction disturbance so as to keep disturbed soils and areas subject to erosion to a minimum.

(D) Prevent any hazardous substances injurious to aquatic life used during the repair activity from entering any adjacent water and freshwater wetlands.

(E) Stabilize all disturbed soils following construction activities to ensure erosion will not take place.

(F) Minimize clearing of vegetation to that necessary to conduct the project and remove the slash material from adjacent freshwater wetlands and water bodies.

(G) Use only the amount of fill of other material necessary to complete the project and minimize the placement of material in any flood plain.

(H) Replace, restore or mitigate alterations to freshwater wetlands as deemed necessary in the opinion of the Department.
E.40. South Carolina
Summary of the SC Dams and Reservoirs Safety Act

The SC Dams and Reservoirs Safety Act is the basis of South Carolina’s dams and reservoirs safety programs. The purpose of the act is to protect citizens’ health, safety, and welfare by creating a regulatory program to reduce the risk of failure of dams. The law confers upon the Department the regulatory authority to accomplish the purposes of the act. This includes the power to promulgate regulations, require permits, conduct inspections and take enforcement actions among other things.

Section 49-11-190 of the act allows the Department to issue emergency orders as may be necessary from time to time to protect life and property. This section also allows the Department to enter on private property to take immediate actions necessary to protect life and property when the owner of a dam does not comply with an emergency order.

Section 49-11-200 of the act requires a permit from the Department before a new dam may be constructed or before the alteration, repair, or removal of an existing dam.

Section 49-11-230 grants authority to the Department to conduct inspections while Section 49-11-240 allows the Department entry on property to carry out the general provisions of the program.

In summary, this act empowers the Department to conduct the dams and reservoirs safety program through a wide range of activities such as permitting, inspections, compliance, monitoring, enforcement and public education. To meet the requirements of the act, the Department regulates a large number of dams.

Summary of Regulation 72-1: Dams and Reservoirs Safety Act Regulations

The regulations were initially approved in 1977 and they were most recently amended in July of 1997. The regulations for the most part mirror the requirements of the SC Dams and Reservoirs Safety Act. The regulations create a tiered permitting program based on a classification system of dams. Dams regulated by the Department are classified based on size and hazards. The size classifications are large, intermediate, small, and very small. Hazard classifications are high hazard, significant hazard, and low hazard.

These regulations specify the administrative process for obtaining a permit for either a new dam or the alteration, repair, or removal of an existing dam. The items required to be submitted to the Department as part of the permit application package are also given in the regulations as well as some general design criteria a dam must meet.
Title 49 - Waters, Water Resources and Drainage

CHAPTER 11. DAMS

ARTICLE 1. GENERAL PROVISIONS

SECTION 49-11-10. Prohibition on dams or banks erected or water let off to injury of others.

No person shall be permitted or allowed to make or keep up any dam or bank to stop the course of any waters so as to overflow the lands of another person without the consent of such person first had and obtained nor shall any person be permitted or allowed to let off any reserved water to injure the crops upon the grounds of other persons.

SECTION 49-11-20. Persons may not keep water on other's lands.
Nothing contained herein shall be construed to authorize any person to keep water at any time on any lands other than his own.

ARTICLE 3.

DAMS AND RESERVOIRS SAFETY ACT

SECTION 49-11-110. Short title.

This article shall be cited as the "Dams and Reservoirs Safety Act."

SECTION 49-11-120. Definitions.

Unless the context otherwise requires, as used in this article:

(1) "Alterations" and "repairs" mean only the alterations or repairs which may affect the safety of a dam or reservoir.

(2) "Appurtenant works" include, but are not limited to, structures such as spillways, either in the dam or separate from it, low-level outlet works, and water conduits.

(3) "Department" means the South Carolina Department of Health and Environmental Control or its staff or agents.

(4) "Dam" means an artificial barrier with appurtenant works, including, but not limited to, dams, levees, dikes, or floodwalls for the impoundment or diversion of waters or other fluids where failure may cause danger to life or property. However, this does not include a dam:

(a) less than twenty-five feet in height from the natural bed of the stream or watercourse measured at the downstream toe of the dam, or less than twenty-five feet from the lowest elevation of the outside limit of the dam, if it is not across a stream channel or watercourse, to the maximum water storage elevation and has an impounding capacity at maximum water storage elevation of less than fifty-acre feet unless a situation exists where the hazard potential as determined by the department is such that dam failure or improper reservoir operation may cause loss of human life;

(b) owned or operated by a department or an agency of the federal government;

(c) owned or licensed by the Federal Energy Regulatory Commission, the South Carolina Public Service Authority, the Nuclear Regulatory Commission, the United States Corps of Engineers, or other responsible federal licensing agencies considered appropriate by the department;

(d) upon which the Department of Transportation or county or municipal governments have accepted maintenance responsibility for a road or highway where that road or highway is the only danger to life or property with respect to failure of the dam.

(5) "Districts" means the soil and water conservation districts of this State. For the purposes of this article the districts may serve as agents and advisors to the department.

(6) "Danger to life or property" means a situation exists where the hazard potential as determined by the department is such that dam failure or improper reservoir operation may cause injury to persons, loss of human life, or damage to property.

(7) "Detailed inspection" means all studies, investigations, and analyses necessary to evaluate conclusively the structural safety and hydraulic capacity of a dam or reservoir and appurtenant works. This inspection includes, but is not limited to, soil analyses, concrete or earth stability analyses, materials testing, foundation explorations, and hydrologic analyses, including basin studies and flood potential. This inspection must be performed by a qualified registered professional engineer.
(8) "Enlargement" means a change in or an addition to an existing dam or reservoir which raises or may raise the water storage elevation of the water impounded by the dam or reservoir.

(9) "Owner" means those who own, control, operate, maintain, manage, or propose to construct a dam or reservoir.

(10) "Removal" means destruction or breaching of an existing dam or drainage of water impoundment or reservoir.

(11) "Reservoir" means a reservoir which contains the impoundment of water by a dam or reservoir.

(12) "Order" means a written document prepared and issued by the department which mandates specific actions to be accomplished by a dam owner within a specified time frame. Failure to comply makes the owner subject to penalties outlined in Section 49-11-260.

(13) "Unsafe" means the condition of the dam is such that repairs or alterations are necessary to reduce the risk of dam failure.

SECTION 49-11-130. Declaration of purpose.

It is the purpose of this article to provide for the certification and inspection of certain dams in South Carolina in the interest of public health, safety, and welfare in order to reduce the risk of failure of the dams, prevent injuries to persons and damage to property, and confer upon the department the regulatory authority to accomplish the purposes.

SECTION 49-11-140. General duties of department.

The authority for the safe maintenance of the dams and reservoirs of this State and the powers of inspection and certification provided in this article are the responsibility of the department. The department may employ engineers and technicians it considers necessary to implement this article for which appropriations are available.

SECTION 49-11-150. Owner responsible for safe maintenance of dam or reservoir; notice of change of ownership; emergency action plan requirement.

The owner of a dam or reservoir constructed in this State solely is responsible for maintaining the dam or reservoir in a safe condition throughout the life of the structure. The owner of a dam or reservoir shall inform the department in writing within thirty days after title to the dam or reservoir legally has been transferred from his ownership. The notice must include the name and address of the new owner. The owner of a dam or reservoir whose failure likely would cause loss of life or substantial property damage, a dam or reservoir classified as a high or significant hazard under existing regulations, shall provide the department a current emergency action plan in the format the department by regulation requires.

SECTION 49-11-160. Order to maintain, alter, repair, or remove dam or reservoir; findings supporting order.

The department may issue an order directing the owner of a dam or reservoir to make at his expense the necessary maintenance, alteration, repair, or removal upon a finding that the dam or reservoir:

(a) is or has become unsafe and is dangerous to life or property;

(b) is not maintained in good repair or operating condition; or

(c) is not maintained or operated in accordance with the terms and conditions of the certificate of completion and operation issued by the department.

SECTION 49-11-170. Bringing unsafe dams to attention of department; preliminary inspections;
detailed inspection at owner's expense; notice to owner; hearings.

(A) The existence of a dam which is not maintained in good repair or operating condition or may be unsafe and a danger to life or property may be brought to the attention of the department by complaint, staff, or authorized investigation or by other means.

(B) Upon staff or other authorized investigations or upon receipt of a written private complaint alleging that the person or property of the complainant is endangered by the construction, maintenance, operation, or condition of a dam or reservoir, the department shall cause a preliminary inspection of the structure and downstream development to be made by field observations to determine if the complaint is meritorious. The department may require the owner of the dam or reservoir to provide data, records, and design plans of the structure specified by regulations.

(C) If upon the preliminary inspection it is determined that the dam or reservoir is unsafe and is dangerous to life or property, the department may order the owner at his expense to make a detailed inspection of the dam and reservoir and surrounding area and to provide to the department within a time frame specified by the department plans prepared by a qualified registered professional engineer for correction of all deficiencies of the dam or to provide to the department plans and specifications for removal of the dam. In either instance the plans must be approved by the department before implementation and implemented within a time frame specified by the department. If upon inspection it is determined that the dam or reservoir has not been maintained in good repair or operating condition, the department may order the owner at his expense to accomplish the necessary maintenance or to obtain a permit for removal and to remove the dam within a time frame specified by the department.

(D) The department shall give the owner notice of its action when:

1. a complaint has been filed alleging that the owners' dam or reservoir is unsafe and a danger to life or property stating the nature of the complaint;

2. a preliminary inspection has been made with findings.

(E) The owner of a dam or reservoir determined through a preliminary inspection not to be maintained in good repair or operating condition or to be unsafe and a danger to life or property may request a hearing before the board of the department within thirty days after notice of the findings are delivered. The owner may submit written or present oral evidence which must be considered by the board of the department in the issuance of the order.

SECTION 49-11-180. Voluntary compliance; time extensions.

(A) The department may solicit voluntary compliance by the owner of a dam or reservoir found to be unsafe and a danger to life or property to take remedial steps necessary to render the dam safe.

(B) Extension of time to complete work specified in an order may be granted by the department. No extension may be granted when there appears substantial and immediate danger of dam failure.

SECTION 49-11-190. Emergency orders; owner to notify department of emergency; action when owner is unknown or fails to comply with order.

(A) The department immediately shall order remedial measures necessary to protect life or property if the condition of a dam or reservoir is so dangerous to the safety of life or property as not to permit time for the issuance and enforcement of a repair order or passing or imminent floods threaten overtopping erosion or destruction of a dam or reservoir capable of danger to life or property.

(B) In applying emergency measures the department has the following limited powers to order the owner to:

1. lower the water level by releasing water from the reservoir;
(2) empty the reservoir completely;

(3) take other steps essential to safeguard life and property.

(C) For an emergency where the owner finds repairs are necessary to safeguard life or property, he may start the repairs immediately but shall notify the department at once of the proposed repair and work underway.

(D) When the owner fails to comply with the emergency order or cannot be ascertained or found, the department or its authorized agents may enter and immediately take actions necessary to provide protection to life or property, including removal of the dam. The department may recover from the owner, in the name of the State, the expenses incurred in taking the action in the same manner debts are recoverable by law.

SECTION 49-11-200. Department approval required for construction or alteration; exceptions.

(A) The construction of a new dam or reservoir or enlargement, removal, or repair may not begin until the owner has applied for and obtained from the department written approval of plans and specifications.

(B) Where the location and size of the dam or reservoir renders the requirements of subsection (A) and Section 49-11-210 unnecessary, the department may grant approval and waive certain nonessential requirements in instances, including, but not limited to, small dams and reservoirs for agricultural, fish or wildlife, or recreational uses on private lands and of no danger to other life or property downstream.

SECTION 49-11-210. Separate application required for each alteration; information to accompany application.

A separate application for each dam or reservoir and all enlargements, removals, or repairs to existing dams or reservoirs must be filed with the department upon forms to be provided by it, except only one application need be filed for a dam and the reservoir which will contain the water impounded by the dam. The application must be accompanied by maps and plans and specifications of a character and size and setting forth pertinent details and dimensions required by regulation. The application for construction of a new dam or reservoir whose failure likely would cause loss of life or substantial property damage, a dam or reservoir classified as high or significant hazard under existing regulations, must include a fully-developed emergency action plan in a format the department by regulation requires. After the dam or reservoir is constructed, this emergency action plan must be updated by the owner of the dam or reservoir each time it becomes noncurrent.

SECTION 49-11-220. Filing of certification of approved design; designs by federal agencies excepted.

An applicant for approval of a dam or reservoir subject to Section 49-11-200 also shall file with the department a design approved by a registered professional engineer legally qualified in the State. Dams designed by the USDA-Soil Conservation Service or other federal agencies do not require certification by a registered professional engineer.

SECTION 49-11-230. Inspections during construction; maximum rate of discharge for water released during construction.

(A) The department may make necessary inspections during construction of new dams and reservoirs, enlargements, removal, and repairs of dams and reservoirs and during work done pursuant to repair orders to assure compliance with the approved plans and specifications or provisions of the order.

(B) If water is to be released during the construction, repair, or removal, the department shall specify the maximum discharge rate allowable to avoid endangering or causing injury to downstream owners.

SECTION 49-11-240. Authority of department to inspect and enter on lands and waterways; regulations.
(A) The department or its authorized agents may inspect the dam or reservoir and surrounding area to determine the safety of the structure.

(B) An authorized member, agency, or representative of the department may enter state or private lands and natural or artificial waterways in the State to discharge the duties set forth in this article.

(C) The department shall formulate reasonable regulations, including, but not limited to, minimum safety design standards for impoundments, safety inspection standards, water discharge, or drawdown rates and levels in unsafe impoundments and for other purposes necessary to administer this article.

(D) The department shall issue all orders, permits, or licenses set forth in this article.

SECTION 49-11-250. Liability for actions or failure to act.

Nothing in this article and no action or failure to act under this article:

(1) imposes liability on the State, the department, districts, or an agency or its officers or employees for the recovery of damages caused by the action or failure to act; or

(2) relieves the owner or operator of a dam or reservoir of the duties, obligations, responsibilities, or liabilities arising from or incident to the ownership or operation of a dam or reservoir.

SECTION 49-11-260. Penalties; injunction; appeals; disposition of fines.

(A) A person violating this article is guilty of a misdemeanor and, upon conviction, must be fined not less than one hundred nor more than five hundred dollars. Each day the violation continues after notice to take corrective action is a separate offense.

(B) The department may assess an administrative fine of not less than one hundred nor more than one thousand dollars against a person who violates this article or an order issued or regulation promulgated pursuant to it. In determining the amount of the fine the department shall consider the degree and extent of harm caused by the violation and the cost of rectifying the damage. Fines assessed under this subsection may be appealed to the department who may reduce them based on information presented at the appeal hearing.

(C) Upon a violation of this article or related regulations the department may institute legal action to obtain injunctive relief in the name of the department.

(D) A person against whom a final order or decision has been made, except for emergencies specified in Section 49-11-190, may appeal to the board under the Administrative Procedures Act. The burden of proof is on the party attacking an order or a decision of the department to show that the order is unlawful or unreasonable.

(E) Civil fines collected under this article must be deposited in a special account of the department to fund educational activities relating to dams and reservoirs safety, including, but not limited to, workshops, seminars, manuals, and brochures.
E.41. South Dakota
CHAPTER 74:02:08

SAFETY OF DAMS

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74:02:08:01. Definitions. Terms defined by SDCL 46-1 to 46-7, inclusive, have the same meaning when used in this chapter. In addition, terms used in this chapter mean:

(1) "Area capacity curves," graphic curves which show the relationship between reservoir surface area and the storage capacity of the reservoir at given elevations;

(2) "Breach analysis," a simulated dam failure performed to determine the outflow hydrograph and to route the resulting flood wave;

(3) "Category 1 dam," a high hazard dam whose failure may cause loss of life;

(4) "Category 2 dam," a significant hazard dam whose failure may cause damage to buildings, highways, railroads, bridges, or public utilities; loss of a water supply reservoir for a water distribution system; other extensive economic loss; or the reservoir is the only source of water for a water distribution system;

(5) "Category 3 dam," a low hazard dam whose failure may cause limited damage to agricultural lands or county and township roads or minimum economic loss;

(6) "Conservation storage capacity," the volume in acre-feet in the reservoir at the crest of the primary spillway;
(7) "Dam," for the purpose of this chapter an artificial barrier, including appurtenant works, which impounds or diverts water and which is 25 feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier, if it is not across a stream channel or watercourse, to the maximum water storage elevation or has an impounding capacity at maximum water storage elevation of 50 acre-feet or more. A barrier is not considered a dam for the purpose of this chapter if the height does not exceed 6 feet regardless of storage capacity or if the storage capacity at maximum water storage elevation does not exceed 15 acre-feet regardless of height;

(8) "Effective height," the difference in elevation in feet between the lowest point in the cross section taken along the centerline of the dam and the crest of the emergency spillway. If there is no emergency spillway, the top of the dam is the upper limit;

(9) "Emergency preparedness plan," "EPP," a predetermined plan of action to be taken to reduce the potential for property damage and loss of lives in an area that may be affected by a dam break;

(10) "Engineer," a person who is registered as a professional engineer pursuant to SDCL 36-18, or a person who is employed by a federal or state agency and who designs or inspects dams as part of the person's employment, acting under the supervision of a professional engineer registered pursuant to SDCL 36-18;

(11) "Freeboard," the vertical distance between the top of the dam and the estimated maximum water level;

(12) "Height," the difference in the elevation of either the natural bed of the stream or watercourse or the lowest point on the toe of the dam, whichever is lower, and the crest elevation of the dam;

(13) "Inspection," a visual or mechanical check by measuring, boring, or any method necessary to determine the adequacy of construction techniques and the safety and operating performance of a dam;

(14) "Intermediate storage capacity," the volume in acre-feet in the reservoir at the crest of the emergency spillway;

(15) "Maximum storage capacity," the volume in acre-feet in the reservoir at the crest of the dam;

(16) "Owner," "dam owner," a person as defined by SDCL 46-1-6(1) who owns, controls, operates, maintains, manages, or proposes to construct a dam or reservoir;

(17) "Preliminary risk assessment," as applied to dam safety, the process of identifying the downstream hazard potential for the purpose of classifying a dam;
(18) "Probable maximum flood," "PMF," the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are possible in the region;

(19) "Probable maximum precipitation," "PMP," the precipitation that may be expected from the most severe combination of critical meteorologic conditions that are reasonably possible in an area as found in the National Weather Service Hydrometeorological Report No. 51, "Probable Maximum Precipitation Estimates, United States East of the 105th Meridian"; or Hydrometeorological Report No. 55, "Probable Maximum Precipitation Estimates, United States Between the Continental Divide and the 103rd Meridian";

(20) "Process water," water that may have chemicals, sewage, metals, or any other material added to it during the use of the water in an operation;

(21) "Risk assessment," as applied to dam safety, the process of identifying the likelihood and consequences of dam failure to provide the basis for informed decisions on a course of action;

(22) "Spillway," an open or closed channel, conduit, or drop structure used to convey water from a reservoir.

(23) "Spillway design flood," the flood that the spillway of a given project is designated to pass safely without overtopping the structure;

(24) "25-year, 24-hour duration flood," the flood magnitude expected to be equaled or exceeded on the average of once in 25 years, with a four percent chance of being exceeded in any given year, determined by using the 25-year, 24-hour storm unless gauging data is available and proved to be accurate;

(25) "50-year, 24-hour duration flood," the flood magnitude expected to be equaled or exceeded on the average of once in 50 years, with a two percent chance of being exceeded in any given year, determined by using the 50-year, 24-hour storm unless gauging data is available and proved to be accurate;

(26) "100-year flood," the flood magnitude expected to be equaled or exceeded on the average of once in 100 years, with a one percent chance of being exceeded in any given year, determined by using the 100-year, 24-hour storm unless gauging data is available and proved to be accurate.


General Authority: SDCL 46-2-5, 46-7-3.

Law Implemented: SDCL 46-1-6, 46-1-15, 46-5-10, 46-5-11, 46-5-47, 46-7-3, 46-7-5.

74:02:08:02. Scope. This chapter applies to all new dams and all existing Category 1 dams and Category 2 dams. Category 2 dams constructed before October 27, 1986, that have highways across the crest or that have highways, railroads, or bridges below the dams are exempt from spillway requirements unless a dam fails and is to be rebuilt and provided that an emergency plan is established by the owner to monitor the dam and procedures are established to close the crest highways or downstream highways, railroads, and bridges during flood conditions. Other category 2 dams constructed before October 27, 1986, are exempt from spillway requirements, except for dams that serve as the sole source of water for a water distribution system or whose failure may cause extensive downstream damage, unless a dam fails and is to be rebuilt and provided that the spillway capacities comply with spillway requirements for category 3 dams. Category 3 dams constructed before October 27, 1986, are exempt from spillway requirements unless a dam fails and is to be rebuilt. Reconstruction of category 2 and 3 dams that fail must comply with the requirements of § 74:02:08:07. New dams are dams constructed after October 26, 1986.

If the classification of a category 3 dam changes to a category 2 or 1 dam or if a category 2 dam changes to a category 1 dam, the spillway capacity must comply with the spillway requirements for the new category classification.

General Authority: SDCL 46-2-5, 46-7-3.
Law Implemented: SDCL 46-5-8, 46-5-30, 46-7-3, 46-7-5.

Note: The owner of a dam may be responsible for resultant damage if a dam fails. Although § 74:02:08:02 exempts category 3 and certain category 2 dams constructed before October 27, 1986, from the spillway requirements of § 74:02:08:07, the owner should make an assessment of the risks and potential for damage in the event of dam failure.

74:02:08:03. Intent. The intent of this chapter is to provide minimum standards for design, construction, alteration, maintenance, and repair of dams and to prevent loss of life. These standards are not intended to apply to ordinary maintenance and repair of dams if the work is performed in accordance with an original design prepared by an engineer and no change in safety hazard or purpose is involved.

When conflicts develop in the interpretation of the rules in this chapter, this section will be the basis for settlement of the conflicts.
74:02:08:04. Actions required to be performed by engineers. The following shall be completed by engineers:

(1) Prepare plans and specifications for the construction of new dams or alteration of existing dams;
(2) Inspect the construction or alteration of dams; and
(3) Perform periodic inspections, detailed investigations, and analyses of existing dams.

74:02:08:05. Classification of dams -- Hazard potential. The classification of dams based on potential hazards is as follows:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>LOSS OF LIFE POTENTIAL</th>
<th>ECONOMIC LOSS POTENTIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>None expected</td>
<td>Minimal (undeveloped to occasional structures)</td>
</tr>
<tr>
<td>2</td>
<td>None expected</td>
<td>Extensive (community or industry)</td>
</tr>
<tr>
<td>1</td>
<td>Potential loss</td>
<td></td>
</tr>
</tbody>
</table>

74:02:08:05.01. Preliminary risk assessment. The chief engineer may request a preliminary risk assessment. The preliminary risk assessment shall consist of an on-site inspection of the downstream area with a description of any structures and an elevation in reference to the stream channel bottom. The hazard classification is subject to approval of the preliminary risk assessment by the chief engineer. The preliminary risk assessment must be performed by an engineer as defined in this chapter.


General Authority: SDCL 46-2-5, 46-7-3.

**Law Implemented:** SDCL 46-1-15, 46-5-8, 46-5-10, 46-5-11, 46-5-30, 46-7-3, 46-7-5.

**74:02:08:06. Classification of dams -- Size.** The classification of dams by size is as follows: The size classification is determined by either the maximum storage capacity or the height, whichever gives the larger size category.

<table>
<thead>
<tr>
<th>SIZE</th>
<th>STORAGE CAPACITY</th>
<th>HEIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(acre-feet)</td>
<td>(feet)</td>
</tr>
<tr>
<td>Small</td>
<td>50 to 1000</td>
<td>25 to 40</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1001 to 50,000</td>
<td>41 to 100</td>
</tr>
<tr>
<td>Large</td>
<td>greater than 50,000</td>
<td>greater than 100</td>
</tr>
</tbody>
</table>

**Source:** 13 SDR 49, effective October 27, 1986; 13 SDR 129, 13 SDR 141, effective July 1, 1987; 13 SDR 197, effective July 2, 1987.

**General Authority:** SDCL 46-2-5, 46-7-3.

**Law Implemented:** SDCL 46-5-8, 46-5-30, 46-7-3, 46-7-5.

**74:02:08:07. Minimum spillway design flood requirements -- Exception.** The hydraulic capacity of a dam must, by category and size, be such that the following minimum spillway design floods can be passed through the spillways without overtopping the structure:

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SIZE</th>
<th>SPILLWAY DESIGN FLOOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Small</td>
<td>50-year frequency unless dam qualifies for § 74:02:08:07.01 exception</td>
</tr>
<tr>
<td>Intermediate</td>
<td>100-year frequency</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>0.5 PMF</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Small</td>
<td>100-year frequency</td>
</tr>
<tr>
<td>Intermediate</td>
<td>0.5 PMF, unless dam qualifies for § 74:02:08:07.02 exception</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>PMF</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Small</td>
<td>0.5 PMF</td>
</tr>
<tr>
<td>Intermediate</td>
<td>0.5 PMF</td>
<td></td>
</tr>
<tr>
<td>Large</td>
<td>PMF</td>
<td></td>
</tr>
</tbody>
</table>

A spillway system for a dam must meet the requirements in this section unless the owner can provide information and justification to show the chief engineer that the proposed design...
flow can be stored, passed through, or passed over the dam without failure of the dam or if a variance is granted pursuant to SDCL 46-7-5.3.


General Authority: SDCL 46-2-5, 46-7-3.

Law Implemented: SDCL 46-5-8, 46-5-30, 46-7-3, 46-7-5, 46-7-5.3.

74:02:08:07.01. Category 3 spillway design flood exception. For small size category 3 dams with an emergency spillway, the minimum spillway design flood is a 25-year frequency if the product of the intermediate storage capacity times the effective height is less than 3000. For small size category 3 dams without an emergency spillway, the spillway design flood is a 25-year frequency if the product of the maximum storage capacity times the effective height is less than 3000.


General Authority: SDCL 46-2-5, 46-7-3.

Law Implemented: SDCL 46-5-8, 46-5-30, 46-7-3, 46-7-5.

74:02:08:07.02. Category 2 spillway design flood exemption. Unless the reservoir of a category 2 dam serves as the sole water supply source for a water distribution system, the spillway design flood for a new or rebuilt intermediate size category 2 dam may be lowered to a design flood between the 0.5 PMF and 100-year spillway design flood based upon a risk assessment. The risk assessment must be submitted to and approved by the chief engineer.


General Authority: SDCL 46-2-5, 46-7-3.

Law Implemented: SDCL 46-5-8, 46-5-30, 46-7-3, 46-7-5.

74:02:08:07.03. Design requirements for category 1 tailings dams. Dams constructed to store, without discharge, tailings as defined by 45-6B-3 (14) shall be sized to retain the PMF plus at least a 100-year flood.


General Authority: SDCL 46-2-5, 46-7-3.

Law Implemented: SDCL 46-5-8, 46-5-30.

74:02:08:07.04. Design requirements for dams constructed without spillways. Dams which are designed and constructed without spillways and constructed so that there is no external drainage into the facility, and constructed for the purpose of containing process water shall be sized to contain design operating volumes from the operation plus enough freeboard to contain the PMP falling on the facility.


General Authority: SDCL 46-2-5, 46-7-3.

Law Implemented: SDCL 46-5-8, 46-5-30.
74:02:08:08. Additional design requirements. In addition to the minimum spillway design flood requirements of § 74:02:08:07, all new category 1 and 2 dams must have low-level drawdown facilities. If an existing category 1 or 2 dam undergoes extensive repairs which require complete drawing down of the reservoir or is being repaired after the dam has failed, a low-level drawdown facility must be installed. A low-level drawdown facility may be either a gated pipe through the embankment that would allow the release of water below the primary spillway or sufficient available pumping capacity to draw down the reservoir. A breach analysis report must be completed by the owner for the proposed dam if a preliminary risk assessment indicates that the dam is a category 1 or 2 dam and must be submitted to the chief engineer with the plans and specifications required by § 74:02:08:09. A breach analysis, if required, must be performed with a simulated water surface at or above the top of the dam.

General Authority: SDCL 46-2-5, 46-7-3.
Law Implemented: SDCL 46-5-8 to 46-5-11, 46-5-47, 46-7-3, 46-7-5.

74:02:08:09. Contents of plans and specifications. Minimum plans and specifications submitted to the chief engineer for review must include the following:

1. A topographic map of the dam site specifying the legal description of the proposed dam and the location of the spillway and outlet works, and all test borings, test pits, and borrow pits. The map shall also show all property contiguous to the dam site and contiguous to the flood zone behind the dam and the owners of the contiguous property;

2. A profile along the dam axis showing the location, elevations, and depth of borings or test pits, including logs of bore holes or test pits;

3. A maximum cross-section of the dam showing the elevation and width of the crest; slopes of upstream and downstream faces; thickness of riprap; zoning of earth embankment; location of cutoff and bonding trenches; and elevations, size, and type of outlet conduit, valves, and operating mechanism;

4. Area-capacity curves of the proposed reservoir;

5. Detailed drawings showing plans, cross and longitudinal sections of the outlet conduits, valves and controls for operating the outlet, and trash racks;

6. The discharge capacity in cubic feet per second of the spillway for each foot in water depth above the spillway crest up to the maximum high-water level and the formula used in making the calculations;

7. Detailed plans of spillway structures, cross-section of the channel heading to and from the spillway, spillway profile, and procedures for operation of the spillway structure;
(8) Specifications including provisions during the period of construction for supervision by an engineer; and

(9) An EPP for a proposed category 1 dam.

Reconstruction, alteration, or repair that requires plans and specifications, or breaching of an existing dam may not begin until plans and specifications have been approved by the chief engineer. Construction of a new dam pursuant to this chapter may not begin until plans and specifications have been approved by the chief engineer and a water permit to construct the dam has been approved by the water management board pursuant to SDCL 46-2A-7 or 46-2A-11.

**Source:** 13 SDR 49, effective October 27, 1986; 13 SDR 129, 13 SDR 141, effective July 1, 1987; 13 SDR 197, effective July 2, 1987; 14 SDR 67, effective November 8, 1987.

**General Authority:** SDCL 46-2-5, 46-7-3.

**Law Implemented:** SDCL 46-1-15, 46-5-8 to 46-5-11, 46-5-47, 46-7-3, 46-7-5.

**74:02:08:10. Emergency preparedness plan.** An EPP shall be prepared by the owner for all existing category 1 dams and submitted to the chief engineer for approval prior to January 1, 1988.

**Source:** 13 SDR 49, effective October 27, 1986; 13 SDR 129, 13 SDR 141, effective July 1, 1987.

**General Authority:** SDCL 46-2-5, 46-7-3.

**Law Implemented:** SDCL 46-5-8, 46-7-3, 46-7-5.

**74:02:08:11. Periodic inspection program.** The chief engineer may inspect all category 1 dams at least once every five years or as often as necessary in order to ensure the continued safety of a dam.

**Source:** 13 SDR 49, effective October 27, 1986; 13 SDR 129, 13 SDR 141, effective July 1, 1987.

**General Authority:** SDCL 46-2-5, 46-7-3.

**Law Implemented:** SDCL 46-2-19, 46-5-8, 46-5-30, 46-7-3, 46-7-5.
Citation

South Dakota dam safety statutes are contained in the South Dakota Codified Laws (SDCL) Chapter 46-7, enacted in 1955 and last amended in 1996. Dam safety regulations are in Administrative Rules of South Dakota (ARSD) Chapter 74:02:08, which became effective in 1986 and were last amended in 1992.

History


Definitions/Dam Classifications

The term dam is defined in ARSD 74:02:08:01 (7) as "an artificial or manmade barrier that is 25 feet or more in height or that may store more than 50 acre-feet of water". A barrier is not considered a dam if the height does not exceed 6 feet regardless of storage capacity, or if the storage capacity at maximum storage elevation does not exceed 15 acre-feet regardless of height. The term height is defined in the same section as "the difference in the elevation of either the natural bed of the stream or watercourse or the lowest point on the toe of the dam, whichever is lower, and the crest elevation of the dam.

Dams are classified according to hazard potential and size:

<table>
<thead>
<tr>
<th>Category</th>
<th>Loss of Life Potential</th>
<th>Economic Loss Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>none expected</td>
<td>minimal</td>
</tr>
<tr>
<td>2</td>
<td>none expected</td>
<td>appreciable</td>
</tr>
<tr>
<td>1</td>
<td>potential loss</td>
<td>extensive</td>
</tr>
</tbody>
</table>

Size Classification

<table>
<thead>
<tr>
<th>Size</th>
<th>Storage Capacity (acre-feet)</th>
<th>Height (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>50 - 1000</td>
<td>25 - 40</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1001 - 50,000</td>
<td>41 - 100</td>
</tr>
<tr>
<td>Large</td>
<td>greater than 50,000</td>
<td>greater than 100</td>
</tr>
</tbody>
</table>

Design Criteria

Hydrologic:

74:02:08:07. Minimum spillway design flood requirements -- Exception. The hydraulic capacity of a dam must, by category and size, be such that the
following minimum spillway design floods can be passed through the spillways without overtopping the structure:

<table>
<thead>
<tr>
<th>Category</th>
<th>Size</th>
<th>Spillway Design Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Small</td>
<td>50-year frequency unless dam qualifies for exception</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>100-year frequency</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>0.5 PMF</td>
</tr>
<tr>
<td>2</td>
<td>Small</td>
<td>100-year frequency</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>0.5 PMF, unless dam qualifies</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>PMF</td>
</tr>
<tr>
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</tr>
<tr>
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<td>0.5 PMF</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>PMF</td>
</tr>
</tbody>
</table>

A spillway system for a dam must meet these requirements unless the owner can provide information and justification to show the chief engineer that the proposed design flow can be stored, passed through, or passed over the dam without failure of the dam or if a variance is granted pursuant to SDCL 46-7-5.3.

**Seismic:** South Dakota has no specific Seismic Criteria.

**Jurisdiction/Powers of Department**

The Chief Engineer of the SD Water Rights Program has the statutory authority to review and approve or disapprove plans to construct, alter, maintain or repair dams.

(See ARSD 74:02:08:03 and :09) The Chief Engineer, according to the provisions of SDCL 46-7-5, may also inspect dams, and if a dam is found to be in an unsafe condition, issue orders for remedial work to be done at the owner's expense. The statutes (Section 46-7-5.1) also grant to the Chief Engineer the authority to enter upon the property of a dam owner who has failed or refused to comply with an order to repair, for the purpose of making the necessary changes. Powers in an emergency situation are addressed in SDCL Section 46-7-5.2

Section 78:02:08:09 of the Rules states that the Chief Engineer must review and approve plans and specifications prior to the new construction, reconstruction, alteration, repair or breaching of a dam. In addition, the Water Management Board has the power to issue permits for construction and impoundment, and a permit must be obtained prior to the construction of a new dam. The Water Management Board is also responsible for the promulgation of rules to establish minimum safety standards for the design, construction, alteration, maintenance and repair of works. (See SDCL 46-7-3)

**Permit/Approval Process**

ARSD 74:02:08:09 requires that minimum plans and specifications for the design, construction, or alteration of dams be submitted to the Chief Engineer for review, and sets forth the types of information which must be included. Plans and specifications must be prepared, and construction or alteration inspections must be performed by a
registered professional engineer in accordance with the provisions of ARSD 74:02:08:01. Plans and specifications must be approved, and a water permit to construct must be acquired from the Water Management Board before new construction can begin.

Minimum spillway design flood requirements are listed for each hazard category and size of dam in the rules, section 74:02:08:07. Exceptions to these standards, standards for tailings dams, and additional design requirements are addressed in ARSD 74:02:08:07.01 through :07.04. Water permit application fees are addressed in SDCL Section 46-2-13.

**Fees:** Fees are based on storage capacity, the 1st 120 acre-feet = $150.00, the 2nd 120 acre-feet = $75.00 and then each additional 120 acre-feet = $25.00 plus a $50.00 inspection fee.

**Inspection Process**

ARSD 74:02:08:11 authorizes the Chief Engineer to inspect all category 1 dams at least once every 5 years or as often as necessary in order to ensure the continued safety of a dam. If the works are found to be unsafe, the Chief Engineer is authorized by law (SDCL 46-7-5) to issue an order for necessary changes within a specified time, and if the owner fails to make the repairs, the Chief Engineer may enter the property and put the works in a safe condition. Costs incurred are borne by the owner. Inspection fees are not assessed by the state.

Section 46-7-3 of the statutes charges the owner of a dam with the responsibility of keeping the works "in good repair at all times" to ensure safety of the works. Additionally, the rules (section 74:02:08:04) require that periodic inspections, detailed investigations, and analysis of existing dams be performed by registered professional engineer. No requirements regarding the scheduling or frequency of such inspections are found in the statutes or rules.

**Frequency of Inspections**

<table>
<thead>
<tr>
<th>Hazard Classification</th>
<th>Inspection Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Every 3 years.</td>
</tr>
<tr>
<td>Significant</td>
<td>Every 3 years.</td>
</tr>
<tr>
<td>Low</td>
<td>Every 3 years if state-owned</td>
</tr>
</tbody>
</table>

**Owner Non-Compliance/Violations/Penalties**

SDCL Sections 46-7-5 and 5.1 state that if upon inspection, the Chief Engineer finds that a dam is in an unsafe condition, he may issue an order for remedial work or repairs within a specified time limit. If the owner fails or refuses to make the required repairs, the Chief Engineer is authorized to enter the property and make them. Costs of such repairs are the responsibility of the owner, and may be recorded as a lien against the owner's property until paid. It is also noted in the statutes that the authorization of these activities does not limit any other remedy against the owner of the works, although additional penalties may include fines, and are referenced in SDCL 46-1-11.
Emergencies

Emergency procedures are addressed in SDCL 46-7-5.2. The Chief Engineer may immediately breach or repair any works if, in his judgment, it is necessary to protect human life from imminent danger. Emergency Preparedness Plans (Rules 74:02:08:09 & :10) are required to be prepared and submitted by the owners of all existing category 1 dams, and as part of the plans and specifications for proposed category 1 dams.

Liability

SDCL 46-7-5 provides that "The Chief Engineer, the state or its employees shall not incur any liability, either sovereign or personal, as a result of the duties imposed by this section or other provisions related to the inspection and repair, maintenance or alteration of works or the notification to owners of unsafe conditions".

Oversight

A hearing process by which owners may contest an order of the Chief Engineer is described in SDCL 46-7-5. Owners may file a written protest, which suspends the operation of the order until a hearing has been scheduled and action taken by the Water Management Board. In addition, Section 46-7-5.3 allows owners to petition the Chief Engineer for a variance to board rules relating to minimum spillway design requirements. The Chief Engineer then investigates the works and conducts the necessary analysis to determine the potential for damage to downstream residents or property in the case of failure due to inadequate spillway capacity. After the investigation and analysis, the Chief Engineer may recommend to the Water Management Board that the variance request be granted or denied.

SDCL 46-7-5.4 through 5.11 provides that owners of privately owned high hazard dams who refuse to correct an unsafe condition identified by order of the Chief Engineer may execute an affidavit assuming liability for the dam and holding the state harmless from all such liability and damages to the dam's failure. The affidavit must certify, among other things, that the owner's family is the only family inhabiting the floodplain.

Miscellaneous

1. SDCL 46-7-1 provides that the owners of a storage or diversion works may be required to make excess capacity of the works (over and above that needed by the owner for lawful application of water to beneficial use) available at reasonable rates, to any person entitled to use water for beneficial purposes. The Water Management Board is responsible for determining the amount of excess capacity, establishing reasonable rates, and setting the amount of compensation to be paid the owner for damage to the works.

2. The Water Management Board is authorized in SDCL 46-7-2 to require any appropriator to construct head gates and measuring devices before allowing the diversion of water.

3. Section 46-7-14 of the statutes makes it unlawful in the state for any person to interfere with, damage or destroy any dam or embankment, or to interfere with or damage any pier, boom, gate or piles used in securing a dam.
## State Citations

<table>
<thead>
<tr>
<th></th>
<th>STATUTE</th>
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<tr>
<td>Original</td>
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State Web Site:  [http://www.state.sd.us/denr/denr.html](http://www.state.sd.us/denr/denr.html)
E.42. Tennessee
RULES
OF
TENNESSEE DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF WATER SUPPLY

CHAPTER 1200-5-7
RULES AND REGULATIONS APPLIED TO THE SAFE DAMS ACT OF 1973

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1200-5-7-.01 GENERAL.


(2) Under the Act, certain provisions and conditions are established for the issuance and continuance of said certificates, and authority is granted the Commissioner for the adoption of general rules and regulations which he deems necessary to accomplish the purpose of the Act. To safeguard the public by reducing the risk of failure of such dams, the following rules and regulations are made to (1) effect the orderly inventory and inspection of existing dams in Tennessee; (2) provide for pre-construction review and approval of all future dam construction and alteration of dams; and (3) allow for a program of regular inspection of dams within the State.


1200-5-7-.02 DEFINITIONS. For the purpose of these rules and regulations, the term:

(1) Abutment means the bordering area of the dam site which functions as a support for the ends of the dam structure.


(3) Alterations means any repair, change to the structure, removal or change in use of a dam that may affect the safety of that dam.

(4) Applicant means any owner of an existing or new dam who applies to the Division for a "Certificate" under the provisions of the Act.

(5) Appurtenant Works means such structures as spillways, either in the dam or separate therefrom; the reservoir and its rims; water level outlet works; access bridges; and water conduits such as tunnels, pipelines or penstocks, either through the dam or its abutments.

(6) Certificate means a "Certificate" as required by the Act for the construction, alteration, or operation of a dam.
(7) Commence Construction means the actual start of on-site building but does not include preliminary surveying work or engineering plans preparation.

(8) Commissioner means the Commissioner of the Department of Environment and Conservation, his duly authorized representatives and in the event of his absence or a vacancy in the office of Commissioner, the Deputy Commissioner.

(9) Conduit means any closed waterway including but not limited to, a cast-in-place cut-and-cover culvert, a precast or prefabricated pipe embedded in the dam or foundation or a tunnel bored through the dam.

(10) Dam means any artificial barrier, together with appurtenant works, which does or may impound or divert water, and which either (1) is or will be twenty (20) feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier, as determined by the Commissioner, or (2) has or will have an impounding capacity at maximum water storage elevation of thirty (30) acre-feet or more. Provided, however, that any such barrier which is or will be less than six (6) feet in height, regardless of storage capacity, or which has or will have a maximum storage capacity not in excess of fifteen (15) acre-feet, regardless of height, shall not be considered a dam, nor shall any barrier, regardless of size, be considered a dam, if, in the judgment of the Commissioner, such barrier creates an impoundment used only as a farm pond. Diversion weirs, roadbeds, water tanks, and wastewater impoundment barriers as defined in this section are not dams.

(11) Days means calendar days, including Sundays and holidays.

(12) Division means the Division of Water Supply of the Tennessee Department of Environment and Conservation.

(13) Director means the Director of the Division of Water Supply of the Department of Environment and Conservation of the State of Tennessee.

(14) Diversion Weir means a structure substantially within the bed of a stream, designed to impound water only during low flow conditions, that would not cause substantial overflow of water onto the downstream floodplain in the event of failure, and meets the definition of a Category 3 dam in Rule 1200-5-7-.05(2)(b)(3).

(15) Easily Erodible means any soil with a plasticity index of less than ten (10) or greater than forty (40).

(16) Emergency Spillway means the spillway which conveys out of the reservoir any runoff in excess of that conveyed by the principal spillway.

(17) Engineer means a professional engineer registered by the State of Tennessee.

(18) Erosion Resistant means any soil not easily erodible.

(19) Existing Dam means any dam complete and capable of impounding water prior to October 3, 1987.

(20) Enlargement means any change in, or addition to, an existing dam or reservoir, which does or may raise the water storage elevation of the dam.
(Rule 1200-5-7-.02, continued)

(21) Factor of Safety means the ratio of the forces or moments resisting mass movement to the forces or moments tending to produce mass movement.

(22) Farm Pond means any impoundment used only for providing water for agricultural and domestic purposes such as livestock and poultry watering, irrigation of crops, recreation, and conservation, for the owner or occupant of the farm, his family, and invited guests, but does not include any impoundment for which the water, or privileges or products of the water, are available to the general public.

General Public as used above means patrons, members, and customers of institutions and/or clubs such as but not limited to summer camps, schools, retirement facilities, churches, private clubs, communes, hunting clubs, and health care facilities.

The following are some examples of impoundments which are not farm ponds:

Lakes owned or operated by a city, county, or the state, lakes that lie on three or more property parcels, residential subdivision lakes, industrial waste impoundments, industrial water supply impoundments, impoundments owned or used by hunting clubs, public water supply impoundments, commercial land development impoundments, and watershed district impoundments.

The following are some examples of impoundments which are farm ponds:

1. Impoundments directly used in support of farming operations.

2. Impoundments used for agriculture, livestock watering, recreation or conservation solely by the owner and not available to the general public.

(23) Foundation means the earth or rock on which the dam rests.

(24) Freeboard means the difference in elevation between the top of the dam and the maximum reservoir water surface that would result should the inflow design flood occur and should the outlet works function as planned.

(25) Impoundment means the water or liquid substance that is or will be stored by a dam.

(26) Maximum Water Storage Elevation means the elevation of the lowest point on the top of the dam, excluding any spillway structures.

(27) Maximum Storage Capacity means the volume of water stored at the maximum water storage elevation.

(28) New Dam means any dam that is not an existing dam.

(29) Normal Water Storage Elevation means the normal elevation of water surface which is obtained by the reservoir when the intake and outlet works are operating as planned during periods of normal precipitation and runoff and not during periods of drought or flood.

(30) Owner means any person who owns an interest in, controls, or operates a dam.

(31) Person means any individual, firm, association, organization, partnership, business trust, corporation, company, county, municipal or quasi-municipal corporation, public utility, utility or other district, the State of Tennessee and its departments, divisions, institutions, and agencies, and the duly authorized officers, agents, and representatives thereof, or any
combination of any of the above. Person does not include the United States government nor any agency owned by the United States or any agency thereof, nor those who own a dam or reservoir leased to or operated by the United States or any agency thereof, nor those dams licensed by the Federal Energy Regulatory Commission (previously the Federal Power Commission).

(32) Principal Spillway means the spillway which conveys normal runoff out of the reservoir.

(33) Probable Maximum Precipitation (PMP) means the greatest amount of rainfall of a six-hour duration which would be expected for a given drainage basin as determined by National Weather Service meteorological estimates. The PMP for 10 square miles shall be used for watersheds smaller than 10 square miles.

(34) Probable Maximum Flood (PMF) means the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is derived from the probable maximum precipitation (PMP).

(35) Removal means altering a dam such that it is no longer a dam as defined in these rules.

(36) Reservoir means any basin which contains or will contain the water impounded by a dam.

(37) Roadbed means the earth support work of a road prepared for surfacing which is not intended to impound water and which does not impound water continuously.

(38) Spillway means the feature of a storage or detention dam which is designed to release surplus water, and at diversion dams is a means to bypass flows exceeding those which are turned into the diversion system.

(39) Structural Height means the height of the dam measured from the natural bed of the stream or watercourse at the downstream toe of the barrier to the low point in the top of the dam.

(40) Wastewater Impoundment Barrier means an artificial barrier impounding a body of wastewater for the purpose of treatment and designed so that no surface runoff from areas adjacent to the barrier is introduced into the impoundment.

(41) Water Tank means a vessel designed and used to hold water.


1200-5-7-.03 DUTIES AND AUTHORITY. The general responsibility to administer and enforce the provisions of this Act and all rules and regulations thereunder shall be carried out by the Division of Water Supply of the Department of Environment and Conservation.


1200-5-7-.04 CERTIFICATES OF CONSTRUCTION, OPERATION, AND ALTERATION.

(1) General Provisions for Certificates.
Certificate applications shall be made on forms available from the Commissioner. Where there are multiple owners of a dam, each owner shall not be required to file an application if all owners are listed in the application filed by any one of them.

Application for a Certificate shall be made on forms available from the Commissioner and shall include the following information:

1. The name of the dam.
2. The name of the owner.
3. The legal address of the owner and/or lessee.
4. The location of the dam.
5. The type, size and height of the dam.
6. The storage capacity and reservoir surface area for normal and maximum water surface elevation.
7. The purpose or purposes for which the dam or reservoir is to be used.
8. In the case of an application by an owner or lessee of a dam, the names and addresses of all persons having a real property interest in the dam.
9. Such other plans and detailed information as the Commissioner may deem reasonable and necessary to fulfill his responsibilities hereunder.

An owner making application for an Alteration or Construction Certificate shall engage a qualified professional engineer, practicing in accordance with the registration laws of Tennessee, to plan, to prepare designs and specifications, and to supervise construction. This engineer must be qualified and experienced in the design and construction of dams of the type proposed and may be required to present evidence of his qualifications to undertake the project.

The Commissioner shall examine the application for a certificate of approval and cause an on-the-ground inspection to be made of the existing or proposed dam or reservoir and downstream floodplain. He shall then, within sixty (60) days of the receipt of the completed application for a certificate of approval, either grant the certificate or disapprove it in writing, stating the reasons for disapproval. In the case of applications for construction certificates, applicants who fail to submit, within 18 months from the date of the original application submittal, plans or other detailed information required by the Commissioner must refile an application and plans review fee to obtain a construction certificate.

Certificates are not transferable from one person to another or from one dam to another.

The Commissioner shall be notified of any proposed change in the operation of a dam.

Certificates shall not be granted until all fees required by the provisions of the Act and these rules have been paid.
(Rule 1200-5-7-.04, continued)

(h) It shall be a violation of the Safe Dams Act for any person to knowingly submit a false or inaccurate report, data, or information.

(2) Operating Certificate.

(a) No person shall operate a dam without an Operating Certificate.

(b) Application for an Operating Certificate for a new dam already having a Construction Certificate shall be made on forms available from the Commissioner within thirty (30) days of the completion of the dam. The application shall be accompanied by a history of the construction of the dam as maintained by the responsible engineer and by a statement signed by the responsible engineer certifying that the project was constructed in conformity with approved plans and specifications. The history of construction shall include but not be limited to:

1. A record of all geological and foundation data.
2. Date, location, and results of all material tests made.
3. Narrative of problems encountered during construction and changes in design. (Necessity for such changes shall be reported to the Division for approval before proceeding with construction.)
4. Photographs of completed foundations, critical features (such as construction and backfilling around conduits and low level outlet structures) and periodic stages of construction are desirable. These may be required for selected projects.
5. A record of permanent location points, benchmarks, and any instruments embedded in the structure.
6. Plans which show the actual construction of the dam after changes in the original design.

(c) Application for an Operating Certificate for a dam already having an Alteration Certificate shall be made within thirty (30) days from the completion of the alteration on forms available from the Commissioner. The application shall be accompanied by a statement signed by the responsible engineer certifying that the project was constructed in conformity with the approved plans and specifications. Additional information about the construction, such as that listed in 1200-5-7-.04(2)(b), must be included if the Commissioner determines that such information is needed to insure that the alteration is constructed properly.

(d) Any new dam or dam alteration must be constructed in accordance with the approved plans and specifications in order to receive an Operating Certificate.

(e) A new dam must not be allowed to impound water other than transient storage due to storm runoff until an Operating Certificate has been issued.

(f) Application for an Operating Certificate shall be made on forms available from the Commissioner. Any dam owner who is notified by the Commissioner of the need to apply for an Operating Certificate shall submit such application within thirty (30) days.
(g) Whenever legal title to a dam, for which a certificate of approval has been issued, is modified to create real property interests, including leasehold interests, in persons not listed on the application for such certificate, the owner of such dam shall make application for a new certificate within ninety (90) days of the date such interests are created, other provisions of this chapter notwithstanding.

(h) An Operating Certificate shall be issued only on evidence satisfactory to the Commissioner that the requirements of Rule 1200-5-7-.06 are being met for an existing dam and the requirements of Rule 1200-5-7-.07 are being met for a new dam.

(3) Construction Certificate.

(a) No person shall commence construction on a new dam without first obtaining a Construction Certificate from the Commissioner.

(b) Application for a Construction Certificate shall be made at least 60 days prior to the commencement of construction on forms available from the Commissioner.

(c) The Commissioner shall issue a Construction Certificate for construction of a new dam only if the requirements of Rule 1200-5-7-.07 Design Standards for New Dams, Rule 1200-5-7-.08 Engineering Requirements, and Rule 1200-5-7-.09 Fees, are met.

(d) The owner or his agent shall provide written notice to the Commissioner within five days of the date that construction commences and shall include the name of the engineer's inspector. For dams which are to be greater than 30 feet high or which will impound more than 100 acre-feet at the maximum storage capacity, the engineer in charge of construction or his inspector shall be on site whenever construction is occurring. The Commissioner may require such full time inspectors on smaller dams as he deems necessary. During construction the Commissioner may make such inspections as are needed to ensure conformity with approved plans and specifications. The inspection by the Commissioner does not relieve the owner or the responsible engineer from providing adequate inspection of the construction in progress.

(e) If at any time during the progress of the work the Commissioner finds that the work is not being done in accordance with the approved plans and specifications or approved revisions, he shall serve written notice to that effect to the owner. Such notice shall state the particulars in which the approved plans and specifications have not been complied with and may request the suspension of work until such compliance has been effected. If, after due notice, the owner, or his duly authorized agents, fails to comply with the requirements of the above notice, the Certificate by which construction is authorized shall be subject to revocation by the Commissioner.

(f) The owner or his agent shall give written notice of the completion of the dam to the Commissioner within five (5) days of the completion or in time for the Commissioner’s representative to be present at the final inspection with the engineer and the contractor, whichever occurs sooner.

(4) Alteration Certificate.

(a) No person shall make an alteration to a dam without first obtaining an Alteration Certificate.
(b) Application for an Alteration Certificate shall be made on forms available from the Commissioner at least 60 days prior to a planned alteration. The application shall identify the dam, state reasons why alteration, repair, or removal is necessary, give details of the proposed work, and provide an evaluation of the effects of the contemplated action. Plans and specifications will accompany the application along with a schedule for accomplishing the proposed project. The plans and specifications shall be submitted in conformance with Rule 1200-5-7-.08. The Commissioner may require full time inspection of any alteration construction by the responsible engineer or his inspector as he determines is necessary to ensure that the construction is performed properly.

(c) The owner or his agent shall provide written notice to the Commissioner within five days of the date that construction commences and shall include the name of the engineer's inspector if an inspector is required. The owner or his agent shall give written notice of the completion of the alteration to the Commissioner within five (5) days of the completion or in time for the Commissioner's representative to be present at the final inspection with the engineer and the contractor, whichever occurs sooner.

(d) In the event of an emergency where immediate repairs are necessary to safeguard life and property, such repairs shall be made immediately by the owner, or his duly authorized agents, and in accordance with Rule 1200-5-7-.10. In such events, the Commissioner shall be notified of the necessary emergency repairs and of work under way. The owner shall give written notice to the Commissioner within two days of learning of the emergency.

(5) Duration of Certificates.

(a) Construction and Alteration Certificates shall be for a single construction event. Construction Certificates shall be valid only for construction that begins within one year of issuance of the certificate.

(b) Alteration and Operating Certificates shall be valid for a definite period of time, not to exceed five (5) years, as determined by the Commissioner and stated on the certificate. In determining the period of approval, the Commissioner may take account of any circumstances pertinent to the situation, including, but not limited to, the size and type of dam, topography, geology, soil conditions, hydrology, climate, use of reservoir and the lands lying in the floodplain downstream from the dam, and the hazard category of the dam.

(6) Imposition of Additional Conditions - Hazard Categories.

(a) In granting a Certificate, the Commissioner may impose such conditions relating to the inspection, operation, maintenance, alteration, repair, use, or control of a dam or reservoir as he determines are necessary for the protection of public health, safety, or welfare.

(b) The Commissioner shall establish hazard categories for dams in accordance with Rule 1200-5-7-.05(2).

(7) Modification of certificates. The Commissioner may modify a Certificate or the conditions attached to it. Such modifications shall become effective ninety (90) days following issuance by the Commissioner of a revised Certificate, except when the Commissioner finds that a state of emergency exists, and that life or property would be endangered by delay. In case of
an emergency declared by the Commissioner, the new conditions shall be effective immediately.

(8) Suspension, Revocation, or Modification. The Commissioner may revoke, suspend, or modify any Certificate issued pursuant to the Act or deny the issuance of a Certificate for cause including, but not limited to the following:

(a) Violation of any condition of said Certificate.

(b) Obtaining a Certificate by misrepresentation, or failure to disclose fully all relevant facts.

(c) Violation of any provision of the Act or any rule promulgated thereunder.

(9) Rights of Appeal. Any applicant aggrieved by the denial of a Certificate or any term or condition in a Certificate may appeal to the Commissioner for a hearing within sixty (60) days of the date of issuance of the Certificate or the denial of a Certificate. After sixty (60) days no such appeal may be filed. All appeals shall be conducted in accordance with T.C.A. §69-11-118 of the Act and Uniform Administrative Procedures Act, T.C.A. §§4-5-301 et seq.


1200-5-7-.05 CLASSIFICATION OF DAMS. Dams will be classified in accordance to size, hazard potential, and design characteristics in order to formulate a priority basis for selecting dams to be scheduled in the inspection program and also to provide compatibility between guideline requirements and involved risks. When conditions at the dam or the hazard potential changes, the dam may be reclassified, and, if necessary, the dam must be upgraded to meet the standards of the new classification. The downstream conditions will be evaluated for hazard potential reclassification at least every 5 years.

(1) Size. The classification for size is based on the height of the dam and storage capacity in accordance with the table below. The height of the dam is established with respect to the maximum water storage elevation measured from the natural bed of the stream or watercourse at the downstream toe of the barrier, or if it is not across a stream or watercourse, the height from the lowest elevation of the outside limit of the barrier, to the maximum water storage elevation. For the purpose of determining project size, the maximum storage elevation will be considered equal to the top of dam elevation as defined in Rule 1200-5-7-.02(26). Size classification will be determined by either storage or height, whichever gives the larger size category. For size classification purposes, fractions of heights and storages shall be rounded down to the nearest whole number, e.g., 49.9 feet would be classified in the 20 to 49 feet category.

<table>
<thead>
<tr>
<th>Category</th>
<th>Storage (Ac-Ft)</th>
<th>Height (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>30 to 999</td>
<td>20 to 49</td>
</tr>
<tr>
<td>Intermediate</td>
<td>1,000 to 49,999</td>
<td>50 to 99</td>
</tr>
<tr>
<td>Large</td>
<td>50,000 or greater</td>
<td>100 or greater</td>
</tr>
</tbody>
</table>

(2) Hazard Potential Category.
(Rule 1200-5-7-.05, continued)

(a) Every dam will be assigned a hazard potential category to reflect the damage which might occur in the event of a dam failure, either structurally or operationally. The hazard potential will take into account a number of factors which will include, but not be limited to: the physical characteristics and degree of development of the site and valley downstream; the relationship of the site to industrial and residential areas; use of downstream properties throughout the danger reach; geological considerations; public and private uses of the impoundment or reservoir; and probable future downstream development.

(b) The hazard potential category of a dam may impose different standards at different sites for design and conditions for issuance of a Certificate and will have a bearing upon the frequency of inspections by the Commissioner. The following categories are established to permit the association of criteria with the damage that might result from such a failure.

1. Category 1 dams are located where failure would probably result in any of the following: loss of human life; excessive economic loss due to damage of downstream properties; excessive economic loss, public hazard, or public inconvenience due to loss of impoundment and/or damage to roads or any public or private utilities.

2. Category 2 dams are located where failure may damage downstream private or public property, but such damage would be relatively minor and within the general financial capabilities of the dam owner. Public hazard or inconvenience due to loss of roads or any public or private utilities would be minor and of short duration. Chances of loss of human life would be possible but remote.

3. Category 3 dams are located where failure may damage uninhabitable structures or land but such damage would probably be confined to the dam owner's property. No loss of human life would be expected.

(3) Removal of Dams. A dam shall be considered removed if it meets one of the following criteria.

(a) A portion of the dam is removed such that at the invert of the removed portion the dam is less than six feet high or has less than 15 acre-feet of storage capacity.

(b) A portion of the dam is removed or an open-channel spillway is built such that the invert of the removed portion is at the approximate elevation of the top of the tailings or sediment in the impoundment and the dam can no longer permanently impound water. In the case of embankment dams that receive surface runoff from areas adjacent to the impoundment, the open channel must be sufficiently large to preclude overtopping during the Freeboard Design Storm specified in Rule 1200-5-7-.06(3)(b) or Rule 1200-5-7-.07(4)(d), respectively.


1200-5-7-.06 STANDARDS FOR EXISTING DAMS.

(1) Stability. All dams shall be stable. There shall not be excessive cracks, sloughing, seepage or other signs of instability or deterioration. In cases where the stability of the dam is questionable, it shall be the responsibility of the owner to either demonstrate to the
(Rule 1200-5-7-.06, continued)

Commissioner that the dam is stable or drain the reservoir and remedy the unstable condition prior to refilling the reservoir.

(2) Slope Protection

(a) Earth embankments shall be protected from surface erosion by appropriate vegetation or some other type protective surface such as riprap or paving and shall be maintained. Examples of appropriate vegetation include, but are not limited to, Bermuda grass and fescue. All inappropriate vegetation such as honeysuckle, briers, bushes, and trees shall be removed from the dam. Some trees may be allowed to remain on a dam if the Commissioner concurs with a justification from a qualified engineer for doing so. Such justification must satisfy the Commissioner that the number, size, location, root characteristics, etc., of such trees will not adversely affect the dam’s structural integrity and safety nor impede inspection.

(b) The root mass of all trees larger than four (4) inches in diameter as measured at two feet above ground level shall be grubbed out and the hole backfilled with suitable fill material properly compacted. Smaller trees may either be cut at ground level or be removed as specified above. The Commissioner may require an engineer to oversee the tree removal.

(3) Emergency Spillway.

(a) All dams shall have an emergency spillway system with capacity to pass a flow resulting from a 6 hour design storm indicated in (b) below for a hazard classification appropriate for the dam. However, if the applicant's engineer provides calculations, designs, and plans to show that the design flow can be stored, passed through, or passed over the dam without failure occurring, or if he can successfully demonstrate to the Commissioner by engineering analysis that the dam is a safe structure and can certify that the dam is sufficient to protect against probable loss of human life downstream, said dam design may be approved by the Commissioner.

(b) Minimum Freeboard Design Storms.

<table>
<thead>
<tr>
<th>Hazard Potential Category</th>
<th>Size</th>
<th>Freeboard Design Storm (6 Hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 3 (Low)</td>
<td>Small</td>
<td>100 year</td>
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<tr>
<td></td>
<td>Intermediate</td>
<td>1/3 PMP</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>1/2 PMP</td>
</tr>
<tr>
<td>Category 2 (Significant)</td>
<td>Small</td>
<td>1/3 PMP</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>1/2 PMP</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>PMP</td>
</tr>
<tr>
<td>Category 1 (High)</td>
<td>Small</td>
<td>1/2 PMP</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>PMP</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>PMP</td>
</tr>
</tbody>
</table>

(c) No dam which is modified after original construction to increase its design storm to a 1/2 PMP or greater shall be required to pass a larger design storm unless the dam itself is enlarged or its normal or maximum storage volume is increased.

(4) Concrete and Masonry Dams. Concrete and/or masonry dams shall be structurally sound and shall have joints free of trees and other vegetation and shall show no signs of significant
structural deterioration such as excessive cracks, spallation, efflorescence and exposed reinforcing steel.


1200-5-7-.07 DESIGN STANDARDS FOR NEW DAMS.

(1) Design of Dams. Designs of dams shall conform to accepted practices and procedures of the engineering profession. Design references developed by the U.S. Army Corps of Engineers, Soil Conservation Service, and the Bureau of Reclamation may be used although the limiting criteria must be in accordance with these rules.

(a) All dams will be considered on an individual basis and reviewed in accordance with prevailing practices that are currently accepted by the engineering profession.

(b) All structures other than Category 3 dams constructed before 2008 shall be designed to withstand seismic accelerations of the following intensities: Zone 1 = 0.025g, Zone 2 = 0.05g, Zone 3 = 0.15g. Zones refer to "Geologic Hazards Map of Tennessee" by Robert A. Miller, 1978. All dams constructed during or after 2008 shall be designed to withstand the peak ground acceleration for an earthquake with a 10% probability of exceedance in 50 years as determined by the United States Geological Survey at the time the construction permit is issued. A different peak ground acceleration may be used if site specific studies using accepted engineering practices determine that a different value is appropriate.

(c) A complete engineering report, plans, and specifications shall be submitted for each dam.

(d) A complete geotechnical report shall be submitted as an integral part of the engineering report for all Hazard Potential Category (HPC) 1 and 2 dams (defined in Rule 1200-5-7-.05). For HPC 3 dams, sufficient investigation will have to be made to determine if the site and the fill material to be used are suitable, and this information will have to be included in the engineering report.

(e) A hydrologic/hydraulic analysis shall be submitted as an integral part of the engineering report for all dams. A breach analysis shall be submitted for all HPC 1 and HPC 2 dams and, for the former, shall be included in the Emergency Action Plan. The breach analysis must use surveyed cross sections at all stations where homes or other structures may be flooded. A sunny-day breach shall be modeled with the impoundment at the elevation of the emergency spillway invert when the failure begins, or, if there is no emergency spillway, at the elevation of the inlet of the principal spillway. Breach modeling under sunny-day, overtopping, or any other conditions, is site specific.

(f) All Category 1 dams shall submit to the Commissioner an Emergency Action Plan. This plan shall include, but not be limited to, the following:

1. Inundation information and an inundation map based on the breach analysis.

2. Procedures for notification of people downstream and law enforcement and other government agencies.
3. Resources for emergency actions such as contractors, equipment supply businesses, etc.

(g) Design calculations for all major components of the structure, i.e., spillways, pipes, etc., shall be included in the engineering report.

2. Principal Spillways.

(a) All component parts of the principal spillway except attached gates and trash racks will be of equal durability. The structural design criteria and detailing of such spillways will conform to recognized standards and codes of practice.

(b) In requiring the capacity of the principal spillway, the Commissioner may consider: (1) the benefits that accrue to the reduction of the discharge rate, (2) damages that may result from prolonged storage in the reservoir, (3) damages that may result from prolonged outflow, (4) the possibility of occurrence of significant runoff from two or more consecutive storm events within the time required to empty the reservoir, and (5) limitations in water rights or other legal requirements.

1. All conduits under a dam shall support the external loads imposed with an adequate factor of safety. They must withstand the internal hydraulic pressures without leakage under full external load and settlement. They must convey water at the design velocity without damage to the interior surface of the conduit.

2. Principal spillway conduits under earth dams shall be designed to support fill heights greater than the original constructed height where there is a reasonable possibility that it may become desirable to raise the embankment height at a later date to incorporate additional storage.

3. Principal spillway conduits shall be of reinforced concrete pipe, cast-in-place reinforced concrete, ductile iron pipe, or plastic pipe. Fill height and foundation conditions require special considerations for ductile iron pipe and plastic pipe so that each use will be checked on an individual basis; cradling or encasement in concrete may be required. Welded steel pipe is not acceptable for Category 1 and Category 2 dams, and corrugated metal pipe is not acceptable for any class of dam.

4. Principal spillway conduits shall be field tested for watertightness before backfilling. This requirement as well as the method of testing shall appear on the plans or in the specifications.

5. Rigid principal spillway conduits shall be designed as positive projecting conduits.

6. All reinforced concrete water pipe - steel cylinder type - prestressed, all reinforced concrete water pipe - steel cylinder type - not prestressed, and all reinforced concrete water pipe - noncylinder type - not prestressed, shall meet the AWWA specifications effective at the time of application.

7. Elliptical or other systems of reinforcement requiring special orientation of pipe sections are not permitted in pipe drop inlet barrels.

8. Reinforced concrete pipe, with or without cradles, shall be designed to support at least 12 feet of earth fill above the pipe at all points along the conduit.
(c) The minimum inside diameters of pipes shall be as follows:

1. Category 3 dams: The minimum diameter of the principal spillway barrel will be 18 inches for fill heights up to 50 feet and 24 inches for greater heights; or
   Where the drop inlet is designed hydraulically in such a way that the flow in the barrel under all possible conditions of discharge and foundation consolidation is positively known to be open channel flow with the water surface in the conduit subject to atmospheric pressure only, the minimum diameter shall be 18 inches; or
   Where welded steel pipe is used, the principal spillway shall be designed in accordance with conditions presented in Rule 1200-5-7-.07(2)(e).

2. Category 2 dams: The minimum diameter of the principal spillway barrel shall be 24 inches.

3. Category 1 dams: The minimum diameter of the principal spillway barrel shall be 30 inches.

4. Smaller conduits may be used if detailed calculations show them to be hydraulically and structurally adequate and all other requirements of Rule 1200-5-7-.07 are met.

(d) Where the barrel and cradle or bedding are to rest directly on firm bedrock thick enough so that there is essentially no foundation consolidation under the barrel, the cradle under the pipe need not be articulated.

(e) Principal spillways of welded steel pipe may be used for Category 3 dams under the following conditions, all of which must be met:

   1. The minimum diameter of the barrel will be 18 inches.
   2. The height of fill over the pipe will be less than 35 feet.
   3. Welded steel pipe conduits are to conform to American Society of Testing Materials (ASTM) specifications A53, A120, A135, A139, or A134 and are to be structurally designed as rigid pipe. A joint extension safety margin of 1.5 inches is to be provided for conduits on yielding foundations. Welded pipe is to be protected by an approved exterior coating.

(f) Conduit joints will be designed and constructed to remain water tight under maximum anticipated hydrostatic head and maximum probable conditions of joint opening, including the effects of joint rotation, and must have a margin of safety where required.

(g) Trash racks will be designed and built to provide positive protection against clogging of the spillway at any point. The average velocity of flow through a clean trash rack will not exceed 2.5 feet per second with the water elevation in the reservoir five feet above the top of the trash rack or at the crest of the emergency spillway, whichever is lower. Velocity will be computed on the basis of the net area of opening through the rack.

   For dry dams, a trash rack may be used in lieu of a ported concrete riser. The principal spillway trash rack will extend sufficiently above the anticipated sediment elevation at the inlet to provide full design flow through the spillway with velocities through the net ...
RULES AND REGULATIONS APPLIED TO  
THE SAFE DAMS ACT OF 1973 

(Rule 1200-5-7-.07, continued)

area of the trash rack above the sediment elevation not in excess of two feet per second when the water surface in the reservoir is five feet above the top of the trash rack.

(h) All closed conduit principal spillways designed for pressure flow will have an anti-vortex device.

(3) Drawdown Facilities.

(a) All new dams shall have a drawdown facility. This facility shall be capable of draining the reservoir in ten (10) days or less. It may be assumed that this requirement has been met if seventy-five (75) percent of the liquid volume from the normal water storage elevation has been evacuated in the ten (10) day period. The use of a longer period must be justified.

(b) The necessary drawdown facility for any dam shall be made an integral part of the principal spillway structure if the principal spillway configuration warrants it, but in no case will the drawdown facility be valved on the downstream side of the embankment. Siphon facilities will be accepted after proper engineering justification.

(c) The above stated requirement does not apply in the case of a water supply line through the dam, but in such cases provision must be made for a positive shutoff on the upstream side of the structure.

(d) Drawdown systems shall be maintained in an operable condition. Drawdown valves shall be opened and closed at least annually to ensure operability.

(4) Emergency Spillways.

(a) An emergency spillway shall be provided for each structure, unless the principal spillway is large enough to pass the routed freeboard hydrograph discharge and the debris that comes to it. A conduit type principal spillway having a barrel with a cross-sectional area of 20 square feet or more, an inlet which will not clog, and an elbow designed to facilitate the passage of debris, is the minimum size and design that may be utilized without an emergency spillway. If a principal spillway of this type and size is not provided, danger from clogging requires the use of an emergency spillway regardless of the volume of storage provided.

(b) A single uncontrolled open channel spillway may be used for all purposes provided it is designed to accommodate all discharges, including the freeboard storm, without damage to the structure. However, a positive means to drain the reservoir must also be provided.

(c) Emergency spillways shall be proportioned so that they will pass the freeboard hydrograph at the safe velocity determined for the site. They shall have sufficient capacity to pass the freeboard hydrograph with the water surface in the reservoir at or below the maximum storage elevation.

(d) Minimum Freeboard Design Storms

<table>
<thead>
<tr>
<th>Size</th>
<th>Freeboard Design Storm (6 Hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>½ PMP</td>
</tr>
<tr>
<td>Intermediate</td>
<td>PMP</td>
</tr>
</tbody>
</table>

July, 2008 (Revised) 15
(e) All dams shall have an emergency spillway system with capacity to pass a flow resulting from a 6 hour design storm indicated in (d) above for the size corresponding to the dam. Any new dam constructed between October 3, 1987, and February 19, 2001, shall be required to pass the Freeboard Design Storm specified in subparagraph 1200-5-7-.06(3)(b). However, if the applicant's engineer provides calculations, designs, and plans to show that the design flow can be stored, passed through, or passed over the dam without failure occurring, or if he can successfully demonstrate to the Commissioner that the dam is a safe structure and can certify that the dam is sufficient to protect against probable loss of human life downstream, said dam design may be approved by the Commissioner. The establishment of the criteria in (d) above does not eliminate the need for sound engineering judgment but only establishes the lowest limit of design considered acceptable.

(f) The relationship between the water surface elevation in the reservoir and the discharge through the emergency spillway shall be evaluated by computing the head losses in the inlet channel upstream of the control section, or if a control section is not used, by computing the water surface profile through the full length of the spillway. Manning's formula will be used to evaluate friction losses and determine velocities.

(g) The freeboard hydrograph shall be routed through the reservoir starting with the water surface at the elevation of the principal spillway inlet.

(h) A vegetated earth or unlined emergency spillway shall be approved when computations indicate that it will pass the design storm without jeopardizing the safety of the structure. The risk of recurring storms, excessive erosion, and inadequate vegetative cover will be considered acceptable in such a spillway when its average frequency of use is predicted to be not more frequent than once in 25 years for Category 3 dams, once in 50 years for Category 2 dams, and once in 100 years for Category 1 dams.

1. Vegetated and earth emergency spillways may be open channels and may consist of an inlet channel, a control section and an exit channel. Subcritical flow exists in the inlet channel and the flow may be supercritical in the exit channel.

2. Vegetated emergency spillways may be trapezoidal in cross-section and shall be protected from damaging erosion by a grass cover. They shall be used at sites where a vigorous grass growth can be sustained by normal maintenance without irrigation.

3. Earth spillways may be used in those areas where vegetative growth cannot be maintained. They are similar to vegetated spillways but are designed for lower permissible velocities and less frequent use. The needed maintenance after a flow occurs is the responsibility of the certificate holder.

4. Earth and vegetated emergency spillways are designed on the basis that some erosion or scour is permissible if its occurrence is infrequent, if maintenance facilities are provided, and if damage from a severe storm, as represented by the freeboard inflow hydrograph, will not endanger the structure.

5. A Manning's "n" of 0.040 may be used for determining the velocity and capacity in vegetated spillways. Permissible velocities in earth spillways may be based on an "n" value of 0.020 but the capacity of earth spillways will be based on an appraisal of the roughness condition at the site.
6. When the anticipated average use of a vegetated emergency spillway is more frequent than once in 50 years, the maximum permissible velocity will be in accordance with the values given below. The values may be increased 10 percent when the anticipated average use is not more frequent than once in 50 years or 25 percent when the anticipated average use is not more than once in 100 years. The maximum velocity limitations given below for vegetated or earth emergency spillways apply to the exit channel.

7. The values given will be the upper limit for all grasses. Values for grasses or grass mixtures will be determined by comparison with the values shown, with due consideration given to the growth characteristics and density attained in the local area by the species under consideration.

8. Where bona fide studies or investigations have been made to determine the permissible velocity for a specific soil and site, these values may be used in lieu of those shown below.


<table>
<thead>
<tr>
<th>Grasses or Grass Mixtures</th>
<th>Maximum Permissible Velocity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Type</td>
<td>Slope</td>
</tr>
<tr>
<td>Erosion Resistant</td>
<td>0-5 %</td>
</tr>
<tr>
<td></td>
<td>5-10%</td>
</tr>
<tr>
<td>Easily Erodible</td>
<td>0-5 %</td>
</tr>
<tr>
<td></td>
<td>5-10%</td>
</tr>
</tbody>
</table>

(5) Earth Embankments.

(a) Sufficient freeboard shall be provided to prevent overtopping with the passage of the freeboard hydrograph plus the additional freeboard required by the site for wave action.

(b) The top width of earth embankments will not be less than the value given by the following equation:

\[ W = \frac{H + 35}{5} \]

where \( H \) = height of embankment in feet.

\( W \) = minimum top width of embankment in feet.

(c) The earth embankment will be riprapped or have other wave erosion protection provided over the full range in stage between three feet above and below the normal pool elevation.

(d) All dams shall be designed and constructed to prevent the development of instability due to excessive seepage forces, uplift forces, or loss of materials in the embankment, abutments, spillway areas, or foundation. Seepage analysis for design and inspection during construction shall be in sufficient detail to prevent the occurrence of critical
(Rule 1200-5-7-.07, continued)

seepage gradients. All dams permanently impounding water shall be constructed with an embankment toe drain with drain pipes installed to discharge the seepage.

(e) All dams shall have a permanent bench mark monument located near the embankment in undisturbed soil or in bedrock. This bench mark shall be detailed in the plans and specifications.

(f) All dams shall be protected from surface erosion by appropriate vegetation or some other type of protective surface such as rip-rap or paving and shall be maintained. Examples of appropriate vegetation include, but are not limited to, Bermuda grass and fescue. All inappropriate vegetation such as honeysuckle, briers, bushes and trees shall be kept off the dam by routine mowing.


1200-5-7-.08 ENGINEERING REQUIREMENTS.

(1) Engineering Standards. The design engineer shall take into consideration the standards and recommendations made in accepted publications concerning dams, and also the current practices of the various agencies that may be concerned with the design and construction of dams.

(2) Engineering Drawings. All drawings shall be submitted in the form of permanent type drawings of a standard and uniform size. Drawings that do not conform to standard practices and drawings that are not easily legible will not be reviewed.

(3) Engineering Plans. At least four (4) complete sets of construction plans and specifications shall be submitted to the Commissioner. Upon approval, each submitted copy shall be stamped accordingly, two copies retained for the Division's file, and the remaining copies returned to the applicant. An approved copy bearing the stamp of approval must be kept at the construction site during all times of construction.

(4) Engineering Report. The engineering report shall be submitted for review prior to or along with the submittal of the plans and specifications. The engineering report is the basis of the design and shall include, but not be limited to, the data and analyses required by Rule 1200-5-7-.07 for new dam construction or by Rule 1200-5-7-.06 for alterations to existing dams.

(5) Plans and Specifications. The plans and specifications shall provide the details of the structure designed in the engineering report, the construction materials, the construction methods, and shall include, but not be limited to, the following:

(a) Standard and uniform paper. Preferably 24" x 36".

(b) Cover sheet.

(c) Site plan.

(d) Embankment plan and profile views.

(e) Spillways plan and profile views.
(Rule 1200-5-7-.08, continued)

(f) Seepage control detail including collection system.

(g) Wave protection detail.

(h) Service spillway outfall structure and energy dissipator details.

(i) Location of permanent bench mark.

(j) Location sketch.

(k) Actual mean sea level (MSL) elevations of the dam and its appurtenant works.


1200-5-7-.09 FEES.

(1) Project Review Fee. A project review fee will be charged by the Commissioner for all new dam and reservoir construction. The fee is to accompany the application for a Construction Certificate. New dams will not be charged for the inspection fee for the initial Operating Certificate. The fee will be based upon the size categories shown below, but in no case shall the total project review fee exceed one percent (1%) of the total estimated cost of the dam.

<table>
<thead>
<tr>
<th>Height of Dam</th>
<th>Charge for Project Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 40 feet</td>
<td>$1000</td>
</tr>
<tr>
<td>41 - 60 feet</td>
<td>$1500</td>
</tr>
<tr>
<td>greater than 60 feet</td>
<td>$2000</td>
</tr>
</tbody>
</table>

If a construction certificate expires without construction having begun, the certificate holder may re-apply for a new construction certificate within one year of the expiration date of the original certificate and pay a project review fee of only $500, provided that no substantial changes have been made to the plans and specifications.

(2) Safety Inspection Fee. Fees will be charged for Safety Inspections by the Division. The fee is to accompany the application for an Operating Certificate. The fee will be $500 per inspection. All fees and charges shall be payable only by check or money order to the State of Tennessee.

(3) No fees shall be imposed for inspections of dams which are constructed, operated, or maintained by a watershed district pursuant to T.C.A. §69-7-101 et seq.


1200-5-7-.10 EMERGENCY ACTION BY OWNER. Nothing in T.C.A. §69-11-117 of the Act, whereby the Commissioner has the authority to act under a state of emergency requested of and declared by the Governor, nor any provisions or requirements for Certificates, shall be construed to relieve or prevent an owner or operator of a dam of the legal duties, obligations, or liabilities incident to the ownership or
operation of the dam. In the event of an emergency where immediate repairs are necessary to safeguard
life and property, such repairs shall be made immediately by the owner or his duly authorized agents. In
such events, the Commissioner shall be promptly notified of the necessary emergency repairs and of
work under way, if any, and such work shall conform to such requirements as specified by the
Commissioner.

filed August 19, 1987; effective October 3, 1987. Amendment filed August 2, 1995; effective October 15,
1995.

1200-5-7-.11 REPEALED.

E.43. Texas
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1.0 Introduction
These guidelines present instructions, standards, and accepted procedures for the hydrologic and hydraulic analysis of existing and proposed dams in Texas. They also clarify the expectations of the TCEQ with respect to submitted analyses, and simplify review by standardizing processes and elements so they will be acceptable to the reviewer. Though the guidelines are relatively specific, the engineer may always submit alternate procedures that either are more conservative or are sufficiently explained and justified.

Dams and spillways designed to comply with TCEQ rules, using hydrologic and hydraulic procedures of the Natural Resources Conservation Service, are acceptable, provided that they are shown to be equally conservative as, or more conservative than, designs developed using the criteria contained in this set of guidelines. The breach-analysis procedures described in Chapter 8 do not depend on which design method is used, and more exact full breach-analysis procedures can always be used in lieu of the conservative simplified procedures.

1.1 Regulatory Authority
These guidelines supplement the Texas Administrative Code, Title 30, Part 1, Chapter 299.

1.2 Professional Responsibility and Duty
These guidelines assume that anyone using or referencing them is a licensed professional engineer or is working under the guidance of a professional engineer. Users should also have appropriate knowledge of the processes and methodologies referenced, and be able to use standard software common in the engineering profession that is appropriate to the analysis.

The hydrologic and hydraulic analyses associated with the design or evaluation of dams, or their rehabilitation, in Texas is considered the practice of Engineering and, as such, subject to the Texas Engineering Practice Act, as amended.

1.3 Copies
Copies of the guidelines may be viewed online at <www.tceq.state.tx.us/goto/damhhguidelines>.

1.4 Feedback
Direct any questions or comments on the content of these guidelines to the coordinator of the Dam Safety Program, Texas Commission on Environmental Quality.

1.5 Applicability
The guidelines described in this document apply to all dams and all design floods determined for dams under the jurisdiction of the TCEQ Dam Safety Program. Some dams may also need to meet the requirements of other agencies such as the NRCS or the U.S. Army Corps of Engineers. Design floods developed to meet requirements of these agencies will be accepted by TCEQ as long as their results are shown to be at least as conservative as would be required by this document.

1.6 Definitions
Many of the words and terms used throughout these guidelines are defined in the Glossary.

1.7 Acknowledgments
These guidelines were prepared by Freese and Nichols, Inc., Austin, under the direction of Warren D. Samuelson, P.E., coordinator of the Dam Safety Program, Texas Commission on Environmental Quality, and Jack Kayser, Ph.D., P.E., senior water resources engineer, Dam Safety Program, TCEQ.

These guidelines have drawn liberally upon the work of many agencies and individuals who have greatly contributed to the state of the art in hydrologic and hydraulic designs of dams in the United States. Acknowledgments of the contributions of these agencies and individuals appear throughout the text of these guidelines.
Appreciation is expressed to the following organizations and firms that supplied data and gave input or reviewed these guidelines:

**Federal Agencies**
- U.S. Army Corps of Engineers
- Natural Resources Conservation Service
- U.S. Bureau of Reclamation
- Interagency Committee on Dam Safety
- Federal Energy Regulatory Commission
- National Weather Service
- U.S. Geologic Survey

**State Agencies**
- Texas Department of Transportation
- North Central Texas Council of Governments

**Professional Associations**
- Association of State Dam Safety Officials
- American Society of Civil Engineers

**Project Consultants**
- Freese and Nichols, Inc., Austin
- Raymond Chan and Associates, Austin
2.0 Introduction
All hydrologic and hydraulic analysis reports investigating one or more dams in Texas are to be prepared by, or under the direct supervision of, a professional engineer with direct responsibility for the analysis of the dam. Reports submitted to the TCEQ must document the technical basis for the analysis sufficiently for a thorough review by TCEQ personnel, including methods used, key assumptions, the results and conclusions of the analysis, and any recommendations. Such reports must also include all pertinent and significant data utilized in the analysis and necessary for the TCEQ to perform their desired review of the analysis. The engineer should supply the required information regardless of whether the analysis is a standalone review of an existing dam or supports the design of a new dam or the rehabilitation of an existing one.

The TCEQ’s requirements as to detailed preparation of plans, specifications, and designs are not part of these guidelines.

2.1 Minimum Requirements for Submission
For hydrologic and hydraulic studies that are either individual or part of a design project, include their bases and results in a report. Fill in all appropriate Dam Information Forms (Appendix B) and submit them with the report. Tabulate the following data in the report, if applicable:

- Rainfall and Runoff Information
  - characteristics for the entire watershed and all subbasins, as applicable to calculation methods
  - data used to develop parameters describing the watershed characteristics, including any available calibration data
  - design-flood inflow and discharge hydrographs
  - reservoir routing data and parameters
  - discharge-frequency relationships
  - determinations of hydraulic roughness
  - water-surface profiles

- Dam and Spillway Information
  - spillway stage–discharge relationships
  - maximum height and reservoir storage values
  - elevation-area-storage relationship
  - key operational elevations for the dam and spillway
  - pertinent spillway dimensions
  - energy-dissipating facility features
  - results of hydraulic model tests when the hydraulic design is based on a model study
  - details of low-flow release structures

- Breach-Analysis information
  - breach parameters
  - profile of peak flood levels
  - profile of warning time versus distance downstream
  - delineation on the best available mapping base of the extent of inundation for the normal pool and design-flood breach events for the project
  - identification of any potential loss of public services and of critical facilities
  - assessment of hazard-potential classification
3.0 Introduction
Dams more than 6 ft high fall under TCEQ jurisdiction and are to comply with TCEQ regulations on dam safety regardless of whether the TCEQ requires a water right for the impoundment.

The TCEQ regulations and these guidelines do not apply to:
- dams designed by, constructed under the supervision of, and owned and maintained by federal agencies such as the Corps of Engineers and the Bureau of Reclamation;
- embankments used for roads, highways, and railroads, including low-water crossings, that may temporarily impound floodwater;
- dikes or levees designed to prevent inundation by floodwater; and
- off-channel impoundments authorized by the TCEQ under Texas Water Code Chapter 26.

3.1 Dam Size Classification
The classification for size based on the maximum height of the dam or maximum reservoir storage capacity shall be in accordance with Chapter 299 of the Texas Administrative Code (TAC).

3.2 Design-Flood Criteria
Existing and proposed dams must safely pass the design-flood hydrograph, expressed as a percentage of the probable maximum flood. The design flood is determined based upon the size (previous section) and hazard-potential classification (Chapter 9) of the dam. TAC Chapter 299 describes the required design flood for the various combinations of size and hazard classification. Safely passing a flood for an existing dam means discharging the flood without a failure of the dam or one of its critical elements. A failure would be considered an unintended release of impounded water due to the loss of all or a portion of the dam or affiliated structure. For dams without a structural design that allows for safe overtopping, any overtopping of an earthen embankment would be considered not safely passing the flood.

Design-flood criteria established by other public agencies, if shown to be more conservative, will generally be acceptable. Those that may produce a less conservative result, such as the FEMA Inflow design-flood methodology, if based on a properly prepared incremental risk analysis, may be acceptable, but will require a thorough review of the risk analysis as well as the hydrologic and hydraulic analyses.

3.3 Minimum Freeboard
No freeboard for wave action is required for existing dams above the peak design-flood level, either for determination of existing conditions or for the design of an upgrade or modification.

New dams should have appropriate freeboard. As part of the freeboard calculations for a proposed new dam, consider an appropriate wave run-up. Overtopping from wave action due to design wind loads, as described below, is generally not allowable. It may, however, be acceptable if the design engineer can show reasonable cause—as in the case of a new concrete dam or a dam with other appropriate slope protection on the downstream side. Freeboard between the effective crest of the dam and the various water surface elevations that may be associated with the reservoir is to be based on suitable assumed wind speeds and related wave heights.

The longer that a reservoir is shown to be at or above a certain level, the higher the potential wind speeds that should be considered. In addition, the timing of the peak lake level with respect to the storm event that generated it is also a factor. For example, the freeboard above the maximum normal operating level should be greater than or equal to the maximum wave height, including run-up, caused by the maximum wind potential along the maximum fetch of the reservoir.

Freeboard above higher flood levels in the reservoir, such as the top of any dedicated flood pool, should consider wave height and run-up for lesser winds consistent with the potential risks associated with wind-driven waves overtopping or eroding the embankment and potential flood durations at those levels. Freeboard above the maximum reservoir level resulting from the design flood does not need to reflect significant wave height from unusual wind conditions, if it can be shown that the peak...
reservoir level occurs after the intense portions of the storm that generated the design flood. Multiple storm events do not need to be considered.

The freeboard should include the expected wind effects that could occur during the design-flood event if the peak reservoir level occurs within the critical portion of the storm event itself. This critical portion would generally be considered the portion of the critical duration prior to the break point, if the temporal distribution described in Chapter 4 is employed. An acceptable rule of thumb would be to use 50 percent of the maximum wind speed if the peak occurs before the break point, 33 percent of the maximum if the peak is after the break point but before the onset of the critical storm, and 20 percent of the maximum wind speed if the peak occurs after the end of the assumed rainfall event.

These are general guidelines and the engineer should provide reasonable explanation of assumed winds for freeboard determination. Appropriate determinations will be needed if a different temporal distribution is used.

All freeboard calculations should include the expected future settlement and consolidation of the embankment after construction in addition to wave run-up.
4.0 Introduction
The design flood hydrograph for existing and proposed dams shall be derived from the appropriate percentage of the probable maximum flood (PMF), which is, in turn, derived from the estimated runoff resulting from the probable maximum precipitation (PMP). The PMP varies depending on the size and shape of the dam’s contributing drainage area. The intent of the precipitation analysis is to find the critical storm size, location, orientation, and duration that would produce the most critical loading on the dam. PMP values in Texas are generally derived from HMR-51 (Schreiner and Riedel 1978) and HMR-52 (Hansen, Schreiner, and Miller 1982) for most of the state and HMR-55A (Hansen et al. 1988) for parts of extreme west Texas. (HMR = ‘hydrometeorological report.’) These would apply unless an approved site-specific PMP study is performed. All references to “PMP” are to one of these sources of derivation.

4.1 Watershed Delineation
Many of the dams in Texas can be modeled appropriately with a single basin. However, many will need to be divided into multiple subbasins. The size and delineation of the subbasins is dependent on the rainfall-runoff method used and various hydrologic factors. Subdivision should also be considered if there are portions of the drainage basin that:

- possess hydrologic characteristics obviously different from the average characteristics of the total basin,
- may contribute to delays in flood passage, such as upstream lakes,
- are controlled by large constrictions that can act as hydraulic control structure by restricting, cross-sectional areas and attenuating water flow, as may occur at some bridges,
- have a total drainage area that is too large for averaging a single storm distribution, or
- have stream gauges or observed data that may be used for calibration.

Watersheds should be delineated and their characteristics determined in accordance with the standards of the following references:
- EM 1110-2-1417 (U.S. Army Corps of Engineers, 1994)

4.2 Minimum PMP Duration
The PMP depths for a particular storm size and range of storm durations are used to determine the critical storm duration for a dam. The intent is to review multiple potential durations of storm events in order to determine a critical event, namely, that which produces the maximum reservoir level. Possible durations would include 1, 2, 3, 6, 12, 24, 48, and 72 hours. The minimum design-storm duration is based on the total contributing drainage area for the dam, as shown in Table 4.1.

<table>
<thead>
<tr>
<th>Contributing Drainage Area (DA) (sq mi)</th>
<th>Minimum Storm Duration (hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA &lt; 25</td>
<td>1</td>
</tr>
<tr>
<td>25 ≤ DA &lt; 100</td>
<td>3</td>
</tr>
<tr>
<td>100 ≤ DA &lt; 1,000</td>
<td>6</td>
</tr>
<tr>
<td>1,000 ≤ DA &lt; 10,000</td>
<td>24</td>
</tr>
<tr>
<td>DA ≥ 10,000</td>
<td>72</td>
</tr>
</tbody>
</table>

The PMP depths should first be determined for the minimum storm duration listed in Table 4.1. Then each possible duration up to 72 hours should be reviewed in order to determine the critical duration. For example, for a reservoir with a drainage area of 80 sq mi, the minimum duration is 3 hr. First, the peak reservoir level from a 3-hour PMP is determined, then that of a 6-hour and a 12-hour PMP event. This continues until the peak reservoir level from a longer duration event is lower than the previous one, thus bounding
the critical duration. The duration that produces the maximum reservoir level then becomes the critical duration and that duration event is used for the PMF. If the 72-hour PMP produces the maximum reservoir level, then a 72-hour PMF is utilized. No durations longer than 72 hours need to be reviewed.

4.3 Temporal Distribution of Design-Storm Precipitation

Distribute the total depth of the PMP, for both the entire basin as well as for each subbasin, as appropriate, temporally in accordance with the dimensionless parameters of Figure 4.1 and Equation 4.1. Since the new temporal distributions are different for each duration, a dam needs to be evaluated for all of the durations required by Section 4.2 and the peak elevation for each duration must be estimated in order to determine the critical duration for that structure. This critical peak lake level may then be compared, if desired, to the peak lake level determined by other methods in order to determine which method is more conservative.

The new temporal distributions will tend to reduce the conservatism of the PMP on the flood routings by reducing the intensity of the peak portion of the rainfall event. The result will be tend to include flatter inflow hydrographs, significantly lower peak inflow rates, and slightly lower peak lake levels.

The development of the guideline’s temporal distributions is based on observed evidence that near-PMP values for significantly different durations have not occurred in the same event. In other words, though previous methods assumed the PMP value for the peak one-hour event occurred within the same event as the peak PMP value for 24 hours and also for 72 hours, such storms have never actually been observed. Historical data has also shown that the most extreme near-PMP events tend to be front loaded, with most of the rainfall occurring early in the event. The guidelines attempt to provide a reasonably conservative temporal distribution for the given set of durations. It is important to note that only the distribution of the rainfall has changed; the total rainfall amounts for any given duration are unchanged from previous methods. More

![Figure 4.1. Temporal Distribution of Total Depth of PMP for All Durations of PMPs](image)

This distribution can be estimated within calculations and spreadsheets as:

Eq. 4.1

For $T \le x$:

$$P = \left( \frac{T}{x} \right) \cdot y$$

For $T > x$:

$$P = y + \left( \frac{100-y}{100-x} \right) \cdot (T-x)$$

Where:

$P$ = percentage of total precipitation

$T$ = percentage of storm duration

$x, y$ = coordinates of breakpoint

The breakpoint will vary depending on the duration storm being analyzed (Table 4.2). For a one-hour event, a breakpoint with coordinates at 50 percent, 50 percent is listed for consistency, though that represents a linear distribution of rainfall over the hour.
conservative distributions can be used, such as the HMR-51 or the NRCS distributions.

### Table 4.2. Breakpoints for PMP Temporal Distributions

<table>
<thead>
<tr>
<th>Duration (hr)</th>
<th>x (%)</th>
<th>y (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>3</td>
<td>33</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>33</td>
<td>60</td>
</tr>
<tr>
<td>12</td>
<td>33</td>
<td>70</td>
</tr>
<tr>
<td>24</td>
<td>33</td>
<td>80</td>
</tr>
<tr>
<td>48 to 72</td>
<td>33</td>
<td>85</td>
</tr>
</tbody>
</table>

#### 4.4 Storm Location and Spatial Distribution of PMP

**Drainage Areas ≤ 10 Square Miles:** Apply the total depth of the PMP, estimated as the point values delineated in HMR-51 and HMR-52, over the entire drainage area for all storm durations.

**Drainage Areas > 10 Square Miles:** Distribute the total depth of the PMP for all storm durations spatially over the drainage area using the single-centered concentric ellipse pattern and methodology specified in HMR-52. For single basins, the center of the storm should generally be at the centroid of the basin and a basin-average total depth of design storm precipitation calculated for the specified duration. For larger basins, when the watershed is divided into multiple subbasins, the center of the PMP storm isohyets must be moved to multiple locations away from the geometric centroid of the overall drainage area to verify the critical design storm location and orientation that produces the maximum corresponding PMF level in the reservoir. This will generally be the same storm center that produces the maximum basin-average total PMP depth. However, in very large basins (greater than 10,000 sq mi), the location of the storm center producing the maximum rainfall depth and the storm center producing the maximum basin discharge may not be the same, depending on the size and orientation of the various tributaries, so the full flood routing through the reservoir should include iterative trials to determine the critical storm location.
5.0 Introduction
Precipitation hyetographs, developed as described in Chapter 4, that are calculated for the watershed above a reservoir are used to develop estimates of runoff hydrographs in two basic steps. First, the excess precipitation is generated by deducting estimated losses from the total precipitation. This excess precipitation will generate the full volume of runoff from the storm event. In the second step, the excess rainfall is applied to a suitable unit hydrograph for the basin or subbasins to produce a runoff hydrograph.

5.1 Antecedent Moisture Conditions
Superimpose the PMP upon watershed soils assumed to be saturated. This will equate to losses at the beginning of the design storm equal to zero or Natural Resources Conservation Service Antecedent Runoff Conditions III (ARC III), or some other equivalent and approved assumptions. In Texas, there is no need to analyze snowmelt contributions to runoff or frozen ground conditions for infiltration for design-flood calculations.

5.2 Infiltration Losses—Excess Precipitation
Determination of excess rates of precipitation and infiltration losses can be determined by one of several precipitation loss methods. The two most common are:
- Initial and Constant-Rate Loss Method
- NRCS Curve Number Loss Method
Other usable methods include:
- Green and Ampt Loss Method
- Holton Loss Rate
- Exponential Loss Rate
These methods are described in most hydrology textbooks and in user manuals for modeling software.

For certain areas—paved areas, buildings, and open water—it may be appropriate to assume a certain percentage of the basin or subbasin has no infiltration at all. Such areas are typically designated by an impervious-area percentage in the description of the basin characteristics. A large area—such as the reservoir area itself, if it is a significant portion of the drainage area—can be modeled as a unique subbasin with zero infiltration losses.

The methodologies for the first two methods and their associated input parameters are described below.

Initial and Uniform
This simple method is widely used and consists of establishing an initial loss amount and a uniform loss rate. The initial assumption is that all rainfall is lost to infiltration up to the initial loss amount. After that, the uniform rate is adjusted to the calculation time step and then subtracted from each rainfall amount for that time step. The remaining precipitation is the excess rainfall.

For all design-flood calculations, the initial loss amount should be zero, equivalent to saturated conditions. The uniform rate is estimated based on soil types. The values will typically range from 0.05 in/hr for clays to as high as 0.4 in/hr for sandy soils.

NRCS Curve Number Loss Method
The NRCS has standardized detailed procedures for developing estimates of infiltration rates based on soil types and land use characteristics. The process is summed up in the derivation of the curve number (CN), from which estimates for soil moisture deficit, initial abstraction, and the resulting excess rainfall are derived. Multiple NRCS publications are available that provide guidelines for estimating the CN based on soil classifications and land use parameters. Soil classifications are most readily obtained from NRCS County soil maps. Many of these were published when the agency was known as the Soil Conservation Service (SCS). All of the soil classifications listed in the County Survey reports are classified in one of the four hydrologic soil groups, A, B, C, and D. These four groups range from the most pervious, A, to the most impervious, D. Generally, multiple groups will
be represented within a basin or subbasin and the representative values can be averaged over the basin, weighted by representative area. Either calculate the average to develop a basin average hydrologic group and then assign the entire basin a CN, or assign each of the various soil types within the basin a hydrologic group and then a CN, and average all the CNs, weighted by area.

Most of the available tables indicating CN assume an ARC (formerly referred to as antecedent moisture condition, or AMC) II antecedent condition. This needs to be adjusted to reflect ARC III conditions.

**Infiltration Loss Methods**

For comparison, Table 5.1 shows a general relationship between the NRCS soil classification (described in the next section) and uniform loss rates.

### 5.3 Land-Use Assumptions

For developing the design storm runoff hydrograph for design and risk assessment of proposed dams or modifications to existing dams, assume land uses expected to exist at the completion of the modification or construction project. Dam owners will be held responsible for the safety of the dam throughout its entire life; therefore, they should attend to the build-out conditions that are reasonably expected to occur within the entire drainage area during the operational life of the dam.

#### 5.4 Unit Hydrograph Method

The PMP needs to be transformed into the PMF runoff hydrograph for each basin or subbasin using an acceptable unit hydrograph method. The two most commonly used methods for hydrologic and hydraulic studies associated with dams are:

- Snyder Unit Hydrograph Method
- NRCS Dimensionless Unit Hydrograph Method

Other possible methods that are used include:

- Clark Unit Hydrograph Method
- Kinematic Wave Method

<table>
<thead>
<tr>
<th>Soil Group</th>
<th>Description</th>
<th>Range of Uniform Loss Rates (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Deep sand, deep loess, aggregated silts</td>
<td>0.30–0.40</td>
</tr>
<tr>
<td>B</td>
<td>Shallow loess, sandy loam</td>
<td>0.15–0.30</td>
</tr>
<tr>
<td>C</td>
<td>Clay loams, shallow sandy loam, soils low in organic content, soils usually high in clay</td>
<td>0.05–0.15</td>
</tr>
<tr>
<td>D</td>
<td>Soils that swell significantly when wet, heavy plastic clays, certain saline solutions</td>
<td>0.00–0.05</td>
</tr>
</tbody>
</table>

References: NRCS 1997, Skaggs and Khaleel 1982

These two most widely used methods, the Initial and Constant Rate method and the NRCS Curve Number method, are contrasted in Table 5.2.

<table>
<thead>
<tr>
<th>Method</th>
<th>Pros</th>
<th>Cons</th>
<th>References</th>
</tr>
</thead>
</table>
| Initial and Constant Rate | ■ Simple and easy to use.  
■ Easy to calibrate.  
■ Apply to all storm durations. | Since it does not reflect varying loss rates, it can misestimate losses within the event, particularly those of very short duration. | ■ EM 1110-2-1417 (U.S. Army Corps of Engineers 1994)  
■ Hydrology Handbook (ASCE 1996) |
| NRCS Curve Number     | ■ Simple and easy to use.  
■ Easy to calibrate.  
■ Good availability of material to estimate parameters for ungauged areas. | Infiltration rate will be asymptotic to zero and losses tend to be understated for storms longer than 24 hours in duration. | ■ EM 1110-2-1417  
■ Hydrology Handbook (ASCE 1996)  
■ Win TR-55 (NRCS 1998)  
■ National Engineering Handbook (NRCS 1997) |
These methods are described in most hydrology textbooks and in user manuals for modeling software.

Procedures for the first two methods and their associated input parameters are described below.

**Snyder Unit Hydrograph**

The Snyder method estimates a peak discharge and a time to the peak of the unit hydrograph. It also estimates shape parameters. Rainfall runoff models, such as HEC-1, will typically complete the unit hydrograph based on assumed parameters and relationships. Typically, two parameters are needed to develop a Snyder Unit Hydrograph:
- \( T_L \), lag time
- \( C_p \), shape factor, also commonly expressed as \( C_{p640} \).

The lag time has historically been calculated in multiple ways. The following equation is best suited to regional parameters:

\[
T_L = C_T (L \cdot L_{CA}/S^{0.5})^{0.38}
\]

Where:
- \( T_L \) = Lag Time (hr)
- \( C_T \) = coefficient
- \( L \) = hydraulic length of watershed along the longest flow path (mi)
- \( L_{CA} \) = hydraulic length along the longest water course from the point under consideration to a point opposite the centroid of the drainage basin (mi)
- \( S \) = weighted slope of the basin (ft/mi), measured from the 85% to the 10% points along the longest stream path in the basin (EM 1110-2-1405)

The value \( C_p \) is a dimensionless parameter that is typically assumed to be consistent for various areas of the state. For instance, it could be estimated from neighboring areas or calibrated for the whole or portions of the basin, and then applied to multiple subbasins within the watershed.

Note that there are multiple forms of the Snyder equation for \( T_L \). Some use ft/ft for the slope and some do not include the slope at all. If a regional value for \( C_p \) is used, verify that the same equation was used in the study within which it was developed. Values generally range from about 0.7 up to about 3.0, though values outside that range have been calibrated.

The shape factor, \( C_{p640} \), reflects the sharpness of the hydrograph. High values, up to about 500, reflect a rapidly responding basin with a sharp peaked hydrograph. Low values, such as 250, generally reflect a flatter, slow responding basin with a longer, flatter hydrograph. These values are generally divided by 640 and entered into HEC-1, if that model is used, as the \( C_p \) value, ranging from about 0.4 to 0.8. Generally, smaller \( C_p \) times are associated with higher \( C_{p640} \) values, though many exceptions exist.

**NRCS Dimensionless Unit Hydrograph**

Only one parameter is used in the models that use the NRCS Unit Hydrograph method—the lag time, \( T_L \), typically estimated as 0.6 times the time of concentration, \( T_C \), which is estimated through a procedure of several steps based on parameters reflecting the basin. The factor 0.6 for conversion from \( T_C \) to \( T_L \) has been shown to vary with certain urban characteristics, but, without detailed information, 0.6 is generally considered acceptable for most situations. The time of concentration, \( T_C \), is the time it takes for water to flow from the most hydraulically remote point of the drainage area to the outlet of the drainage basin. There are multiple methods to determine the time of concentration, each generally associated with a particular unit hydrograph estimation procedure.

One of the more common methods for estimating \( T_C \) is to sum three runoff time components: overland sheet flow, shallow concentrated flow, and open channel. *Sheet flow* reflects the uppermost end of the basin and consists of flow traveling over the open planar surfaces and not in formed channels. Its length is generally estimated from maps, but should be no greater than 100 ft. The primary factors for estimating the time for sheet flow are length, slope, and roughness. *Shallow concentrated flow* reflects the flow as more concentrated, but still not in a fully formed channel. It may be in minor ditches and swales and is also affected primarily by the length, slope, and roughness. *Open channel flow* is the flow in distinct, well formed channels, within which flow can be readily depicted using Manning’s equation. More than one channel type, with separate time calculations for each, may be added to obtain the overall time of concentration. However, there cannot be more than one component for sheet flow or shallow concentrated flow.

The intention of these estimates is to sum the estimated travel time of flow across each component. The factors listed above are estimated in order to determine a flow velocity which is assumed constant over the defined length. Times for each of the three components are estimated, totaled, and the sum used as the time of concentration for the basin, which is then adjusted to estimate the lag time, \( T_L \). These two widely used unit hydrograph methods, Snyder’s and the NRCS method, are contrasted in Table 5.3.

### 5.5 Calibration

The calibration of hydraulic and hydrologic runoff parameters is strongly preferable in most cases. For breach analyses, a recently prepared PMF analysis usually suffices. If the previously prepared
PMF was not based on calibrated runoff values, a new calibration is not needed, except for large, high-hazard dams. For PMF determinations associated with new dams or the upgrade of existing dams, use calibrated values for all intermediate and large high-hazard dams and large significant-hazard dams. Exceptions may be allowed if the values chosen can be demonstrated to be conservative or if insufficient data are available.

The following suggestions should be considered during calibration:

- The process compares calculated runoff hydrographs to observed hydrographs from gauges or calculated from lake levels. Inflow rates estimated from reservoir levels will generally need some smoothing, as small errors in lake-level measurements typically represent a large error in inflow. However, these will tend to be self-correcting in subsequent time steps.
- There is error in all observed data, so multiple storms should be used for calibration. Three or four events are preferable. If an event suggests values that are inconsistent with others, consider not using that event.
- Most rain gauges use daily values and their temporal distribution will need to be estimated based on adjacent hourly gauges. Some lag time between the gauges is often appropriate.
- The Theissen Polygon method is a simple and suitable way to distribute rainfall values across basins. However, multiple tools that make use of GIS technology are also available and well-suited to the task.
- Distributing observed rainfall values across large areas will tend to exacerbate the errors inherent in the rainfall. Inevitably, the calibration of infiltration rates tends to be more of a correction of rainfall errors than a determination of true infiltration. Unless a strong, repetitive pattern is noted, determine loss rates from analysis of the soil types with little emphasis on the calibrated infiltration rates.
- When calibrating a model, first adjust infiltration losses to obtain a matching runoff volume. Then, adjust the parameters that reflect the timing to match the time of the peak flow. Finally, adjust the hydrograph shape, including the magnitude of the peak flow. Some iterations will typically be necessary.
- Minimize the number of variables to be calculated. For example, rather than attempting to adjust the lag time for each subbasin within the Snyder methodology, assume one \( C_T \) and one \( C_p \) value for the entire group of subbasins above the observed hydrograph, with each basin’s lag time calculated based on the dimensions of its own basin. If variations in the \( C_p \) values are deemed appropriate, then it helps to keep the ratios between them constant so that all are effectively calibrated together.

### Table 5.3. Unit Hydrograph Methods Compared

<table>
<thead>
<tr>
<th>Method</th>
<th>Pros</th>
<th>Cons</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snyder’s Unit Hydrograph</td>
<td>Simple and easy to use. Easy to calibrate.</td>
<td>Parameters cannot be estimated from field observations. Values must be calibrated or estimated from similar areas.</td>
<td>EM 1110-2-1417 (U.S. Army Corps of Engineers 1994)</td>
</tr>
<tr>
<td></td>
<td>Simple and easy to use. Easy to calibrate.</td>
<td>Not well-suited to large drainage areas. Should not be used for subbasins larger than about 20 sq mi.</td>
<td>Hydrology Handbook (ASCE 1996)</td>
</tr>
<tr>
<td>NRCS Dimensionless Unit Hydrograph</td>
<td>Simple and easy to use. Easy to calibrate. Good availability of material to estimate parameters for ungauged areas.</td>
<td></td>
<td>EM 1110-2-1417</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hydrology Handbook</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>TR-55 (NRCS 1998)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>National Engineering Handbook (NRCS 1997)</td>
</tr>
</tbody>
</table>
6.0 Introduction
The last of the three primary steps in determining the design flood is the routing of hydrographs through the reservoir. Watersheds modeled as a single basin need no streamflow routing, and the design-flood runoff hydrograph is the reservoir-inflow hydrograph. Watersheds modeled with multiple subbasins need streamflow routing unless all subbasins drain directly into the reservoir.

6.1 Methods for Hydrologic and Hydraulic Streamflow Routing
In models that require routing of the design-storm runoff hydrographs through a stream channel, either a hydrologic or hydraulic routing method may be used. The hydrologic methods are either empirical or semi-empirical. Approved hydrologic routing methods include:
- Muskingum
- Muskingum-Cunge
- Average-Lag
- Successive Average-Lag (Tatum)
- Modified Puls
- Working R and D

Hydraulic routing methods are more complicated and difficult to use as they are based on theoretical hydraulic equations, but they more accurately reflect flood-routing conditions. Hydraulic methods are typically used under the following conditions:
- Very flat channel slopes, less than 5 ft/mi
- Wide floodplains with significant storage effects on the hydrograph
- High flows from a tributary
- Unusual backwater effects from structures

Acceptable hydraulic modeling methods include:
- Kinematic Wave
- Dynamic Wave
- Diffusion Wave

6.2 Base Flow
Estimates of base flow conditions to which calculated runoff hydrographs are added are sometimes appropriate on larger rivers, particularly for frequency flood-level events, such as 10-year or 100-year floods. However, in Texas, they are rarely a significant component of the design-storm peak flows, generally much less than 1 percent. For any river with a dependable flow that could be counted as a base flow, the drainage area is usually quite large and the resulting design-flood runoff will still dwarf the base flow. For these reasons, base flow is not required within design-flood calculations but may be employed if the analyst deems appropriate; it will typically be of the same order of magnitude as median flows or estimated as the receding limb of an antecedent event.

6.3 Hydraulic Input Parameters
All of the streamflow routing methods use various input parameters, generally measured or estimated from the physical characteristics of the channel. All will include a parameter that measures the length of the channel directly or reflects it in an estimate of travel time. For these, use the full length of the channel without assuming shortening due to overbank flooding. Even in very high flows, the predominant conveyance is usually within the channel itself. If the overbank flows are thought to be a dominant factor in the flood conveyance, then employ a routing method that takes differing floodplain flow characteristics into account, possibly including hydraulic models.

The Muskingum routing method, instead of physically measured values, incorporates an estimate of storage effects through the storage coefficient, x. This value ranges from 0.0 to 0.5, where 0.0 reflects a straight translation of a hydrograph and 0.5 reflects a storage-controlled routing process. The former would indicate of a steep narrow channel with little attenuation of the peak expected. The latter would reflect a broader, flatter channel with significant attenuation of the peak from overbank storage effects. This parameter cannot be measured from physical characteristics of the channel, but can be calibrated or estimated with experience.
Most methods will also typically use some description of a typical cross-section or multiple cross-sections. These should simply be measured from available mapping and should represent average conditions. For hydraulic models, where the entire length of the channel is modeled with cross-sections, reasonable mapping will be necessary, though rarely are surveyed cross-sections justified. For unsteady-flow hydraulic models, such as the NWS models and HEC-RAS, it is important that the cross-sections reflect with reasonable accuracy the existing floodplain storage. In steady-state models, there is a tendency to place cross-sections at constrictions and other features that control the flow rate. However, in unsteady models, the full flood storage of the floodplain tends to control the downstream movement of the hydrograph. Therefore, cross-sections should reflect both the constricted sections and the wider sections, as well as the storage that occurs in tributaries and adjacent draws. Off-channel storage, or ineffective flow area—often ignored in steady-state models—can be significant in unsteady models.

Manning’s Roughness Coefficients

Except for the purely empirical hydrologic equations, each of the streamflow routing models will use the most widely recognized flow relationship, Manning’s equation. Input parameters to Manning’s equation consist simply of descriptions of the topography through the use of cross-sections, either in detail or simplified, and the roughness coefficient.

Numerous sources exist that describe the use of the equation and provide means to estimate Manning’s coefficient \( n \), both for channel flow and overbank flow. The primary criterion is the size of the roughness particle, usually vegetation or the exposed channel surface, relative to the overall flow area. For example, the same grass-lined channel will have a smaller value for \( n \) if the channel area is large than if it is small. For that reason, roughness values will decrease with increasing flow for a consistent channel. However, this trend is often countered by the fact that roughness in the form of vegetation tends to increase quickly when significant portions of the flow are in the overbank areas. Single \( n \) values for a channel regardless of flow apply only in simplified estimates or in a narrow range of flows.

For design-flow calculations, there is likely to be a large component of flow area in the floodplain, some variation in the value of \( n \) will need to taken into account. The simplest way to do this is to use three \( n \) values, one for the channel and one for each overbank. This is a very common technique, used in some routing methods in HEC-1 and often in the hydraulic model, HEC-RAS. The NWS models require input roughness values that are related to each top-width elevation or to flow, so weighted values need to be determined. These are typically best weighted by conveyance rather than by area as that will proportion the effective roughness relative to the portion of the flow it affects.

Table 6.1 compares some of the more common hydrologic and hydraulic streamflow routing methods and gives some of the pros and cons of each.

6.4 Calibration

The calibration of hydraulic and hydrologic streamflow routing parameters, similar to runoff parameters, is strongly preferable in most cases when sufficient data is available. For breach analyses, a recently prepared PMF analysis can usually be employed. If the previously prepared PMF was not based on calibrated runoff values, a new calibration is not needed, except for large high-hazard dams when sufficient data are available. For PMF determinations associated with new dams or the upgrade of existing dams, use calibrated values for all intermediate and large high-hazard dams and large significant-hazard dams. Exceptions may be allowable if the values used can be demonstrated to be conservative or insufficient data are available. During calibration, consider the following:

- The process compares calculated routed hydrographs to observed hydrographs from gauges or calculated from lake levels. Inflow rates estimated from reservoir levels will generally need some smoothing, as small errors in lake-level measurements typically represent a large error in inflow. However, these will tend to be self-correcting in subsequent time steps.
- There is error in all observed data, so multiple storms should be used for calibration. Three or four events are preferable. If an event suggests values that are inconsistent with others, consider not using that event.
- When calibrating a model, first calibrate runoff components, if they can be isolated, in order to match the flow volume. Then, adjust the streamflow parameters to match the translation time of the peak flow. Finally, adjust the hydrograph shape, including the magnitude of the peak flow. Some iterations will typically be necessary.
- Isolate the variables to be calculated and minimize their number as much as possible. For example, if two stream gauges exist, use the observed upstream hydrograph with lateral inflows estimated and calibrated separately, if possible, and estimate the resulting downstream hydrograph. This will isolate the routing parameters of that reach. As another example, rather than attempting to calibrate a wide range of roughness coefficients, relating all the appropriate values of \( n \) to standard channel and overbank values will allow the calibration of only two or three values. This can be carried out with overbank roughness values representing clear and
wooded areas, for instance, that are averaged for different reaches based on field conditions.

6.5 Modeling Through Reservoirs

Hydrologic Routing
For hydrologic routing, the peak design-flood reservoir elevation is determined by routing the estimated inflow hydrograph through the reservoir using one of the various hydrologic models. The methods most typically used for routing a hydrograph through a reservoir in hydrologic models are:
- Level Pool Routing
- Modified Puls

Take the following into consideration:
- Assume that reservoir losses equal zero.
- For gated dams, route the design-flood inflow hydrograph through the reservoir and through the dam’s hydraulic control structures using the planned flood operational rules for the spillway or in a manner that takes into consideration downstream flood risks.
- The antecedent reservoir elevation in the reservoir should be the maximum normal operating pool (MNOP) level, which is the highest water surface elevation within the range of planned operating levels for the reservoir, above which floodwaters would be released. No antecedent storm is required. This applies to all upstream reservoirs in the drainage area.
- For detention ponds that are dry or do not have significant permanent storage, consider the MNOP to be at the level of the primary outlet, above which water is always released.

Table 6.1. Streamflow Routing Methods Compared

<table>
<thead>
<tr>
<th>Method</th>
<th>Pros</th>
<th>Cons</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muskingum</td>
<td>Simple and easy to use. Easy to calibrate. Applications to wide range of channel types.</td>
<td>Parameters cannot be estimated from field observations. Values must be calibrated or estimated from similar areas.</td>
<td>EM 1110-2-1417 (U.S. Army Corps of Engineers 1994) HEC-1 user’s manual Hydrology Handbook (ASCE 1996)</td>
</tr>
<tr>
<td>Muskingum-Cunge</td>
<td>Simple and easy to use. Parameters can be estimated from field observations.</td>
<td>Does not account for overbank or other storage effects well in broad, flat channels.</td>
<td>EM 1110-2-1417 HEC-1 user’s manual Hydrology Handbook (ASCE 1996)</td>
</tr>
<tr>
<td>Kinematic Wave</td>
<td>Simple and easy to use. Parameters can be estimated from field observations.</td>
<td>Does not account for overbank or other storage effects well in broad, flat channels.</td>
<td>EM 1110-2-1417 HEC-1 user’s manual Hydrology Handbook (ASCE, 1996)</td>
</tr>
<tr>
<td>Modified Puls</td>
<td>Simple and easy to use. Applies to storage routing for reservoirs. Well suited to flat, broad channels with significant overbank storage.</td>
<td>Can be difficult to apply to streams if no relationship between flow and storage is available.</td>
<td>EM 1110-2-1417 HEC-1 user’s manual Hydrology Handbook (ASCE 1996)</td>
</tr>
<tr>
<td>Dynamic Wave</td>
<td>Most accurate, particularly in broad, flat channels, with slopes less than about 5 ft/mi. Best method for translating values calibrated from actual events up to design flood–level event. Good availability of material to estimate parameters for ungauged streams. Only method that can accurately describe the impact of major tributary flow that creates backwater or even reverse flow on the main stem.</td>
<td>Difficult to use, requires a large quantity of data.</td>
<td>HEC-RAS user’s manual NWS user’s manuals (DWOPER, NETWORK, DABMRK)</td>
</tr>
</tbody>
</table>
For recharge reservoirs that are normally dry but have no release capabilities, the MNOP would be an empty reservoir provided that it can be shown that the lake has historically been, or will typically be, dry within a week of a major storm event. If not, the design engineer should show a statistically based justification for an appropriate starting water level.

For existing storage reservoirs that have not filled up to their MNOP within the last 10 years, use starting levels at both the MNOP and the maximum level of the lake within the last decade. If the dam can safely pass its appropriate design flood at the lower historical level, but not at the MNOP, then modifications to enable the dam to pass the design flood will still be required. However, these modifications do not need to be initiated until such time as the reservoir reaches a water level starting at which it cannot safely pass the design flood. Determine this “trigger starting elevation”—at which the dam is overtopped by the design flood—and report it along with the rest of the analysis.

Do not assume the reservoir to be drawn down below the maximum normal operating level in advance of the design storm.

For new structures, no long-term effects of sedimentation on flood storage capacity need to be assessed for flood routing. For modification or rehabilitation of existing structures, a revised state-storage curve, accounting for sedimentation, should be developed from a field survey.

Hydraulic Routing

For hydraulic routing of hydrographs through reservoirs, there is no distinction between streamflow and reservoir routing. The reservoir is simply modeled with cross-sections as part of the stream with the spillway modeled either directly in the computer model or as an internal boundary based on the spillway rating curve. Though the modeling methodology is the same, certain issues should be considered.

Through all but the shallowest portions of the reservoir, water levels are not sensitive to roughness coefficients.

Adjust cross-sections and the intervening lengths to match the overall reservoir elevation-storage relationship.

For gated dams, route the design-storm inflow hydrograph through the reservoir and through the dam’s hydraulic control structures using the planned flood-operation rules for the spillway or in a manner that takes into consideration downstream flood risks.

Do not assume the reservoir to be drawn down below the maximum normal operating level in advance of the design storm.

Each method will require hydraulic data about the reservoir and spillway, as described in Chapter 7.

6.6 Design-Flood Hydrographs

After estimating the full PMF hydrograph, determine the design-flood level, based on the size and hazard classification as described in Section 3.2. For hydrologic models that produce a full reservoir-inflow hydrograph, determine the design flood by multiplying each ordinate of the PMF inflow hydrograph by the required percentage. For example, if the design flood is 75 percent of the PMF, then multiply the 100 percent PMF-inflow hydrograph ordinates by 0.75. Make no adjustments to the precipitation data. This design flood-inflow hydrograph is then routed through the reservoir appropriately to determine the peak design-flood level.

For models using hydraulic flood routing methods for the streamflow components and the reservoir, similarly adjust each runoff hydrograph that represents a boundary or lateral inflow hydrograph, multiplying each ordinate of the hydrograph by the specified percentage. Then route these adjusted hydrographs through the hydraulic model to determine the design-flood level.

6.7 Computer Models

Acceptable computer models for hydrologic and some hydraulic modeling methods include:

- HEC-HMS (U.S. Army Corps of Engineers)
- HEC-1 (U.S. Army Corps of Engineers)
- SITES (National Resource Conservation Service)
- WIN TR20 (National Resource Conservation Service)
- WIN TR55 (National Resource Conservation Service)

Acceptable computer models for hydraulic modeling include:

- HEC-RAS, unsteady flow (U.S. Army Corps of Engineers)
- NWS Dynamic Wave Models (DAMBRK, DWOPER, FLDWAV) (National Weather Service)

Other models may be acceptable upon written approval of the coordinator of the Dam Safety Program.
7.0 Introduction

Important components of any design flood determination are the accurate representation of the elevation-area-capacity (EAC) relationship for the reservoir and the dam’s spillway rating curve. Each is an essential component of the process of routing hydrographs through the reservoir.

7.1 Elevation-Area-Capacity

Determine the EAC from the best mapping available, commonly by simply measuring the area within the reservoir at all available contours. GIS techniques often suffice, giving due importance to properly accounting for islands within the overall area. In many areas of Texas, U.S. Geological Survey 1:24,000 mapping is the best available with 10-foot contour intervals. If no other updated information is available, these are generally sufficiently accurate for flood routing. In such situations, measure and plot the areas at each contour interval from the bottom of the reservoir to the first contour above the top of the dam. Then use the curve generated through these points to pull off areas at individual one-foot increments and tabulate a summation of the average area for each one-foot increment. This process will generate appropriate volumes of storage at each elevation needed for flood routing.

For existing reservoirs for which no mapping below the water surface is available, this process can be performed starting with an assumed storage at the maximum normal operating level, which will be used as the starting water surface elevation for the flood routing. Incremental storage amounts below the starting water surface do not impact hydrologic flood routing procedures.

For hydraulic routing procedures, do not use an EAC directly, as the reservoir is to be modeled using cross-sections. As described in the previous chapter, adjust the cross-sections or the distances between them so that the volumes calculated within the model are reasonably close to the actual EAC.

7.2 Spillway Rating Curves

The spillway rating curve needs to be determined for both existing and proposed reservoirs and for each component of the dam that will be used to pass flood flows during the design flood event. For many dams, this will be a combination of a principal spillway that is used for all flood events and an emergency spillway that is only used in larger, rarer events. Numerous sources describe appropriate methodologies for determining rating curves. Widely used references—for both existing and proposed spillways—include Design of Small Dams (U.S. Department of the Interior, Bureau of Reclamation, 1987) and NRCS methodologies.

Principal Spillways

Rating-curve development needs to reflect the unique characteristics of the individual spillway. Ungated spillways will generally be shaped as a weir—either ogee, sharp crested, or broad crested—or as a drop-inlet, or morning-glory, spillway. The weirs would utilize the simple weir equation, \( Q = CLH^{3/2} \), with \( C \) set by the shape and dimensions of the structure. In planning stages, \( C \) can be assumed to be constant, but in design-level analyses \( C \) will also vary with the height of water over the crest. Gated spillways will typically require the same procedure for determining total capacity, assuming the gates are opened sufficiently so as to not affect the flow. For discharges through partial gate openings, use orifice-flow assumptions. Standard drawdown profiles are necessary, assuming unimpeded flows, in order to determine the size of the gate opening needed to switch back to weir control for the rating curve.

Rating curves for drop-inlet, or morning-glory, spillways are generally calculated assuming two different types of hydraulic control. For low flows, the circumference of the inlet operates as a weir, with discharge estimated using the weir equation. For higher flows, the inlet will work as an orifice at the narrowest portion, or throat, of the vertical column. If the spillway conduit through the dam is designed for pressure flow, then the hydraulic control may rest with the sum of energy losses acting through the closed system as a whole. In these cases, sum entrance, bend, friction, and exit loss coefficients, along with other losses that may apply, and determine the rating curve.
determined for a closed, pressure-flow system. For these spillways of these types, make calculations assuming each type of flow patterns and use the lowest discharge as the controlling situation.

Points on the final rating curve developed for reservoir routing reflect the total discharge, typically more points at the lower end of the curve where the rates change more rapidly, with points plotted for key break points such as the crest of the emergency spillway or where changes in the gate operating procedures occur.

For proposed dams and new spillways, keep in mind the following concepts in order to determine the most appropriate principal spillway type:

- Generally use drop-inlet, or morning-glory, spillways when there is plenty of available flood-storage volume. The flow capacity of the spillway does not significantly increase once the reservoir reaches a level at which the spillway "plugs" or operates under pressure or orifice control. Morning-glory spillways are well suited to flood control.

- In morning-glory spillways, it is preferable that the conduit through the dam be designed to have open channel flow with depths no more than 75 percent of the height of the conduit. This will generally require a hydraulically steep slope carrying supercritical flow and a diameter greater than that of the throat of the spillway riser. If that is not practical, then a conduit significantly smaller than the riser that forces pressure flow through the conduit quickly will be preferable. Both of these concepts attempt to minimize the large pressure fluctuations that typically occur with flow transitioning from open channel to pressure flow.

- Larger morning-glory inlets will need anti-vortex devices to break up naturally occurring vortices in the entering flow.

- Gated spillways require considerable additional cost for the operating system, operating personnel, and maintenance. In addition, it is generally perceived that an owner takes on significant additional potential liability with a gated spillway.

**Emergency Spillways**

Emergency spillways are generally cut into an abutment and have little or no erosion protection from flows discharging through them. For this reason, only for the largest and rarest of floods are they an economical way to pass large quantities of flow. It is often accepted that erosion damage will occur should the emergency spillway operate, but that the effective cost of the very infrequent repairs is much lower than the upfront capital costs of the means to prevent the erosion. Most emergency spillways are built to prevent passage of flows for less than about the 50- or 100-year flood.

Generally, determine rating curves for emergency spillways using a backwater analysis with a steady-state water-surface profile model, such as HEC-RAS. Perform several runs with varying discharges, relating each to a reservoir water-surface elevation. Enough sections are needed such that the most upstream section has minimal approach velocity; ignore any energy losses upstream from that point. Then find the rating curve by assuming that the energy level, not the water surface elevation, at the most upstream section equates to the reservoir level for the specified discharge. Then plot these values and determine the discharges for set elevations from the curve. A standard equation for broad-crested weirs should be used only for rough planning. For such an equation to be accurate, the slope downstream from the crest would need to be steep enough to create supercritical flow down the slope, which has the consequence of causing much more damage than would occur under critical flow.

For proposed dams and new emergency spillways, consider the following in order to determine the most appropriate configuration and location:

- Locate emergency spillways such that any flows that discharge through them will not strike or flow against the dam embankment.

- Configure the channel such that critical flow will occur as far downstream as reasonably possible so as to maximize the length of any erosion path back to the reservoir. The crest can be centered, but the slope downstream from the crest should be set to effect subcritical flow—generally be a slope of about 0.25 percent or less, depending on the vegetation. An alternative would be to address the potential erosion from supercritical flow, either with the provision of an erosion-resistant surface or a determination that the final configuration will not erode sufficiently to cause a significant release of water from the reservoir.

- The crest of the spillway should be set above the 50- or 100-year flood level to minimize its frequency of operation. In general, the less frequently an emergency spillway operates, the more erosion will be acceptable.

- The roughness coefficients used in the analysis should reflect ultimate vegetative conditions of the emergency spillway, not newly constructed conditions.
8.0 Introduction
Breach analyses for existing dams can be performed in one of two manners, simplified and full.

The simplified method is for proposed and existing small dams, and existing intermediate dams. The method is empirical and conservatively approximates the assumptions for downstream flow and extent of flooding. It will significantly reduce the preparation time and cost of inundation mapping. A full breach analysis may be used for a dam of any size if the owner wishes either to demonstrate a lower hazard classification than that determined using the simplified method or simply to estimate inundation more accurately.

For large dams, use the full breach analysis, whether evaluating a proposed or an existing dam. Also use a full breach analysis for proposed intermediate-sized dams.

8.1 Hydrologic Conditions
Perform full breach analyses for the following hydrologic conditions at a minimum:

- **Sunny-day breach**: Reservoir at its maximum normal operating pool level.
- **Barely overtopping breach**: Inflow design flood set to the percentage of the PMF or design flood that equals the top of the dam. If the dam passes 100 percent of the design flood without overtopping, this scenario does not need to be run.
- **Design-flood breach**: Inflow hydrograph equal to the full design flood.

Compare barely overtopping and design-flood breach runs to runs for the same event assuming that the dam does not fail. The simplified breach method for existing dams only reviews the impacts from a breach occurring with the reservoir at the effective crest of the dam.

If the design-flood breach overtops the dam, the analysis will need to either assume flow over the top of the dam or not. The former adds complexity to the model as the length of the dam that is overtopped is reduced by the breach width, but it also provides a more exact and less conservative determination of breach discharge for existing conditions. For dams for which upgrades to the dam are being considered, assume no flow over the crest, as if the dam were raised to contain the design flood. This is simpler and more conservative.

Initiate the breach at the peak reservoir level under each scenario.

8.2 Downstream Conditions
Under the barely overtopping and design-flood conditions, estimate inflows from downstream tributaries by extending the design-flood ellipses under the HMR-52 methodology over the associated areas. Use the size, location, and orientation of the ellipses used for determining the critical design flood without adjustment. Adjust downstream-runoff hydrographs to the same degree that the barely overtopping flood is upstream of the reservoir. Assume that runoff parameters from the dam’s watershed apply, or extrapolate them appropriately to the adjacent basins. No additional calibration downstream is warranted. If the stream on which the breach hydrograph is being routed opens into a much larger river, then multiple considerations are necessary:

- **DAMBRK** cannot model a dendritic system and can only be used iteratively, with the initial and receiving stream each modeled separately. The stage hydrograph on the receiving stream will serve as a downstream boundary of the initial stream and the discharge hydrograph of the upstream river will serve as a lateral inflow hydrograph to the downstream river. Iterations continue until agreement is reached. HEC-RAS and FLDWAV can model a dendritic system and are usually more appropriate.
- A large volume of water discharging into the receiving stream will tend to distribute flows in both the upstream and downstream directions. Depending on the initial flow on the receiving stream, this can be seen as a reduction in flow rate or even in negative
flows traveling upstream. Therefore, sufficient cross-sections on the receiving stream need to be included upstream of the junction to allow for this phenomenon, if appropriate.

If the drainage area of the receiving stream is too large for it to be effectively covered by the ellipses representing the design flood, an assumption on initial flows is needed. It can be assumed that significant flows will occur coincidental to the design flood on the tributary; however, their timing and magnitude will be virtually unrelated and indeterminate. Therefore a constant flow hydrograph can be assumed. As an example, this could be equal to the 10-, 50-, or 100-year flood, depending on the relative sizes of the two streams. The larger the ratio of the drainage areas (the receiving stream drainage area divided by the dam watershed area), the smaller the assumed flow level should be in the receiving stream. A reasonable level that puts the receiving stream at or slightly above flood stage before the breach flows arrive will usually produce the critical incremental impact due to the breach. This should be considered in the decision.

### 8.3 Breach Parameters

**Breach Location**

Perform the breach analysis on the component of the dam for which failure would create the worst impact downstream, regardless of the relative likelihood of failure. Analyze this component of the structure for the hydrologic conditions listed above. Review each major component of the dam to determine the maximum discharge. This review will not take into account the likelihood of failure of any component, but should look at the most likely configuration of a breach, should one occur. For each structure component, the breach section should be at the maximum portion of the structure that can contain the full bottom width of the breach. For example, if the breach width for an embankment is 200 feet wide, the location should be planned for the lowest 200 ft section of the dam above natural ground at the toe. If the channel downstream is only 50 feet wide, then it would not be in the original channel or at the maximum height of the dam. However, the 200-foot-wide breach at a higher level should be compared to a 50-foot-wide breach at the maximum section over the river channel. Use whichever has the higher peak discharge.

**Breach Configuration (Embankments)**

Assume breach configurations in an embankment, regardless of the failure mechanism to have, at a minimum, a width of three times the depth of water impounded under each hydrologic condition described above, with vertical side slopes. Any configuration that will produce a larger peak breach discharge will be acceptable. This configuration represents a minimum; larger values may be more appropriate in certain situations, based on the engineer's judgment.

### Breach Configuration (Structural Components)

Determine breach configurations in a structural component of the dam, such as the spillway or gravity section, case by case. The minimum breach width will generally match individual elements of the structure, such as one buttress in a slab and buttress dam or one monolith in a gravity non-overflow section. Review multiple adjacent components with varying failure times in order to determine the critical configuration.

**Time of Failure (Embankments)**

Assume that breach configurations in an embankment—regardless of the failure mechanism—form at a minimum rate of three feet of depth of water impounded per minute under each hydrologic condition described above. Any time of failure that will produce a larger peak breach discharge is acceptable. This failure time represents a maximum. Smaller values may be more appropriate in certain situations, based on the engineer's judgment. Longer times to failure may be used in the modeling process if needed for computational stability and if it can be shown that the peak breach discharge is not sensitive to the time to failure. This is often the case for dams with large storage volumes for which the lake level does not change significantly during the elapsed time of the breach formation.

**Time of Failure (Structural Components)**

Determine time of failure for a breach configuration in a structural component of the dam case by case. When assuming an individual element of the structure, such as one buttress in a slab and buttress dam or one monolith in a gravity non-overflow section, the time should be instantaneous. Also review more than one adjacent component with varying failure times in order to determine the critical configuration. Base the incremental failure time of adjacent structures on the estimated time for the component to fail due to erosion of the foundation. Present justification in all cases. However, the amount of failure time per adjacent component needs not exceed 30 minutes per component in an alluvial foundation and one hour in a rock foundation. The analyst should also consider the likelihood that this failure mechanism of adjacent structural components will occur in both directions outward from the original component.
8.4 Dam-Breach Models
When using a full breach analysis method, choose appropriate models that can properly determine and route full breach flood waves. For large high-hazard dams, choose an unsteady, dynamic wave model—such as HEC-RAS, DAMBRK, or FLDWAV—to determine the downstream impacts and inundation limits of a breach. For existing small or intermediate-size dams, regardless of hazard rating, a simpler (but less accurate) hydrologic model, such as HEC 1 (HMS), is acceptable for modeling the breach flood wave and to determine inundation limits. However, a dam owner who is performing the breach analysis in order to justify a reduction from a high hazard classification should use one of the dynamic wave models.

8.5 Breach Inundation Lengths
Extend models of breach flood waves far enough downstream to allow analysis of the area that is likely to be significantly affected by a breach of the dam and to provide sufficient information for proper development and execution of an EAP. Though judgment is needed on the part of the engineer performing the analysis, the following guidelines will generally be suitable:

- Sunny-day breach—The floodwave should be modeled for a length downstream, beyond which approximately 75% of the flow is within the channel and no structures are threatened.
- Barely overtopping and design-flood breaches—These floodwaves should be modeled for a length downstream, beyond which the increase, due to the breach, in the peak flood level over the non-breach condition is insignificant and with no adverse effects—generally 1 ft in developed areas. In undeveloped areas, a higher differential may be acceptable.

8.6 Dams in Sequence
For design-flood PMF analyses, generally assume that upstream reservoirs remain intact, unless the design flood for the dam under consideration would overtop the upstream dam. If so, further analysis of the upstream dam may be warranted. For an upstream dam assumed to breach, assume it to breach in both the breach and non-breach runs for the downstream dam under consideration. Multiple combinations of breach and non-breach conditions for multiple dams are not necessary.

Assume that downstream dams breach if overtopped by either the breach or non-breach condition and that they do not breach if not overtopped. Assumptions possibly could differ if specific information indicates otherwise. However, as with upstream dams, multiple combinations of breach and non-breach conditions for multiple dams are not necessary. It is possible that the design flood for the upstream dam does not overtop the downstream dam, but does so with a failure of the upstream dam. In that case, assume that the downstream dam fails in the breach scenario and does not in the non-breach scenario. The failure of the upstream dams will contribute to the inflow hydrograph, and have an impact on whether the downstream dam overtops and breaches.

8.7 Inundation Mapping
As described above, perform full breach analyses for a sunny-day breach, a barely overtopping breach (if needed), and a design-flood breach. In a breach study, the barely overtopping breach flood is compared to a barely overtopping flood which does not have a breach. A similar comparison would be done using the design-flood breach, and the design flood with no breach. However, inundation mapping, which is to be used in an Emergency Action Plan, should only include the outline of the water levels reached in the sunny-day and the design-flood breach runs. Do not show non-breach runs in EAP inundation maps. The report should compare breach and non-breach runs in tabular form. As described in the following section, for studies using the simplified breach method, only one inundation condition, equivalent to a flood level at the top of the dam, is to be shown.

Base inundation maps on the best available mapping and present them as sequenced 11” × 17” maps for ease in inclusion in EAPs. Choose scales that allow for clear depiction of structures and major infrastructure, yet that do not generate a large number of sequenced maps that would be difficult to interpret during an emergency by non-technical personnel. USGS 1:24,000 maps are generally suitable, though often outdated with respect to showing structures and major infrastructure. Aerial photos, if available with reasonable clarity and scale, can also be used as a background for inundation maps.

Inundation maps should also indicate times to flood, or the time from the breach to the time that critical structures are flooded. Label these times directly on the map at occasional intervals or at critical structures.

8.8 Simplified Breach Method
For small and intermediate-size dams, the following approximation of peak discharge and inundation limits can be applied. The peak discharge from a breach, using the assumed breach criteria for the dam as described above, can be estimated by the following equation:
Eq. 8.1 \[ Q_B = 3.1 \cdot B \cdot H^{3/2} \]
where

- \( Q_B \) = peak total discharge from the breach, in cfs
- \( B \) = bottom width of breach, assumed to be \( 3 \cdot H \) for embankments or \( \frac{1}{2} \) the width of a structural spillway or concrete structure, in ft
- \( H \) = maximum height of the dam, in ft

The total release discharge (\( Q_T \)) would then be:

Eq. 8.2 \[ Q_T = Q_B + Q_S \]
where

- \( Q_S \) = peak discharge capacity from the spillway(s) with the reservoir at the top of the dam, in cfs

Estimate the inundation at selected locations downstream using normal flow calculations and an appropriate representation of the cross-section from available mapping. Manning’s equation should be used for the normal flow calculations. Within this equation, roughness coefficients estimates should be increased by 25% to account for increased turbulence and energy losses typically associated with breach floodwaves. The peak discharge should be assumed to attenuate at a linear rate from its peak at the downstream toe of the dam, \( Q_T \), down to \( Q_S \) over the “inundation length” of the stream downstream. This inundation length, \( L_U \), is to be determined by the following equation:

Eq. 8.3 \[ L_U = 0.012 \cdot K_S \cdot \sqrt{2 \cdot C \cdot H} \]
where

- \( L_U \) = inundation length in miles.
- \( K_S \) = Correction factor for spillway size
- \( K_S = Q_B/Q_S \)
- Maximum value = 2.0
- Minimum value = 0.5
- \( C \) = Total capacity of the reservoir at the top of the dam, in acre-feet
- \( H \) = Maximum height of the dam, in ft

If the inundation length extends past the point where the stream on which the dam is located flows into a larger stream, continue the length on the larger stream either for the full inundation length or to a point where the normal flow estimates show approximately 75 percent of the flow within the channel and no structures threatened.

For each location of interest, estimate the inundation limits by normal flow calculations, as described above, for sufficient points within the inundation length to map an approximate inundation boundary. Also estimate the limits at all identified structures—residences and infrastructure elements alike. At locations where the stream on which the dam is located flows into a larger stream, the first elevation determined on the larger receiving stream shall be used as the elevation of all backwater inundation on that larger stream upstream of where the tributary joined. The downstream surface calculations can also be performed, if desired, using a standard water-surface-profile model, such as HEC-RAS in steady-state mode, using the interpolated discharges along the inundation length.

Then use this entire approximate inundation limit for impact evaluation, hazard classification, and EAP development. Since time is not considered in this simplified method, consider all structures that may be affected as having no warning time for evaluations of hazard classifications. No times to flood need be estimated or shown on inundation maps developed using the simplified method.
9.0 Introduction

Based upon its hazard potential, a dam is classified into one of three risk categories: low, significant, and high. Determine each hazard-potential classification, as described in the following sections, based on the consequences and losses caused by a dam breach under the most critical assumptions for the three hydrologic scenarios described in Chapter 8: sunny-day, barely overtopping (if applicable), and design-flood breaches. In hazard-potential classification, give consideration to potential adverse consequences including deaths and the loss of major infrastructure elements—infrastructure whose loss may indirectly place such a burden on a community that lives would be at risk as a result. Examples include major roads and highways, hospitals, water supply reservoirs, cooling reservoirs, and the like. Hazard assessment is also based on the potential economic risk associated with the flooding of industry, businesses, and infrastructure. This risk and the related regulatory issues are also handled within the confines of local flood protection regulations, such as those enforcing FEMA’s 100-year-floodplain regulations. A hazard-potential classification does not reflect any estimate of the likelihood that a dam may fail, but only reviews the consequences of the assumed failure.

In many cases, the hazard potential classification of a dam is visually apparent from field reconnaissance and, with TCEQ approval, a description of the observations will be sufficient to support a determination. These will typically be for dams that are clearly either low or high hazard. In other cases, classifications must be based on the recommendations—in which conservatism is expected—of a licensed professional engineer knowledgeable in the field. To determine the potential of lowering the hazard classification from a conservative field evaluation, detailed studies including dam-breach analyses are to be performed for various hydrologic conditions to evaluate the effects of a failure of a dam, as described below. For this study, use either the full breach analysis or the conservative, simplified breach-inundation estimation method, as described in Chapter 8, to identify the areas at risk.

9.1 Multiple Dams

If failure of an upstream dam will not cause failure of another dam downstream, then the hazard-potential classification of the upstream dam must be determined independently from that of the downstream dam. If the failure of an upstream dam will likely cause the failure of a downstream dam, then the hazard-potential classification of the upstream dam needs to take into account the potential failure of the downstream dam.

9.2 Individual Components of a Dam

Separate components of a dam may not be assigned separate hazard classifications. Determine a single hazard classification for the entire dam. If the harmless failure of an isolated dike or levee reduces the likely failure of the dam, then the failure of the isolated component should be properly incorporated into the design and operation of the dam, as in the example of a fuse-plug spillway. However, a breach analysis to demonstrate the different incremental impacts of various components may be a useful means of allocating limited resources for repair and maintenance.

9.3 Hazard-Potential Classification

Upon completing the mapping of a breach inundation area and the identification of the population and infrastructure at risk, determine the hazard-potential classification. These guidelines do not provide any set numerical markers or definitive equations for defining the hazard classification. The evaluation is to be a conservative judgment based on the available information. General guidelines and descriptions appear in the Texas Administrative Code, Title 30, Part 1, Chapter 299.

9.4 Alternative Means of Assessing Risk and Hazard

Hazard classifications are subjective, but conservative, evaluations reflecting the quantity of structures that exist within the
breach inundation area, based on the assumption that structures reflect lives at risk. Though purposefully simple and adaptable to many situations, the procedure may not prove capable of discerning clear distinctions in marginal cases. More precise assessments of risk can be made through a variety of procedures. These alternative methods can be used to determine the population at risk within the inundation zone or the incremental value at risk from a breach relative to the costs of implementing modifications to reduce that risk. Such alternative methods are typically based on evaluating the probability of people being home when the flood passes by, or on a more exact analysis of the flood depth and velocity effects on the population exposed to the flood. Statistical economic methods can also be applied. Submission of alternative analyses such as these must include documentation of a theoretical explanation for the method, verifiable calculations, and adequate references for justifying the assumptions and parameters used. The TCEQ must approve all alternative methods.
Appendix

Submittal Forms

Information Sheet: Existing Dam
Form TCEQ-20344

Information Sheet: Proposed New Construction Modification, Repair, Alteration, or Removal of a Dam
Form TCEQ-20345

Hydrologic and Hydraulic (H&H) Evaluation Summary
Form TCEQ-20346

Engineer's Notification of Completion
Form TCEQ-20347
# INFORMATION SHEET: EXISTING DAM

(PLEASE PRINT OR TYPE)

Reference 30 Texas Administrative Code, Chapter 299, Dams and Reservoirs

## SECTION 1: OWNER INFORMATION

<table>
<thead>
<tr>
<th>Owner’s Name</th>
<th>Title</th>
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<tr>
<td>Organization</td>
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(Signature of Owner) (Date)

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<table>
<thead>
<tr>
<th>Phone Number</th>
<th>Emergency Contact Phone</th>
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<th>E-mail</th>
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<p>| Owner Code (Please check one): |</p>
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<th>Local Government (L)</th>
<th>Utility (U)</th>
<th>Private (P)</th>
<th>State (S)</th>
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<td>Other (O) please specify:</td>
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<tr>
<th>Year Built</th>
<th>Year Modified</th>
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| Dam and Reservoir Use (Please check one): |
| Augmentation | Diversion | Domestic | Erosion Control |
| Evaporation | Flood Control | Fire Control | Fish | Hydroelectric | Industrial |
| Irrigation | Mining | Municipal | Pollution Control | Recreation | Stock Water |
| Settling Ponds | Tailings | Waste Disposal | Other, please specify: |

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<th>Engineering Firm</th>
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<tr>
<th>Project Engineer</th>
<th>Texas P.E. License Number</th>
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<table>
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<th>Engineering Firm Address</th>
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<td>City</td>
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<th>E-mail</th>
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## SECTION 2: GENERAL INFORMATION

<table>
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<th>Name of Dam</th>
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<tr>
<th>Other Name(s) of Dam</th>
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<table>
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<tr>
<th>Reservoir Name</th>
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<th>Longitude</th>
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<th>Topographic Map No.</th>
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<th>Distance &amp; Direction from Nearest City or Town</th>
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<tr>
<th>Date of Emergency Action Plan (EAP), if one exists</th>
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Describe the current operating condition of dam

If you have questions on how to fill out this form or about the Dam Safety Program, please contact us at 512-239-5195. Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.
 SECTION 3: INFORMATION ON DAM

Classification
Size Classification:  
- Large
- Medium
- Small
Hazard Classification:  
- High
- Significant
- Low
Number of People at Risk _______________ Study Year _______________

Type of Dam:  
- Concrete
- Gravity
- Earthfill
- Rockfill
- Masonry
- Other (specify) _______________

Dam Structure (dimensions to nearest tenth of foot, volume to nearest acre-foot or cubic yard, areas to nearest acre):
Spillway Height _______________ ft (natural surface of ground to bottom of emergency spillway at longitudinal centerline)
Embankment Height _______________ ft (natural surface of ground to crest of dam at centerline)
Structural Height _______________ ft (bottom of cutoff trench to crest of dam at centerline)
Length of Dam _______________ ft Crest Width _______________ ft
Normal Pool Elevation _______________ ft-MSL Principal Spillway Elevation _______________ ft-MSL
Emergency Spillway Elevation _______________ ft-MSL Top of Dam Elevation _______________ ft-MSL
Embankment Volume _______________ cu yd
Maximum Impoundment Capacity _______________ ac-ft (at top of dam)
Normal Reservoir Capacity _______________ ac-ft (at normal or conservation pool)
Reservoir Surface Area _______________ acres (at normal or conservation pool)

Outlet
Outlet Diameter: _______________  
- in
- ft (check one)
Type: _______________

Principal Spillway
Type:  
- Natural
- Riprap
- Concrete
- CMP
- RCP
- Other
Width (Diam.): _______________ ft Capacity: _______________ cfs

Emergency Spillway
Type:  
- Natural
- Riprap
- Concrete
- CMP
- RCP
- Other
Width (Diam.): _______________ ft Capacity: _______________ cfs
Total Spillway Capacity: _______________ cfs (crest of the dam)

SECTION 4: HYDROLOGIC INFORMATION
Required Hydrologic Criteria (% PMF) _______________ % PMF Passing _______________
PMF Study Year _______________
Drainage Area: _______________ acres, or _______________ sq mi
Curve Number (AMC III condition) _______________
Time of Concentration _______________ hr
Peak Discharge _______________ cfs
Peak Stage _______________ ft-MSL
Storm Duration Causing Peak Stage _______________ hr
INFORMATION SHEET: PROPOSED NEW CONSTRUCTION, MODIFICATION, REPAIR, ALTERATION, OR REMOVAL OF A DAM

(PEASE PRINT OR TYPE)

Reference 30 Texas Administrative Code, Chapter 299, Dams and Reservoirs

PLEASE CHECK ONE: ☐ New ☐ Modification ☐ Repair ☐ Removal ☐ Alteration

SECTION 1: OWNER INFORMATION

Owner's Name ______________________________________ Title ______________________________________

Organization _____________________________________________________________________________________

I have authorized the submittal of the final construction plans and specifications to the TCEQ Dam Safety Program according to 30 TAC Chapter 299.

_______________________________________________________________________________________________

(Signature of Owner)                                                                                 (Date)

Owner’s Address___________________________________________________________________________________

City _______________________________ State ____________________________ Zip Code ____________________

Phone Number (          )_______________________________  Emergency Contact Phone (          )__________________

Fax Number (          ) __________________ E-mail ______________________________________________________

Owner Code (Please check one): ☐ Federal (F) ☐ Local Government (L) ☐ Utility (U) ☐ Private (P) ☐ State (S)
☐ Other (O) please specify:___________________________________________________

Dam and Reservoir Use (Please check one): ☐ Augmentation ☐ Diversion ☐ Domestic ☐ Erosion Control
☐ Evaporation ☐ Flood Control ☐ Fire Control ☐ Fish ☐ Hydroelectric ☐ Industrial
☐ Irrigation ☐ Mining ☐ Municipal ☐ Pollution Control ☐ Recreation ☐ Stock Water
☐ Settling Ponds ☐ Tailings ☐ Waste Disposal ☐ Other, please specify:_____________________________

Engineering Firm __________________________________________________________________________________

Project Engineer________________________________________ Texas P.E. License Number_____________________

Engineering Firm Address____________________________________________________________________________

City _______________________________ State ____________________________  Zip Code ___________________

Phone (          ) _______________________ Fax (          ) ______________________

E-mail __________________________________________________________________________________________

SECTION 2: GENERAL INFORMATION

Name of Dam ____________________________________________

Other Name(s) of Dam __________________________________

Reservoir Name __________________________________________________________________________________

Location _____________________________________________ Latitude _________________________ Longitude __________

County ___________________________ Stream Name _______________________

River Basin __________________________ Topographic Map No._________________________

Distance and Direction from Nearest City or Town _________________________________

TX Number ________________________ Water Rights Number ____________________________

If you have questions on how to fill out this form or about the Dam Safety Program, please contact us at 512-239-5195. Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.

TCEQ-20345 (1/07)
### SECTION 3: INFORMATION ON DAM

#### Classification
- Size Classification: □ Large □ Medium □ Small
- Hazard Classification: □ High □ Significant □ Low
- Number of People at Risk _____________ Study Year ________________

#### Type of Dam:
- □ Concrete □ Gravity □ Earthfill □ Rockfill □ Masonry □ Other (specify) ________________

#### Dam Structure (dimensions to nearest tenth of foot, volume to nearest acre-foot or cubic yard, areas to nearest acre):
- Spillway Height _______________ ft *(natural surface of ground to bottom of emergency spillway at longitudinal centerline)*
- Embankment Height ___________ ft *(natural surface of ground to crest of dam at centerline)*
- Structural Height ______________ ft *(bottom of cutoff trench to crest of dam at centerline)*
- Length of Dam________________ ft
- Crest Width_________________________ ft
- Normal Pool Elevation_____________________ ft-MSL
- Principal Spillway Elevation______________________ ft-MSL
- Emergency Spillway Elevation________________ ft-MSL
- Top of Dam Elevation____________________ ft-MSL
- Embankment Volume __________________________ cu yd
- Maximum Impoundment Capacity ______________ ac-ft *(at top of dam)*
- Normal Reservoir Capacity ______________ ac-ft *(at normal or conservation pool)*
- Reservoir Surface Area______________________ acres *(at normal or conservation pool)*

#### Outlet
- Outlet Diameter: _______________ □ in □ ft *(check one)*
- Type: ____________________________

#### Principal Spillway
- Type: □ Natural □ Riprap □ Concrete □ CMP □ RCP □ Other
- Width (Diam.): _______________ ft
- Capacity: _______________ cfs

#### Emergency Spillway
- Type: □ Natural □ Riprap □ Concrete □ CMP □ RCP □ Other
- Width (Diam.): _______________ ft
- Capacity: _______________ cfs
- Total Spillway Capacity: ___________________________ cfs *(crest of the dam)*

### SECTION 4: HYDROLOGIC INFORMATION

- Required Hydrologic Criteria (% PMF) ___________ % PMF Passing ________________
- PMF Study Year ____________________________
- Drainage Area: ____________________________ acres, or ____________________________ sq mi
- Curve Number (AMC III condition) ____________
- Time of Concentration ______________________ hr
- Peak Discharge ___________________________ cfs
- Peak Stage ___________________________ ft-MSL
- Storm Duration Causing Peak Stage __________ hr
HYDROLOGIC AND HYDRAULIC (H&H) EVALUATION SUMMARY

(Please complete all sections, unless otherwise specified)

Name of Dam: ___________________________________________________________

TCEQ Dam Safety Project No.: ____________________________________________

County: _______________________________________________________________

Year to Build: __________________________________________________________

Maximum Record Precipitation (in): _______________________________________

Record Area (county or city): _____________________________________________

Duration (hr): __________________________________________________________

Date of Record (MM/DD/YY): _____________________________________________

Source Ref. (FEMA, National Weather Service, etc.): _________________________

Downstream Dam Toe _________________________ (ft-MSL) Normal Reservoir Capacity ______________________ (ac-ft)

Normal Pool ______________________________ (ft-MSL) Maximum Reservoir Capacity ______________________ (ac-ft)

Principal Spillway ___________________________ (ft-MSL) Reservoir Surface Area ______________________ (ac)

Emergency Spillway __________________________ (ft-MSL) Drainage Area ________________ (ac)

Top of Dam _____________________________(ft-MSL) Outlet Diameter or Cross-Section _______________ (in)

<table>
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<tr>
<th>Storm Duration</th>
<th>Peak Inflow (cfs)</th>
<th>Peak Outflow (cfs)</th>
<th>Peak Stage (ft-MSL)</th>
<th>% PMF Passing</th>
<th>Comments (if needed)</th>
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To the best of my knowledge, I certify the above data are correct. I will supply the hydrologic and hydraulic reports to the Texas Commission on Environmental Quality upon request.

_____________________________________________
(Signature)

(P. E. Seal)

_____________________________________________
(Date)
# ENGINEER’S NOTIFICATION OF COMPLETION

(PLEASE PRINT OR TYPE)

**PLEASE CHECK ONE:**  
- [ ] New  
- [ ] Modification  
- [ ] Repair  
- [ ] Removal  
- [ ] Alteration

<table>
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<th>TX Number</th>
<th>County</th>
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<th>Permit Number</th>
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</table>

Name of Dam/Project

**Owner:**

Name  
Address  
City  
State  
Zip Code  
Phone ( )  
Emergency Contact Phone ( )  
Fax ( )  
E-mail

**Engineering Firm:**

Firm Name  
Project Engineer  
TX P.E. License No  
Firm Address  
City  
State  
Zip Code  
Phone ( )  
Fax ( )  
E-mail

The project was completed on ____________, 20____. To the best of my knowledge, the project was constructed in substantial conformance with plans, specifications, and change orders filed with and approved by the Texas Commission on Environmental Quality.

_____________________________________________  
(Signature)  
(P. E. Seal)  
(Date)

*If you have questions on how to fill out this form or about the Dam Safety Program, please contact us at 512-239-5195. Individuals are entitled to request and review their personal information that the agency gathers on its forms. They may also have any errors in their information corrected. To review such information, contact us at 512-239-3282.*
**Glossary**

**breach**—An excavation through a dam or spillway that is capable of draining the entire reservoir so the structure—no longer considered a dam—will no longer impound water.

**breach analysis**—The determination of the most likely uncontrolled release of water from a dam (magnitude, duration, and location), using accepted engineering practice, to evaluate the inundation downstream.

**breach area**—An area that would be flooded as a result of a dam failure.

**dam**—Any barrier or barriers, with any appurtenant structures, constructed for the purpose of impounding water.

**design flood**—The flood used in the design and evaluation of a dam and appurtenant structures, particularly for determining the size of spillways, outlet works, and the effective crest of the dam.

**effective crest**—The elevation of the lowest point on the crest (top) of the dam, excluding spillways.

**emergency action plan (EAP)**—A written document prepared by the owner or the owner’s professional engineer describing a detailed plan to prevent or lessen the effects of a potential failure of the dam or appurtenant structures.

**emergency spillway**—A secondary spillway designed to pass a large, but infrequent, volume of flood flows.

**fetch**—The straight-line distance across a reservoir subject to wind forces.

**fuse-plug spillway**—An auxiliary spillway that is intentionally blocked by an erodible berm. A higher discharge elevation is maintained during normal floods, while during extreme flooding the discharge elevation is lowered by erosion.

**hazard classification**—A categorization of the potential for loss of life or property damage in the area downstream of the dam in the event of a failure or malfunction of the dam or appurtenant structures. Does not represent the condition of the dam.

**height of dam**—The difference in elevation between the natural bed of the watercourse or the lowest point on the toe of the dam, whichever is lower, and the effective crest of the dam.

**isohyet**—An elliptical area representing the size, shape, and rainfall intensity of a PMP event.

**inundation map**—Map delineating the area that would be newly covered by water in a particular flood event.

**maximum normal operating level**—The highest water-surface elevation within the range of planned operating levels for the reservoir, above which floodwaters would be released.

**maximum storage capacity**—The volume, in acre-feet, of the impoundment created by the dam at its effective crest. Only water that can be stored above natural ground level or that could be released by a failure of the dam is considered in assessing the storage volume.

**minimum freeboard**—The difference in elevation between the effective crest of the dam and the maximum water surface elevation resulting from routing the design flood appropriate for the dam.

**normal storage capacity**—The volume, in acre-feet, of the impoundment created by the dam at the lowest uncontrolled spillway crest elevation, or at the maximum elevation of the reservoir under normal operating conditions.

**population at risk**—The number of people present in an area that would be flooded by a particular flood event.

**principal spillway**—The primary or initial spillway, designed to pass normal flows, that is engaged during a rainfall-runoff event.

**probable maximum flood (PMF)**—The flood magnitude that may be expected from the most critical combination of meteorological and hydrologic conditions that are reasonably possible for a given watershed.

**probable maximum precipitation (PMP)**—The theoretically greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographic location at a certain time of the year.

**professional engineer**—An individual licensed by the Texas Board of Professional Engineers to practice engineering in Texas, with expertise in the investigation, design, construction, repair, and maintenance of dams.

**proposed dam**—Any dam not yet under construction.

**spillway**—An appurtenant structure that conducts overflow from a reservoir.

**top width elevation**—The elevation of the water surface of a flood, associated with the top width of the flood cross-section.
References


E.44. Utah

As in effect on October 1, 2010

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- R655-10-1. Authority.
- R655-10-2. Purpose.
- R655-10-3. Applicability.
- R655-10-5. Hazard Classification.
- R655-10-5A. Hazard Classification--Criteria.
- R655-10-5B. Hazard Classification--Exceptions.
- R655-10-6. Approval Processes.
- R655-10-6A. Application Procedure.
- R655-10-6B. Submission of Plans.
- R655-10-7A. Review of Design.
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- R655-10-7C. Operation.
- R655-10-7D. Selection of Independent Consultants.
- R655-10-7E. Qualifications of Independent Consultants.
- R655-10-7F. Scope of Work.
- R655-10-7G. Purpose of Independent Consultants Investigations.
- KEY
  - Date of Enactment or Last Substantive Amendment
  - Notice of Continuation
  - Authorizing, Implemented, or Interpreted Law

R655-10-1. Authority.

The following rule is established under the authority of Title 73, Chapter 5a. The procedures constitute minimum requirements for dams. Additional procedures may
be required to comply with any other governing statute, federal law, federal regulation, or local ordinance.

**R655-10-2. Purpose.**

The purpose of this rule is to outline the procedures necessary to obtain approval to design, construct, operate, and remove a dam. This rule in no way waives the right of the State Engineer to evaluate the merits of different procedures or to require additional information before approval of any project.

**R655-10-3. Applicability.**

These rules apply to any dam constructed in the state with the exception of those specifically exempted by Section 73-5a-102. Some dams may have an abbreviated approval process as outlined in Section 73-5a-202.

**R655-10-4. Definitions.**

ABUTMENT is the part of the valley side against which the dam is constructed. Right and left abutments are those on respective sides of an observer when viewed looking downstream.

ACRE-FOOT (AC-FT) of water is the volume of water required to cover one acre, one foot deep. This is the term commonly associated with reservoir storage. It is equal to 43,560 cubic feet.

ACTIVE FAULT is a fault that has exhibited one or more of the following characteristics:

(a) movement at or near the ground surface at least once in the last 35,000 years;

(b) instrumentally determined seismicity that demonstrates a causal relationship with the fault;

(c) structural relationship to an active fault such that movement on one fault could be expected to cause movement on the other.

ACTIVE STORAGE CAPACITY is the amount of storage that can be released and utilized.

ANISOTROPY means having physical characteristics which vary in different directions.

APPURTENANT STRUCTURE means the outlet works, spillways, access structures, bridges, and other related structure to a dam.

AXIS OF DAM is the plane or curved surface, arbitrarily chosen by a designer, appearing as a line, in plan or in cross section, to which the horizontal dimensions of the dam can be referred.

BENCHMARK is a permanent physical mark of known horizontal coordinates and elevation.

BREACH is an opening or a breakthrough in a dam.

CALIBRATED WATERSHEDS are watersheds with sufficient precipitation and streamflow measuring devices and records to allow for computations of the relationships between precipitation and streamflow.

CAMBER is additional material placed on the dam crest to protect design freeboard from anticipated settlement.

CAPACITY is the maximum volume that can be stored in a reservoir below the
primary spillway level.

CAVITATION is wear on a hydraulic structure where a high hydraulic gradient is present.

CHANGE ORDER is a document used to modify approved plans or make adjustments in pay quantities.

COLLECTION PIPE is a conduit used to collect seepage waters from drainage blankets and drains and convey the water to a point downstream of the dam.

CONDUIT is a closed channel to convey water through, under, or around a dam.

CONDUIT FILTER DRAIN is a pervious filter drain around a conduit for the purpose of seepage control.

CONTROL SECTION is the section where flow passes through critical depth.

CONTOUR LINE is a line of constant elevation on a map or drawing.

CREST LENGTH is the developed length of the top of a dam.

CREST WIDTH is the developed width of the top of a dam.

CUBIC FEET PER SECOND (CFS) is a unit expressing rates of discharge. One cubic foot per second is equal to the discharge through a rectangular cross-section, one foot wide and one foot deep, flowing at an average velocity of one foot per second.

CUTOFF COLLAR is a projecting collar, usually of concrete, built around the outside of a pipe, tunnel, or conduit, to lengthen the seepage path along the outer surface of the conduit.

DAM is any artificial barrier or obstruction, together with appurtenant works, if any, which impounds or diverts water.

DEAD STORAGE is the storage that lies below the invert of the lowest outlet and that cannot be withdrawn from the reservoir without pumping.

DEFORMATION ANALYSIS is a study of how a dam will permanently deform as a result of strains caused by seismic loads.

DENTAL CONCRETE is concrete used to level discontinuities in dam foundations and abutments.

DESIICCATION is the process of cracking of soils due to shrinkage during drying.

DIFFERENTIAL SETTLEMENT is unequal settlement of a structure or soil mass, often leading to excessive stresses or unacceptable strains.

DISPERSE CLAYS are clays whose particles detach in the presence of water and may be transported by the water, leading to a piping failure.

DRAINAGE AREA or watershed is the area that drains naturally to a particular point on a river, stream or creek.

DRAINAGE BLANKET is a drainage layer placed directly over the foundation material.

DRAINAGE WELLS or pressure relief wells are wells or boreholes usually downstream of impervious cores, grout curtains, or cutoffs, designed to collect and control seepage through or under a dam, so as to reduce uplift pressures under or within a dam. A line of wells forms a drainage curtain.

DRAWDOWN is the lowering of a reservoir’s water surface level due to releases.
DRAWINGS are graphical details of proposed construction.

DROP STRUCTURES are permanent structures used to facilitate the vertical downward movement of water without causing erosion.

DYNAMIC ANALYSIS is an analysis which predicts the stability and/or deformation of a dam due to seismic loads.

EARLY WARNING SYSTEM is an automatic device used to alert downstream interests of existing or impending high flows caused by storms or dam failures.

EMERGENCY ACTION PLAN is a predetermined plan of action to be taken to reduce the potential for loss of life and property damage in an area affected by a dam break.

EMERGENCY SPILLWAY, or secondary spillway, is the spillway designed to convey excess water generated by unusual hydrological events through, over or around a dam.

ENLARGEMENT is any change or addition to an existing dam or its appurtenant works which increases, or may increase, the maximum quantity of water which can be stored therein.

EPICENTER is the point on the earth’s surface directly above the site of initial movement on the fault.

EXIT CHANNEL is an open channel, located downstream from any conduit or spillway, which conducts the flow to a point where it may be released without jeopardizing the dam.

FACE, in reference to a structure, is the external surface that limits the structure.

FILTER or filter zone is a band or zone that is incorporated in a dam and is graded, either naturally or by selection, so as to allow seepage to flow across or down the filter without allowing the migration of material from zones adjacent to the filter.

FLASHBOARDS are lengths of timber, concrete, or steel placed on the crest of a spillway to raise the water level but that may be quickly removed in the event of a flood, either by a tripping device or by a deliberately designed failure of the flashboards or their supports.

FLOOD ROUTING is a computation of the changes in the rise and fall in stream flow or reservoir levels as a flood moves downstream. The results provide hydrographs of flow or elevation versus time at given points on the stream or in a reservoir.

FLOOD STAGE is the stage or elevation in which overflow of the natural banks of a stream or body of water begins.

FLOWLINE or invert is the lowest point in a water conveyance structure where water can flow.

FOUNDATION OF DAM is the natural material on which the dam structure is placed.

GALLERY is a permanent accessible structure within the interior of a dam used for seepage collection, monitoring, and remedial work.

GEOLOGIST is a person with a degree in geology or a related field from an accredited college or university with at least three years of experience in engineering geology.

GEOMEMBRANE is a term for a geosynthetic which is designed to be an
impermeable barrier.

GEOSYNTHETICS is a broad term used to describe manmade fabrics used in geotechnical applications.

GEOTEXTILE is a term for a geosynthetic which is designed to be a filter, a drain, act as reinforcement, or for separation.

GROIN is that area along the contact or intersection of the face of a dam with the abutments.

GROUT CURTAIN is a barrier to reduce seepage under a dam, produced by injecting grout into a vertical zone in the foundation.

HYDRAULIC FRACTURING is the fracturing of soil materials due to excessive fluid pressures.

HYDRAULIC HEIGHT is the vertical dimension of a dam as measured from the natural streambed at the downstream toe to the elevation of the water surface at the crest of the primary spillway.

HYDRAULICS is the science of the static and dynamic behavior of fluids.

HYDROGRAPH is a graphical representation of discharge, stage, volume, or other hydraulic property, with respect to time, for a particular point.

HYDROLOGY is the study of the properties, distribution and movement of water on the earth's surface, in the soil and underlying rocks.

INCREMENTAL DAMAGE ASSESSMENT (IDA) is an analysis showing the influence of a dam failure when superimposed upon an extreme hydrologic event.

INDEPENDENT CONSULTANT is a consultant used, in addition to the owner's engineer, to assess the design, construction, investigation or operation of a dam.

INFILTRATION RATE is the rate at which a given soil can accept surface water.

INFLOW DESIGN FLOOD (IDF) means the flood hydrograph which is used to size a dam's spillway.

INITIAL FILLING PLAN is a written procedure used during the first filling of a reservoir.

INLET CHANNEL is an open channel upstream from a spillway or conduit.

INTERNAL EROSION is piping.

INUNDATION MAPS show areas that would be subject to flooding due to storm conditions or failure of a dam.

LIQUEFACTION is the sudden loss of strength or stiffness of a soil resulting from dynamic loading as from earthquakes.

LOG BOOM is a floating device intended to prevent large floating debris from being carried into a spillway.

LOW-LEVEL OUTLET is a conduit from a reservoir, generally used for lowering the reservoir or for providing downstream releases.

MAGNITUDE of an earthquake is a quantity characteristic of the total energy released by an earthquake.

MAXIMUM CAPACITY is the maximum volume of water that can be stored in a reservoir when filled to the crest of the dam.
MAXIMUM CREDIBLE EARTHQUAKE (MCE) -- All active sources of seismicity with the potential to impact the stability of a dam should be assigned a maximum credible seismic event. The event which has the greatest potential to cause damage at the site will be defined as the Maximum Credible Earthquake.

NAPPE is the free-falling stream from a weir.

NORMAL FREEBOARD is the vertical distance between the primary spillway overflow crest and the top of the dam.

ONE HUNDRED YEAR FLOOD means the flood having a one percent probability of being equalled or exceeded in any given year.

ONE HUNDRED YEAR PRECIPITATION means the precipitation having a one percent probability of being equalled or exceeded in any given year.

OPERATING BASIS EARTHQUAKE (OBE) -- All active sources of seismicity with the potential to impact the stability of a dam should be assigned an operating basis seismic event. This event is considered to have a return interval of at least 200 years. The event which has the greatest potential to cause damage at the site will be defined as the Operating Basis Earthquake.

OWNER includes all who own, control, operate, maintain, manage, or propose to construct a dam; also, their agents, lessees, trustees, and receivers.

OWNER'S ENGINEER is a professional engineer, licensed in Utah, retained to design, construct, monitor, operate, or evaluate a dam.

PEAK FLOW is the maximum instantaneous discharge that occurs during a flood. It is coincident with the peak of a flood hydrograph.

PERVIOUS ZONE is a part of the cross section of an embankment dam comprising material of high permeability.

PHREATIC SURFACE is the free surface of ground water at atmospheric pressure.

PIEZOMETER is an instrument for measuring pore water pressure within soil, rock, or concrete.

PIPING is the progressive development of internal erosion by seepage, appearing downstream as a hole or seam, discharging water that contains soil particles.

PLANS are engineering drawings, specifications, and design reports supporting the design of a dam and detailing the construction of the dam.

POROUS INTERVAL is the portion of a piezometer where infiltrating water is allowed to act on the device.

PRINCIPAL SPILLWAY is the main spillway for normal operating conditions.

PROBABLE MAXIMUM FLOOD (PMF) is the flood that may be reasonably expected from the most severe combination of critical meteorologic and hydrologic conditions that are possible in the region.

PROBABLE MAXIMUM PRECIPITATION (PMP) is the maximum amount of precipitation that could be expected to fall on a drainage under the most severe meteorologic condition.

PSEUDO STATIC ANALYSIS is an approximate method for predicting the dynamic stability of a structure using static loads.

RESERVOIR AREA is the surface area of a reservoir when filled to a given water
RESERVOIR RIM is a term used to describe the land forms around the perimeter of a reservoir which could have an adverse impact on the dam or reservoir due to movement.

RESERVOIR STAGE is the measure of the depth or elevation of water in a reservoir relative to an established datum.

RESIDUAL FREEBOARD means the vertical distance between the maximum water surface during a given hydrologic event and the top of the dam.

RESPONSE SPECTRUM is a graphical representation of actual motions, including displacement, velocity, and acceleration, caused by seismic events.

RIPRAP is a layer of large stones, broken rock, or precast blocks placed on the upstream slope of an embankment dam, on a reservoir shore, or on the sides of a channel, as a protection against waves, ice, and scour.

SEDIMENT POOL is the portion of the reservoir allotted to the accumulation of submerged sediment during the design life of the dam.

SEISMIC means pertaining to an earthquake or earth vibration.

SLOPE PROTECTION is the protection of an embankment slope against wave action or erosion.

SPECIFICATIONS are written descriptions of the proposed construction.

SPILLWAY is an open or closed channel, conduit or drop structure used to convey excess water through a reservoir. It may contain gates, either manually or automatically controlled, to regulate the discharge of the water.

SPILLWAY EVALUATION FLOOD (SEF) is the flood that may be expected at the dam from applying the SEP to a given watershed.

SPILLWAY EVALUATION PRECIPITATION (SEP) is the lowest, site specific, precipitation estimate allowed by the State Engineer, used in the analysis of new, existing, high or moderate hazard dams.

STAFF GAGE is a permanent instrument or device used to read reservoir stage.

STANDARD OPERATING PLAN is a written procedure outlining the operation and maintenance of a dam and its appurtenant structures and equipment.

STATE ENGINEER is the Director of the Utah Division of Water Rights.

STILLING BASIN is a basin constructed to dissipate excess energy of waters emerging from a spillway or outlet.

STOPLOGS are beams placed on top of each other with their ends held in guides on each side of a channel or conduit.

STORAGE CAPACITY is the volume of water which can be stored at the elevation of the primary spillway, including both active and dead storage.

STRUCTURAL HEIGHT means the vertical dimension of a dam as measured from the natural streambed at the downstream toe of a dam to the top of a dam.

SURVEY MARKER is a permanent physical mark on a dam or appurtenant structure used to measure changes in horizontal and vertical movement.

TECTONICS is a study of the broader features of the earth’s crust and the causes of its deformation.
TEST BORINGS are holes drilled to determine the type and physical properties of subsurface materials.

TEST PIT is an excavation used to evaluate and observe subsurface materials.

TOE OF DAM is the junction of a dam face with the foundation. For an embankment dam, the junction of the upstream face with ground surface is called the upstream toe, and the junction of the downstream face with the ground surface is referred to as the downstream toe.

TRANSITION ZONE is a zone of material used to provide filter requirements between two zones of material which do not meet filter requirements.

TRASH RACK is a screen located at an intake to prevent the entry of floating or submerged debris.

UNGATED OUTLET is an outlet that allows uncontrolled flow through or around a dam.

UNIT HYDROGRAPH is a hydrograph which shows the rates at which runoff occurs for one inch of storm runoff from a drainage area.

UPLIFT is the upward water pressure in the pores of a material or on the base of a structure.

WATER STOPS are strips of material used to prevent leakage through joints between adjacent sections of concrete.

WEIR is a device used to measure or control water.

R655-10-5. Hazard Classification.

Hazard classification of a dam places the dam into a category based upon the consequences of failure of the dam. The State Engineer is the ultimate authority on the hazard classification designation for a given dam.

R655-10-5A. Hazard Classification--Criteria.

The hazard classification analysis should include a determination of the threat to human life and property damage in the event of the failure of a dam. In some cases the classification can be assigned by observance of the downstream development in relationship to the location of the dam. In other cases it will be necessary to prepare inundation maps to determine the downstream consequences of failure. In preparing the inundation maps, the following criteria relative to the dam should be used.

1. No concurrent flooding conditions exist.
2. The reservoir level is at the emergency spillway crest.
3. The low level outlet is discharging at capacity.
4. The breach times and geometric parameters used to simulate the dam failure should be acceptable to the State Engineer and consistent with accepted practices.
5. The inundation study should be carried downstream to a point that the breach flows are contained within the banks of the natural channel or a downstream reservoir.

R655-10-5B. Hazard Classification--Exceptions.

It should be noted that the hazard classification as outlined in R655-10-5A may not be an absolute indicator of the hazard of the dam, since a dam failure superimposed on natural flooding conditions may cause incremental risk to life and
property. Although this scenario is not normally used in the hazard classification process, it is a factor the owner should consider in determining their overall liability. Under special circumstances, as determined by the State Engineer, a hazard classification may be determined giving consideration to concurrent flooding events.

R655-10-6. Approval Processes.

There are two procedures for obtaining approval from the State Engineer to construct or modify a dam. The first procedure requires the filing of an application, while the second procedure requires the submission of plans. No approval will be given for any dam unless the water rights are in order.

R655-10-6A. Application Procedure.

For dams not requiring submission of plans as outlined in Section 73-5a-202, an application must be submitted and approved by the State Engineer. Blank applications are available upon request. Upon reviewing the application the State Engineer may approve it, reject it, return it for correction, or approve it with conditions.

R655-10-6B. Submission of Plans.

A. All projects requiring submission of plans should include a package including the drawings, specifications, design reports, and any other information which will assist in reviewing the project. The amount of information generated becomes more involved as the size and hazard rating of the structure increases. The following guidelines are included to alert the designer to the basic information required.

B. All drawings submitted should comply with the following:

1. The size of all drawings submitted for review, shall be 24 inches by 36 inches. Following approval of the project by the State Engineer, two sets of 11 inch by 17 inch drawings shall be submitted.

2. All drawings should include a bar scale to allow for accurate scaling of reductions.

3. All drawings shall have a title block in the lower right corner showing the project name, the owner’s name, the sheet number, and the date of preparation of the plans.

4. All drawings shall have provisions for noting the dates of any modifications.

5. Each drawing shall include the signature and seal of the responsible engineer. Geological drawings should also be signed by the responsible geologist.

C. Drawings to be included in plans are:

1. Title sheet, including:
   a. General location map including access roads.
   b. Signature block for owner’s acceptance.
   c. Index of drawings.
   d. Reference to the water rights for the reservoir.
   e. Reservoir stage/storage curve.
   f. Rating curves for outlets and spillways.

2. Plan view of reservoir, including:
a. Existing topography.
b. Borrow areas.
c. Supply canals and pipelines.
d. Suitable contour lines.
e. Clearing limits.
f. Waste areas.

3. Plan view of dam, including:
   a. Location of all pertinent features.
   b. A survey tie, to an outside section corner, where the longitudinal axis of the
dam intersects the axis of the original stream channel or the low level outlet.
   c. Clearing limits.

4. Longitudinal profile, showing:
   a. Original ground line.
   b. Location of core trench or other cutoff features.
   c. Location of outlets and spillways.
   d. Camber and anticipated settlement.

5. Typical cross-sections of dam, showing:
   a. Embankment geometrics including internal zones.
   b. Slope protection.
   c. Cutoff.
   d. Delineation of embankment on natural ground surface.
   e. Freeboard.
   f. Internal drainage.
   g. Limits of foundation excavation.

6. Plan, profile, cross sections and details of all outlets, spillways, and other
structures.

7. Structural details for reinforcing steel, metal fabrication, or waterstops.

8. Site geology map of the damsite and reservoir basin including locations of all
borings and test pits.

9. Longitudinal geologic profile of both the dam and reservoir, showing:
   a. Original ground line.
   b. Location and orientation of borings.
   c. Geological profile showing pertinent lithologic, hydrologic, and structural
information.

10. Logs of borings with classifications of soil and rock, results of water pressure
tests and other downhole material property tests, soil classification, standard
penetration tests, core recovery, rock quality designations, and strength tests.
11. Any additional drawings such as instrumentation details necessary to construct the project.

D. Specification Requirements.

The State Engineer must review and approve all technical specifications for a proposed project. A partial list of specifications directly related to dam safety follows:

1. Site Preparation.
   a. Clearing and Grubbing.
   b. Soil Stripping.
   d. Diversion and Care of Stream.
2. Foundation Preparation.
   a. Foundation Dewatering.
   b. Relief Wells.
   c. Grouting.
   d. Cutoffs.
   e. Abutment Contacts.
   f. Exploration.
   g. Dental Concrete.
3. Earthwork.
   a. Excavation.
   b. Earth Fill.
   c. Drain Fill.
   d. Rock Fill.
   e. Material Handling.
   f. Testing Procedures.
4. Concrete and Reinforcement.
   a. Concrete Mixing and Placement.
   b. Steel Reinforcement.
   c. Admixtures.
   d. Curing and Curing Compounds.
   e. Joint Fillers and Waterstops.
5. Outlets.
   a. Water Control Gates and Valves.
   b. Air Vent.
   c. Operating Equipment.
d. Bedding Requirements.

6. Aggregates and Rock.
   a. Drain Fill and Filters.
   b. Concrete Aggregates.
   c. Riprap.

7. Erosion Control.

8. Miscellaneous Structural Work.
   a. Metal Fabrication and Installation.
   b. Instrumentation.

9. All technical specifications should also include testing intervals to assure compliance with the specifications.

E. Design Report Requirements. The design report should include all information used to design the dam, including assumptions made and methodology used with sufficient documentation. Any building codes or design manuals used in the design should be referenced, including the year of publication of the source. If the design report is a product of a team effort, the names of all persons producing the report should be included along with the sections they prepared. Examples of items to be included in the design report are as follows:

1. Hydrology calculations for determining the spillway requirements.

2. Hydraulic characteristics of the outlets and spillways.

3. Subsurface investigation including logs of test borings and geologic cross-sections.

4. Material testing results and the location and logs of test pits.

5. Foundation treatment and abutment contact design.

6. Calculations for the reinforced concrete design and the loading conditions utilized.

7. Stability analysis of the dam, abutments, and reservoir rim, including appropriate seismic loading, safety factors and embankment zone characteristics.

8. Geological investigations including:
   a. Regional perspective of the site's geologic and seismic setting at a scale appropriate to the geologic complexity of the area.
   b. Seismic evaluation establishing the relationship of the site to all seismic features of concern and the potential for reservoir induced seismicity.
   c. Site geology of areas affected by construction activities and appropriate adjacent areas.
   d. Plans to compensate for any geological weakness in the dam foundation, abutment areas, and reservoir rim.

9. Seepage considerations including the cutoff trench design and internal drainage design.

10. Post-construction monitoring or alarm systems.
**R655-10-7. Independent Consultant Review.**

The State Engineer may require an independent consultant review to assess the adequacy of the design, construction, or operation of a dam. For purposes of these rules, an independent consultant review is a review of the owner's engineers' work in addition to the review provided by the State Engineer.

**R655-10-7A. Review of Design.**

The following situations will require an independent consultant review of the design of a new dam or significant enlargement of an existing dam.

1. All high hazard dams, which have a structural height over 50 feet and an active storage over 1,000 acre-feet, will require an independent review unless exempted in writing by the State Engineer.

2. Any high or moderate hazard dam which, in the opinion of the State Engineer, has a unique problem requiring additional review.

3. Any high or moderate hazard dam whose design is not typical of dams normally built in the state and is thus beyond the technical abilities of the State Engineer's dam safety staff.

4. If the owner's engineer and the State Engineer cannot reach an agreement on the design of a dam.

5. If the owner specifically requests an independent consultant review.

**R655-10-7B. Review of Construction.**

The State Engineer may require an independent consultant review when peculiar problems are noted during construction of a dam or the dam is not being constructed as per approved plans and specifications.

**R655-10-7C. Operation.**

The State Engineer may require an independent consultant review of the operation of a dam including initial filling plans, standard operating plans, emergency action plans, and performance of the dam if, in his opinion, conditions require a review.

**R655-10-7D. Selection of Independent Consultants.**

Upon notification to the owner, the owner will select independent consultants to conduct the required review. Prior to contracting with the proposed consultants, they must be approved by the State Engineer.

**R655-10-7E. Qualifications of Independent Consultants.**

All independent consultants must have a minimum of ten years' experience related to dams. In the case of engineers, they need to be licensed in the state where they reside, unless exempted by the State Engineer. All proposed consultants must demonstrate that they have the expertise to investigate problems identified and that they have insignificant past association with the dam in question.

**R655-10-7F. Scope of Work.**

In requiring the owner to obtain the services of an independent consultant, the State Engineer will include specific items needing investigation, the format for the reports submitted by the independent consultant, and a timetable for completion of the investigations.
R655-10-7G. Purpose of Independent Consultants Investigations.

The purpose of an independent consultant is to provide additional technical expertise and to insure safety issues are addressed. Conclusions generated by the independent consultants are not binding on the State Engineer.

**KEY**
dam safety, dams, reservoirs

**Date of Enactment or Last Substantive Amendment**
December 10, 2003

**Notice of Continuation**
May 3, 2006

**Authorizing, Implemented, or Interpreted Law**
73-5a

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Utah Administrative Code
The Utah Administrative Code is the body of all effective administrative rules as compiled and organized by the Division of Administrative Rules (Subsection 63G-3-102(5); see also Sections 63G-3-701 and 702).

NOTE: For a list of rules that have been made effective since October 1, 2010, please see the codification segue page.

NOTE TO RULEFILING AGENCIES: Use the RTF version for submitting rule changes.

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As in effect on October 1, 2010

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R655-11. Authority and Applicability.

The following rule is established under the authority of Title 73, Chapter 5a. The procedures constitute minimum design requirements for dams. Additional procedures may be required to comply with any other governing statute, federal law, federal regulation, or local ordinance. These rules apply to any dam constructed in the state with the exception of those specifically exempted by Section 73-5a-102 and those dams not requiring plans as outlined in Section 73-5a-202.

R655-11-2. Purpose and Scope.

A. The following minimum design requirements will serve as a guide to the owner's engineer. It should be noted that these are minimum requirements for general conditions and may be changed when dealing with a specific structure. Designs below the minimum requirements must be approved in writing by the State Engineer prior to final design submittal of the project. The design requirements are quite rigid, allowing little latitude in the utilization of new materials and unproven construction methods. The burden to show adequate protection of public interests with the use of new materials or unproven methods rests with the owner's engineer.

B. The following minimum design requirements apply to all proposed dams where applicable. Since the vast majority of dams in the state are earthfill or rockfill dams, the focus of the design criteria is on these dams. Specific structural design
The criteria for concrete dams is not given. The State Engineer, upon approval in writing, will accept structural design criteria for concrete dams developed by other dam regulatory or dam design agencies, providing it reflects state-of-the-art criteria for the design of concrete dams and does not conflict with the following rules.

**R655-11-3. Definitions.**

Definitions are as outlined in R655-10-4.

**R655-11-4. Hydrologic Design.**

In order to arrive at an Inflow Design Hydrograph or Inflow Design Flood (IDF) more representative of actual conditions in Utah, the State Engineer has commissioned, or has been involved in, numerous studies to supplement the National Oceanic and Atmospheric Administration’s (NOAA) Report entitled "Hydrometeorological Report No. 49 (HMR49) - "Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages". The results of most of these studies are used to better identify soil conditions, discharge coefficients, and unit hydrograph parameters. The results of two of the studies are used directly to refine the calculation of the design rainfall values. Both studies were completed by Donald Jensen of the Utah Climate Center and are entitled, "2002 Update for Probable Maximum Precipitation, Utah 72 Hour Estimates to 5,000 sq. mi. - March 2003" (USUL) and "Probable Maximum Precipitation Estimates for Short Duration, Small Area Storms in Utah - October 1995 "(USUS). All of HMR49, Table 1, page 4 of USUL, and Table 15, pages 74-75 of USUS are hereby incorporated by reference. All High Hazard and Moderate Hazard dams in Utah must use the precipitation values obtained from the use of all three publications. To avoid confusion, precipitation values obtained from HMR49 exclusively will be referred to as the Probable Maximum Precipitation (PMP), while those obtained from using HMR49 in conjunction with USUL or USUS, will be referred to as the Spillway Evaluation Precipitation (SEP). The resulting hydrographs generated will be referred to as the Probable Maximum Flood (PMF) and the Spillway Evaluation Flood (SEF) respectively.

**R655-11-4A. Inflow Design Hydrograph Determination.**

A) In Utah, the IDF for all High and Moderate Hazard Dams will be the SEF. It will be necessary to calculate both the 72 hour SEF using HMR49/ USUL as well as the 6 hour SEF using HMR49/ USUS. Both of these hydrographs must be routed through the reservoir to determine which one represents the most extreme event.

B) Once the critical SEF has been determined, it must be compared to a flood generated by the 100 year, 6 hour (for local storms), or 100 yr, 24 hour (for general storms) precipitation applied on a saturated watershed. If the routed 100 year event, including appropriate allowances for freeboard, is more critical than the SEF it must be used as the minimum IDF. This 100 year flood should also be used as the IDF for all Low Hazard Dams.

**R655-11-4B. Freeboard Requirements.**

All dams must have a normal freeboard above the crest of the principal spillway capable of containing the maximum wave action considering site wind-duration and fetch control characteristics. Wave action includes wave height and maximum runup, as well as reservoir setup against the embankment slope. Unless otherwise justified by specific data acceptable to the State Engineer, an extreme wind velocity (fastest mile) over land of 100 miles per hour should be considered. In addition, while routing the 100 year precipitation event through the spillway, sufficient residual freeboard must be available to control wave action from a fetch controlled 50 miles per hour wind. In no case will the normal freeboard be less than three feet for high
and moderate hazard dams. The State Engineer may reduce the three feet minimum freeboard requirement for low hazard dams based upon a review of the relative increase in risk associated with this reduction.

R655-11-4C. Spillways.

In designing the spillway for a dam to pass the IDF, the State Engineer will consider the use of a principal spillway in conjunction with emergency spillways. The principal spillway must be designed so that no structural damage will occur during passage of the IDF. Emergency spillways, including Fuse Plug Spillways, may be designed so that some damage may be expected during use provided the anticipated damage does not represent a threat to the dam. Sunny day failure modeling of Fuse Plug Spillways may be required to determine if they are creating an additional unacceptable risk. Overtopping of the dam will not be considered as an emergency spillway on earthfill dams, unless it can be demonstrated that the dam is protected from erosion, and the duration of overtopping will not saturate the dam and reduce its stability.

R655-11-4D. Infiltration Rates.

The State Engineer will accept an IDF using SEP values in conjunction with soil moisture conditions representative of historical maximums. If the design engineer is using infiltration rates which represent something less than saturated conditions, information should be submitted to justify the lower soil moisture selection.

R655-11-4E. Flood Routing.

A. In routing the IDF through the reservoir, the initial water surface should reflect conservative estimates which would exist at the time of the flood event. Unless documentation can be provided to the contrary, it should be assumed that all low level outlets are closed during routing of the IDF. For dams receiving inflow from pipelines and supply canals, it should be assumed these additional sources are operating at capacity during the flood event. In the event the spillway is gated or has "stop logs", which are only allowed on existing dams, documentation must be provided to show the gates are automated or operational procedures are in place to insure that the gates can be opened or the stop logs removed in a timely manner.

B. The SEF can be routed so the maximum water surface is at an elevation equal to the lowest point on the crest of the dam with no residual freeboard.

C. In generating the IDF, the basin characteristics used and the parameters used to generate the unit hydrograph should be based on the best information available. Unit hydrographs generated from historical records or calibrated watersheds should be used, where data is available, rather than using synthetic procedures.

R655-11-4F. Incremental Damage Assessment for High and Moderate Hazard Dams.

The State Engineer may, at his discretion, accept an IDF less than the SEF based on the results of an Incremental Damage Assessment (IDA) which shows that failure of the dam would cause insignificant incremental damage to property and no additional threat to human life. The State Engineer may consider the use of early warning systems in evaluating the threat to human life. In requesting the acceptance of an IDF determined from an IDA, documentation must be furnished that the owner of the dam is aware that the design reflects something less than the SEF and they are willing to accept the additional liability. In no case will the State Engineer approve an IDF generated by something less than the applicable 100 year flood event. The resulting selected IDF, based on the IDA, should be reported as a percent of the SEF.

R655-11-4G. Historical Records.
In some cases it may be appropriate to use historical streamflow records to generate a 100 year flood. If these records are used as a basis for the IDF, they should be accompanied by the Synthetic IDF established by using the 100 year precipitation. Following a review of the data, the State Engineer will make a determination of which flood will be used as the IDF.

**R655-11-5. Seismic Design.**

A. Because each dam site has a unique seismic and geological setting, detailed direction cannot be provided for seismic design which is applicable to all dams. Rather, an order of evaluation is presented beginning with more simplified methods and progressing, as required, to more rigorous procedures. In determining the sophistication of analysis required, the State Engineer may consider factors including consequences of failure, available freeboard, duration of reservoir pool, and site geometry. Regardless of the method of analysis, the final determination of seismic adequacy of a dam will be based on all pertinent factors involved and not strictly on the numerical analysis. The order of progression of the seismic analysis follows:

1. Undertake geological and seismological investigations to determine the potential for earthquakes and associated ground motions at the site, including the source and magnitude of the earthquakes to be considered and the selected motions, including potential fault rupture.

2. Undertake field and laboratory investigations of the dam and foundation materials to determine their properties and liquefaction potential.

3. Undertake an appropriate analysis for seismic events to predict factors of safety against slope failures, structural deformations, and liquefaction resulting from earthquake shaking or fault rupture.

4. Incorporate defensive design measures based on the analysis and proven practices.

B. In many instances, an adequate seismic analysis can be determined from the geological study and determination of the general properties of the dam and foundation. Other projects may require more detailed investigations and analyses. Decisions as to seismic safety and risk should be made as the analysis progresses and the extent of further investigations required after each step should be determined following consultation with the State Engineer as necessary.

**R655-11-5A. Geological and Seismic Study.**

A review of the seismic or earthquake history of the region will be performed to establish the relationship of the site to known faults and epicenters. This will be based primarily on review of existing maps and technical literature and should include major earthquakes during historic time, epicenter locations and magnitudes, and the location of any major or regional fault traces. Geologic conditions at or near the dam site that might indicate recent fault or seismic activity should be included. Resulting design earthquakes and associated site ground motion parameters will be selected considering all available evidence including tectonic and seismological history. The ground motion parameters to be selected for the site will consist of those that are needed by the analyses that are appropriately selected for design and may include peak accelerations, velocities, displacements, response spectra, and acceleration time histories. Both the Maximum Credible Earthquake (MCE) and the Operating Basis Earthquake (OBE) will need to be investigated for all projects. The MCE should be evaluated from the following analyses:

1. A deterministic analysis from active faults in the region surrounding the dam.
2. Unless otherwise required by the State Engineer, the random or background event will consist of a minimum magnitude 6.5 event having a peak horizontal site acceleration obtained from a map, herein incorporated by reference, produced by the USGS and entitled "Peak Accelerations (%g) with 5,000 Year Return Time; no fault-specific sources." Alternatively, site specific evaluations may be performed to define ground motions for this event if the methods used and assumptions made are acceptable to the State Engineer. At the discretion of the State Engineer, the OBE requirement may be waived.

3. The OBE will be determined by probabilistic methods acceptable to the State Engineer.

**R655-11-5B. Determination of Dam and Foundation Material Properties.**

Results of the geological and seismological studies may be sufficient to evaluate seismic safety. However, if it appears the dam cannot safely withstand the earthquake motions or if sufficient information is not available to make an adequate determination, the next step of a phased evaluation program would be a field investigation and laboratory testing program. Field investigation should include a sufficient number of borings and test pits to accurately define the embankment, foundation, and abutment materials types, properties, and extent. Particular care and sufficient field data should be obtained where potentially liquefiable soils are present. In place and laboratory testing should be performed to adequately assess the material properties under the anticipated dynamic conditions.

**R655-11-5C. Method of Analysis.**

A. Procedures are available for selecting design earthquakes and associated site-specific motions and for assessing the resistance of dams to these earthquake motions. Procedures and techniques for evaluating the effects on dams from estimated earthquake ground motions range from simplified concepts to comprehensive dynamic analyses. When the degree of sophistication of analytical procedures is far advanced, however, uncertainty is produced in the results by imperfect knowledge of input parameters obtained through field exploration and laboratory testing programs.

B. The extent or scope of studies, investigations, tests and analyses which may be required to adequately determine the seismic safety of a dam will vary from site to site. In general, the following physical factors will indicate a high priority and a greater degree of investigations and analysis:

1. Proximity to known active faults.
2. Indications of low-density materials in the dam or foundation.
3. Zones of high pore pressures or potential liquefaction.
4. Indications of marginal static stability.
5. Lack of adequate construction records for existing dams.

C. Regardless of these factors, however, one of the major considerations will be the "consequences of a failure". High and moderate hazard structures with permanent pools which could result in loss of life or extensive property damage from a failure will, in general, require a greater scope of investigation and analyses.

D. Following are the general analysis requirements for MCE design earthquakes:

1. Embankments, foundations, and abutments not subject to liquefaction:
   a. For a maximum acceleration of 0.2g or less, or a maximum acceleration of .35g
or less if the embankment consists of clay on a clay or bedrock foundation, a
pseudo-static coefficient which is at least 50 percent of the maximum peak bedrock
acceleration at the site should be used in the stability analysis. The minimum factor
of safety in an analysis should be 1.0.

b. For a maximum peak acceleration greater than indicated above, a deformation
and settlement analysis should be performed to estimate anticipated total crest
movement. The evaluation should be performed for both the upstream and
downstream slopes of the dam. Total crest movement should consider potential
accumulation of movement from both sides. The minimum factor of safety against
overtopping should be 2.5.

2. Embankment, foundation, or abutment soils subject to liquefaction:

a. A liquefaction analysis should be completed with enough detail to establish the
boundaries of the liquefiable soils and the physical characteristics of the soil
following liquefaction.

b. A post earthquake stability analysis should be performed to show that the
embankment is stable after liquefaction occurs with a minimum factor of safety of
1.2.

c. Calculated deformation and settlement of the embankment total crest
movement should result in a minimum factor of safety, against overtopping, of 3.0.

3. Other more sophisticated analytical procedures may be required at the
discretion of the State Engineer, where conditions warrant greater detailed studies.

E. In addition to analysis of deformation and liquefaction, it will be necessary to
assess the potential for internal erosion and cracking. Judgment must be used to
decide whether or not erosion would tend to be self-healing as a result of filtering.

F. Construction of dams on active faults will not be allowed unless evidence is
presented to, and approved by, the State Engineer that the dam can safely withstand
the anticipated offset.

G. Evaluation of a dam under OBE conditions should be completed by similar
methods to those described for the MCE. Under the OBE loading conditions the dam
should experience no significant damage.

R655-11-5D. Design Measures.

Design of new dams should include measures, which provide multiple lines of
defense, that enhance their performance under seismic loading. Measures may
include:

1. Significantly wide transition and drainage zones in the embankment of
material not vulnerable to cracking.

2. Controlled compaction of embankment zones to enhance dynamic
performance.

3. Removal or treatment of foundation materials of low strength or density.

4. Enhanced ability to drain reservoir.

5. Flare the embankment core at abutment contacts.

6. Locate the core to minimize saturation of materials.

7. Stabilize slopes around the reservoir rim.

R655-11-5E. Appurtenant Structures.
The effects of seismic loading should also be considered during the design of all appurtenant structures.

**R655-11-6. Embankment Requirements.**

All embankment designs should meet the following criteria.

**R655-11-6A. Factors of Safety.**

A. All dams should meet the following criteria for factors of safety under normal loading conditions.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Minimum Factor of Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>End of Construction Case--upstream and downstream slopes</td>
<td>1.3</td>
</tr>
<tr>
<td>Steady State Seepage--upstream and downstream slopes (full pool)</td>
<td>1.5</td>
</tr>
<tr>
<td>Instantaneous Drawdown--upstream slope</td>
<td>1.2</td>
</tr>
<tr>
<td>OR</td>
<td>1.5</td>
</tr>
<tr>
<td>Actual Drawdown--upstream slope</td>
<td>1.5</td>
</tr>
</tbody>
</table>

B. All factors of safety should be generated by methodology acceptable to the State Engineer. In undertaking the analysis, the effects of anisotropy should be considered and a ratio of horizontal to vertical permeability of at least nine should be used in the seepage analysis. Ratios of up to 100 should be considered if the material types and construction techniques will cause excessive stratification.

C. The strengths used in the stability analysis should be obtained from tests which best model the situation being analyzed.

D. The analysis of the upstream slope stability for actual drawdown should consider drawdown rates which the low level outlets are capable of generating. Actual residual pore pressures should be used.

E. For low hazard dams the State Engineer may waive the requirements of a stability analysis, including a seismic analysis, if it can be demonstrated that conservative slopes and competent materials are used in the dam, and seismic problems (i.e., liquefiable materials, active faults close to the dam) are not present.

F. Stability evaluations where residual strengths are used must have a minimum factor of safety of 1.3.

**R655-11-6B. Dam Crest Requirements.**

A. The crest width of all dams should be, at a minimum, equal to the structural height of the dam divided by five plus five feet. The absolute minimum required shall be 12 feet and the absolute maximum required shall be 25 feet. Wider crest widths may be used at the designer's discretion.

B. All dams shall have a cross slope on the crest of 2% to 3% towards the reservoir.

C. All crests shall be protected with a wearing surface of granular material to prevent vehicular rutting.

D. Dam crests should be cambered to allow for anticipated settlement. The side slopes of the dam may be steepened to accommodate the camber.
E. For dams over 500 feet long which have a crest that dead ends, a turn-around should be provided at the abutment.

F. The impervious portion of the dam under the crest may need to be terminated at the anticipated frost line to prevent desiccation cracking and damage from frost; however, it needs to be carried high enough to prevent seepage over the core by capillary rise.

**R655-11-6C. External Erosion Control.**

A. All downstream slopes of dams should be protected from erosion by placing armor or seeding with grasses. No planting of any shrubs, trees, or other woody vegetation will be allowed unless it is approved in writing by the State Engineer.

B. All downstream groins of dams receiving runoff from adjacent abutments shall be protected from erosion.

C. All upstream slopes on dams which impound water for significant lengths of time shall be armored. If rock riprap is used it shall be well graded, durable, and sized to withstand wave action. If the material underlying the riprap is fine grained and subject to erosion, a properly designed filter blanket must be installed. Geotextiles may be used in lieu of the filter blanket at the discretion of the State Engineer.

**R655-11-6D. Internal Erosion Control.**

A. All dams should have design provisions for controlling internal erosion. In zoned dams all adjacent zones must meet filter criteria with the abutting zones and foundation soils. If filter criteria cannot be met, a transition zone must be provided.

B. All filter zones in a dam must meet criteria acceptable to the State Engineer.

C. In designing filter zones where dispersive clays or broadly-graded materials exist, special considerations may be imposed by the State Engineer.

D. All internal filter zones will have a minimum width of three feet to facilitate construction. Wider zones are encouraged especially in active seismic areas.

E. Proper filtering is essential in all dams where cracking from differential settlement, hydraulic fracturing, or earthquake shaking is possible.

**R655-11-6E. Internal Drainage.**

A. All underdrains and collection pipes shall be constructed using non-corrodible materials capable of withstanding the anticipated loads.

B. Underdrains and collection pipes should be designed to conduct flows several times larger than anticipated. All pipes within the dam which are not easily accessible shall have a minimum diameter of six inches.

C. All internal drain pipes should be enveloped with free draining material, meeting filter requirements with adjacent zones.

D. Where multiple pipes are used to conduct drainage from internal portions of the dam, they should be carried to the downstream toe or gallery separately without intervening connections or manifold systems. If the drain pipes are connected at their termination points, manholes should be provided to facilitate observation and measurement of the separate drain lines.

E. All underdrains and collection pipes should have provisions for measuring discharges in manholes or at their discharge points. If the anticipated discharge is in excess of 10 gallons per minute (gpm), a weir or other suitable measuring device
should be provided. If the anticipated flows are less than 10 gpm, provisions should be made so the water can be discharged freely into a vessel 1.5 feet high and one foot in diameter.

F. All exposed underdrain and collection pipes shall have an appropriate rodent screen attached.

G. All underdrains and collection pipes should be cleaned out prior to the first filling of the reservoir.

H. All seepage collection systems must include a collection pipe to discharge flows.

I. All internal drains must have a minimum cover of 3 feet of impermeable material to eliminate the collection of surface waters.

R655-11-7. Outlet Requirements.
All outlet designs should meet the following criteria.

R655-11-7A. Outlet Sizing.

A. All dams shall have a low level outlet capable of draining the reservoir to the sediment pool. The outlet should be sized to meet the project demands as well as the following criteria.

1. All outlets shall be 24 inches in diameter or larger unless exempted in writing by the State Engineer. Outlets should have valves or capped flanges which can facilitate entry into the pipe by personnel or video equipment.

2. All outlets shall have the capacity to evacuate 90% of the active storage capacity of the reservoir within 30 days neglecting reservoir inflows. The State Engineer may adjust this requirement on large reservoirs if it can be demonstrated that compliance would result in an unreasonably sized outlet or potential releases would exceed the downstream channel carrying capacity.

3. All outlets shall have the capacity to satisfy prior downstream water rights and the owners' release requirements.

R655-11-7B. Outlet Materials.

All outlets will be made of appropriate materials with due regard for loading condition, seismic forces, thermal expansion, resistance to corrosion, and potential abrasion. The use of corrugated metal pipes and other thin-walled steel pipes will not be accepted unless they serve only to provide a form for a poured-in-place concrete conduit or they are specifically accepted in writing by the State Engineer.

R655-11-7C. Outlet Details.

A. All outlets shall have a trash rack to prevent clogging.

B. All outlets connected directly to a downstream pipeline shall have an emergency bypass valve.

C. All outlets shall have a suitable energy dissipator at the discharge end to prevent erosion of the downstream channel.

D. All outlets will be placed on a concrete cradle or encased in concrete unless specifically exempted by the State Engineer in writing.

E. All outlets, with the exception of ungated outlets, shall have an operating gate or a guard gate on the upstream end.
F. All outlets shall have seepage control measures to reduce the potential for piping along the conduit. Common methods may include locating the outlet conduit in bedrock and installing a conduit filter drain to intercept seepage.

G. Outlets encased in concrete should have battered sides to facilitate compaction against the encasement.

H. Every attempt should be made to locate the outlet on bedrock or consolidated materials. In the event this is not possible, consideration should be given to articulating the outlet to allow for settlement.

I. Outlet gates and valves can be either mechanically or hydraulically operated. In either case the hydraulic lines or mechanical stems must be adequately protected from debris, wave action, settlement, and ice damage. Buried stems should be encased in an oil-filled pipe supported on pedestals. No catwalks or similar access structures will be allowed on reservoirs where freezing occurs or significant floating debris is present. All outlets which are operated with electrical equipment must have back-up generating capability or a manual bypass system capable of being operated in a reasonable amount of time.

J. All outlets shall be properly vented to avoid cavitation, surging, and reservoir vortexes. On low head dams adequate ventilation may naturally occur through the conduit if a free water surface is maintained. In most cases a vent pipe and air manifold around the perimeter of the conduit immediately downstream of the gate will be required. The air supply lines should be conservatively sized for the anticipated flows and protected in the same manner as the outlet control lines or stems.

K. All operators and supporting equipment for outlet controls should be properly protected and secured. Particular attention needs to be given to protection from vandals and unauthorized operation. All outlet controls should be clearly marked as to which way the gates and valves operate so that overloading of a closed gate or valve should not occur.

L. Outlet controls should be accessible when the spillways are in use.


A. On all spillway control structures, provisions should be made for aeration of the nappe.

B. All spillways excavated in soils or soft rock should include a check structure to avoid headcutting and lowering of the spillway flowline.

C. All spillway channels should have suitable armor to prevent erosion.

D. If the spillway has concrete sidewalls, adequate weepholes should be provided or the walls should be designed with full hydrostatic loads in conjunction with the soil loads.

E. For spillways in remote areas where significant snowfall occurs, efforts should be made to maximize the southern exposure of the spillway to prevent ice blockage. In many cases elimination of tall trees will be required.

F. All construction joints should be provided with adequate water stops.

G. Design provisions should be made so that downstream spillway channel flows cannot encroach on the dam.

H. All spillways draining reservoirs with large amounts of floating debris should include a log boom to avoid plugging the spillway.
I. Spillway designs should provide for energy dissipation so that waters returned to the natural channel will not cause erosion.

J. For spillways with concrete floors, provisions should be made to control uplift pressures.

K. Stop logs or flashboards which restrict the design spillway capacity will not be allowed.

R655-11.9. Other Design Requirements.

A. To facilitate inspection, all dams shall have a zone 25 feet beyond all contacts at the downstream groins and toe of the dam in which all woody vegetation is to be removed.

B. If the dam is located in an area where grazing occurs, then livestock must be restricted from the dam by suitable fencing.

C. Unless the dam crest serves as a public road, a suitable gate or other barrier should be installed to prohibit traffic.

D. Geosynthetics may not be used in a dam as the primary design feature unless specifically approved, in writing, by the State Engineer.

E. The foundation downstream of a dam should be graded to convey seepage waters and runoff away from the dam.

F. All control houses and other structures housing instrumentation and operating devices should be designed to discourage unauthorized entry and damage from vandalism.

G. If burrowing animal activity is anticipated to be excessive, design consideration should be made to prohibit their entry, or place materials as a shell which are not capable of sustaining a rodent hole.

R655-11.10. Instrumentation.

Instrumentation on a dam serves the purposes of comparing actual performance with predicted performance and to observe the long term performance for unexpected changes, indicating a safety problem. Since each dam site and design varies, considerable judgment is needed in developing an instrumentation plan. The State Engineer may require any instrumentation necessary to adequately monitor a dam to insure its safety. Where instrumentation is required threshold values should be established for field personnel. Readings which exceed threshold values will indicate that the design criteria has been exceeded and the stability analysis should be reevaluated. Some minimal instrumentation will be required on dams as outlined in the following paragraphs.

R655-11.10A. Reservoir Staff Gages.

All dams shall have a suitable staff gage to monitor reservoir levels. Staff gages should be designed to be durable and capable of resisting movement, water forces and ice. All gages shall have permanent markings at a minimum of one foot intervals with actual elevations recorded at five foot intervals. The State Engineer may allow the use of other measuring devices if it can be demonstrated that they are reliable and accurate.

R655-11.10B. Survey Markers and Bench Marks.

All moderate and high hazard dams shall have permanent survey markers on the crest of the dam to monitor vertical and horizontal movement. The survey markers should be located to prevent damage from traffic. In conjunction with the survey
markers a permanent bench mark shall be installed on each abutment, sufficiently removed from the dam so any effects of the dam movement will not be felt at the bench mark. Reference markers should be established so the bench mark can be reset in the event of damage. Spacing of survey markers should not exceed 200 feet and spacing should be decreased as the height of the dam increases.

**R655-11-10C. Piezometers.**

A. All high hazard dams as well as moderate hazard dams, at the State Engineer's discretion, shall include piezometers. As a minimum, piezometers should be installed along two cross sections of the dam, one of which should be at or near the maximum section. Each cross section should include piezometers at critical locations in the embankment and foundation. It is preferable to have only one piezometer in each hole; however, more than one piezometer may be installed in each hole if the intervening zone between the piezometer tips can be adequately sealed.

B. All piezometers should have a surface casing projecting beyond the ground with the surface casing adequately sealed. The surface casing should include a locking cap to prevent unauthorized access.

C. All piezometer holes should be logged during drilling and any pertinent information included on the as-constructed plans. As-built locations, designations and elevations of the top, bottom, and porous interval of the piezometers should be shown on the as-constructed plans.

**R655-11-10D. Seepage Measurements.**

Seepage measurements for all drains and collection pipes should be provided, as outlined in R655-11-6E, for all high and moderate hazard dams. Any significant seepage areas which develop following the initial filling should also be provided with measuring devices.

**R655-11-10E. Strong Motion Instruments.**

The State Engineer may require strong-motion instrumentation in seismic zones 2 and 3.

**R655-11-11. Abandonment of Dams.**

Abandonment of all dams requires approval by the State Engineer.

**R655-11-11A. Removal of Dam.**

If it is proposed to totally remove a dam, the main concern is to return the stream and reservoir basin to their pre-dam condition. Plans should be submitted showing how the original channel is to be reclaimed, how deposited silts are to be controlled, and what methods will be used to revegetate the reservoir basin and riparian areas.

**R655-11-11B. Breaching of Dam.**

If a dam is to be breached the following minimum criteria should be met:

1. The flowline of the breach should be excavated down to natural ground or stabilized at the top of the silt level. In most cases grade control and drop structures will be required to avoid mobilization of reservoir silts and debris.

2. The breach should be designed to pass a flood with a return interval of 100 years without backing water up in the historic reservoir more than five feet.

3. Regardless of hydraulic requirements the bottom width of the breach will be one half the structural height of the dam with an absolute minimum of 10 feet. Additional width may be required by the State Engineer in areas where beaver
activity occurs.

4. Breach side slopes must be flat enough to hold the slope when saturated, with an absolute minimum of one vertical on one horizontal. In areas where there is significant human travel, the minimum side slopes should be one vertical on two horizontal.

5. The exposed banks and bottom of the breach should be protected with riprap, vegetation, or other suitable means to prevent downcutting and lateral slope erosion.

6. Barriers should be placed on the original dam crest to warn any possible traffic on the crest of the breach.


The State Engineer will monitor construction of approved projects as outlined in the following paragraphs.

R655-11-12A. Informal Construction Inspections.

During the course of constructing, enlarging, repairing, or removing a dam, the State Engineer may make periodic inspections to determine compliance with plans and specifications, as well as to observe field conditions to see if actual conditions are consistent with those used during design. Any problems observed will be pointed out to the resident inspector or engineer for correction or change. All significant problems noted will be outlined in a letter to the owner and the owner's engineer. The engineer must respond in writing to the State Engineer as to what steps were undertaken to correct the problems.

R655-11-12B. Formal Construction Inspections.

In approving plans the State Engineer may require his approval of certain construction operations before the next phase of construction can commence. The owner's engineer or inspector must notify the State Engineer and determine a mutually acceptable time to observe and approve the work prior to continuation of the construction. Written acceptance of work inspected during formal inspections will be sent to the owner and his engineer.

R655-11-12C. Construction Reporting Requirements.

Written documentation of all construction activities should be maintained by the owner's engineer. The documentation must be submitted weekly to the State Engineer by the owner's engineer when any work is underway. At a minimum the documentation should include:

1. All materials certifications submitted by suppliers to insure compliance with specifications.

2. Results of all material tests or any other testing undertaken during construction. Any tests not meeting the requirements of the plans must include notations indicating what was done to correct the sub-standard work.

3. All engineers' and inspectors' diaries, field notes, or other written documentation.

4. Photographs to clarify work completed or problems noted.

5. All geological logs of foundation excavations.

R655-11-12D. Change Order Approvals.

All change orders revising the plans that involve technical changes must be
approved by the State Engineer. Since the State Engineer is not a party to the construction contract, change orders involving strictly payment to the contractor do not need to be approved by the State Engineer.

**R655-11-12E. Final Inspection.**

Before any dam can be placed in operation a final inspection of the project must be undertaken by the State Engineer and his written acceptance of the project received. The Emergency Action Plan, Standard Operating Plan, and Initial Filling Plan, if required, must be completed and approved before final acceptance and authorization for filling can be given. As-constructed plans of the project must be submitted within 60 days of the date of the final inspection. All as-constructed plans submitted must be on a high quality reproducible medium. As-constructed plans should reflect design changes made during construction, geological logs of the foundation excavation, and piezometer borings.

**KEY**
dams, earthquakes, floods, reservoirs

**Date of Enactment or Last Substantive Amendment**
December 10, 2003

**Notice of Continuation**
May 3, 2006

**Authorizing, Implemented, or Interpreted Law**
73-5a

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Rule converted into HTML by the Division of Administrative Rules.

For questions regarding the content or application of rules under Title R655, please contact the promulgating agency (Natural Resources, Water Rights). A list of agencies with links to their homepages is available at http://www.utah.gov/government/agencylist.html or from http://www.rules.utah.gov/contact/agencycontacts.htm.

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In order to arrive at an Inflow Design Hydrograph or Inflow Design Flood (IDF) more representative of actual conditions in Utah, the State Engineer has commissioned, or has been involved in, numerous studies to supplement the National Oceanic and Atmospheric Administration’s (NOAA) Report entitled “Hydrometeorological Report No. 49 (HMR49) - “ Probable Maximum Precipitation Estimates, Colorado River & Great Basin Drainages”. The results of most of these studies are used to better identify soil conditions, discharge coefficients, and unit hydrograph parameters. The results of two of the studies are used directly to refine the calculation of the design rainfall values. Both studies were completed by Donald Jensen of the Utah Climate Center and are entitled, "2002 Update for Probable Maximum Precipitation, Utah 72 Hour Estimates to 5,000 sq. mi. - March 2003" (USUL) and " Probable Maximum Precipitation Estimates for Short Duration, Small Area Storms in Utah - October 1995 "(USUS). All of HMR49, Table 1, page 4 of USUL, and Table 15, pages 74-75 of USUS are hereby incorporated by reference. All High Hazard and Moderate Hazard dams in Utah must use the precipitation values obtained from the use of all three publications. To avoid confusion, precipitation values obtained from HMR49 exclusively will be referred to as the Probable Maximum Precipitation (PMP), while those obtained from using HMR49 in conjunction with USUL or USUS, will be referred to as the Spillway Evaluation Precipitation (SEP). The resulting hydrographs generated will be referred to as the Probable Maximum Flood (PMF) and the Spillway Evaluation Flood (SEF) respectively.

R655-11-4A. Inflow Design Hydrograph Determination.

A) In Utah, the IDF for all High and Moderate Hazard Dams will be the SEF. It will be necessary to calculate both the 72 hour SEF using HMR49/ USUL as well as the 6 hour SEF using HMR49/ USUS. Both of these hydrographs must be routed through the reservoir to determine which one represents the most extreme event.

B) Once the critical SEF has been determined, it must be compared to a flood generated by the 100 year, 6 hour (for local storms), or 100 yr, 24 hour (for general storms) precipitation applied on a saturated watershed. If the routed 100 year event, including appropriate allowances for freeboard, is more critical than the SEF it must be used as the minimum IDF. This 100 year flood should also be used as the IDF for all Low Hazard Dams.

R655-11-4B. Freeboard Requirements.

All dams must have a normal freeboard above the crest of the principal spillway capable of containing the maximum wave action considering site wind-duration and fetch control characteristics. Wave action includes wave height and maximum runup, as well as reservoir setup against the embankment slope. Unless otherwise
justified by specific data acceptable to the State Engineer, an extreme wind velocity (fastest mile) over land of 100 miles per hour should be considered. In addition, while routing the 100 year precipitation event through the spillway, sufficient residual freeboard must be available to control wave action from a fetch controlled 50 miles per hour wind. In no case will the normal freeboard be less than three feet for high and moderate hazard dams. The State Engineer may reduce the three feet minimum freeboard requirement for low hazard dams based upon a review of the relative increase in risk associated with this reduction.

R655-11-4C. Spillways.
In designing the spillway for a dam to pass the IDF, the State Engineer will consider the use of a principal spillway in conjunction with emergency spillways. The principal spillway must be designed so that no structural damage will occur during passage of the IDF. Emergency spillways, including Fuse Plug Spillways, may be designed so that some damage may be expected during use provided the anticipated damage does not represent a threat to the dam. Sunny day failure modeling of Fuse Plug Spillways may be required to determine if they are creating an additional unacceptable risk. Overtopping of the dam will not be considered as an emergency spillway on earthfill dams, unless it can be demonstrated that the dam is protected from erosion, and the duration of overtopping will not saturate the dam and reduce its stability.

R655-11-4D. Infiltration Rates.
The State Engineer will accept an IDF using SEP values in conjunction with soil moisture conditions representative of historical maximums. If the design engineer is using infiltration rates which represent something less than saturated conditions, information should be submitted to justify the lower soil moisture selection.

R655-11-4E. Flood Routing.
A. In routing the IDF through the reservoir, the initial water surface should reflect conservative estimates which would exist at the time of the flood event. Unless documentation can be provided to the contrary, it should be assumed that all low level outlets are closed during routing of the IDF. For dams receiving inflow from pipelines and supply canals, it should be assumed these additional sources are operating at capacity during the flood event. In the event the spillway is gated or has "stop logs", which are only allowed on existing dams, documentation must be provided to show the gates are automated or operational procedures are in place to insure that the gates can be opened or the stop logs removed in a timely manner.

B. The SEF can be routed so the maximum water surface is at an elevation equal to the lowest point on the crest of the dam with no residual freeboard.
C. In generating the IDF, the basin characteristics used and the parameters used to generate the unit hydrograph should be based on the best information available. Unit hydrographs generated from historical records or calibrated watersheds should be used, where data is available, rather than using synthetic procedures.

R655-11-4F. Incremental Damage Assessment for High and Moderate Hazard Dams.

The State Engineer may, at his discretion, accept an IDF less than the SEF based on the results of an Incremental Damage Assessment (IDA) which shows that failure of the dam would cause insignificant incremental damage to property and no additional threat to human life. The State Engineer may consider the use of early warning systems in evaluating the threat to human life. In requesting the acceptance of an IDF determined from an IDA, documentation must be furnished that the owner of the dam is aware that the design reflects something less than the SEF and they are willing to accept the additional liability. In no case will the State Engineer approve an IDF generated by something less than the applicable 100 year flood event. The resulting selected IDF, based on the IDA, should be reported as a percent of the SEF.

R655-11-4G. Historical Records.

In some cases it may be appropriate to use historical streamflow records to generate a 100 year flood. If these records are used as a basis for the IDF, they should be accompanied by the Synthetic IDF established by using the 100 year precipitation. Following a review of the data, the State Engineer will make a determination of which flood will be used as the IDF.

KEY: dams, earthquakes, floods, reservoirs
November 29, 2001
Notice of Continuation July 12, 2001
73-5a
Effective Date: 12/10/2003

(1) The state engineer has the authority to regulate dams for the purpose of protecting public safety.

(2) To protect life and property, the state engineer may make rules controlling the construction and operation of dams, including rules controlling:
   (a) design;
   (b) maintenance;
   (c) repair;
   (d) removal; and
   (e) abandonment.

(3) The state engineer may by rule exempt from this chapter any dam that:
   (a) impounds less than 20 acre-feet of water and does not constitute a threat to human life if it fails; or
   (b) does not constitute a threat to human life and would result in only minor damage to property of the owner if it fails.

73-5a-102. Chapter does not apply to certain federal dams and reservoirs.

This chapter does not apply to works owned by the United States Bureau of Reclamation. However, the Bureau of Reclamation shall file plans, drawings, and specifications of its works with the state engineer.

73-5a-103. Liability of owner or operator.

(1) Nothing in this chapter shall be construed to relieve an owner or operator of a dam or reservoir of the legal duties, obligations, or liabilities incident to the ownership or operation of the dam or reservoir.

(2) The owner or operator of a dam or reservoir may not be held to be strictly liable for any act or omission incident to the construction, ownership, or operation of the dam or reservoir.

73-5a-104. Qualifications of persons designing dams.

Each plan for the construction, enlargement, repair, alteration, or removal of any dam in this state shall be prepared by a qualified engineer who is:

(1) licensed in Utah; and
(2) experienced in dam design and construction.

73-5a-105. Independent consultants -- Owner to pay costs.

(1) The state engineer may require the owner of a dam or proposed dam to obtain the services of an independent consultant or team of consultants approved by the state engineer to consult regarding the adequacy of the design, construction, or operation of the dam if safety considerations pertaining to the
design, construction, or operation of the dam warrant an independent review.

(2) The state engineer shall make rules specifying:
   (a) the safety considerations that will be considered in determining if an independent review is required;
   (b) the requisite qualifications and experience of the independent consultants; and
   (c) the timing of the consultants' review so that their recommendations are made in a timely manner.

(3) (a) The independent consultants shall be considered to be the agents of the owner of the dam.
   (b) The costs of the independent consultants' services shall be paid by the owner of the dam.
   (c) The owner of the dam may require the independent consultants to consider other issues, in addition to safety considerations, such as:
      (i) design selections or alternatives;
      (ii) site selection;
      (iii) cost effectiveness; or
      (iv) other tasks as defined by the contract.

73-5a-106. Dams classified according to hazard and use.

(1) Dams shall be classified according to hazard and use.
(2) Hazard classifications are as follows:
   (a) high hazard - those dams which, if they fail, have a high probability of causing loss of human life or extensive economic loss, including damage to critical public utilities;
   (b) moderate hazard - those dams which, if they fail, have a low probability of causing loss of human life, but would cause appreciable property damage, including damage to public utilities; and
   (c) low hazard - those dams which, if they fail, would cause minimal threat to human life, and economic losses would be minor or limited to damage sustained by the owner of the structure.
(3) Use classifications are as follows:
   (a) water storage - dams which impound water for prolonged periods, including those built for irrigation, power generation, water supply, aquatic culture, and recreation;
   (b) flood control - dams constructed to operate only during significant runoff events and which impound water for a small percentage of time, including those built for flood control or sediment control and debris basins;
   (c) tailings - dams in which a large component of the material impounded consists of saturated solids; and
   (d) other - dams which impound a minimal amount of water or where the head behind the dam is minimal, including stock ponds, wash water ponds, recirculated process water ponds, regulating reservoirs, and diversion dams.
E.45. Vermont
State of Vermont
Department of Environmental Conservation

Instructions for Completing
Application for Authorization to Construct or Alter a Dam

10 V.S.A. Chapter 43

Item 1: Applicant. Ordinarily, the applicant(s) should be the owner(s) of the dam and land upon which the dam is or will be located. If there is more than one owner, all owners must be listed and become joint applicants. If the dam is on leased land, both the lessor and lessee become co-applicants.

Item 2: Legal Entity. Complete only if applicant is not applying as an individual, e.g., corporation, partnership, municipality, etc.

Item 3: Contact. Person to contact regarding this application if other than applicant.

Item 4: Land Ownership and Flowage Rights. Complete Schedule A and provide any required documentation.

Item 5: Project Description
   a. Check appropriate box.
   b. Name of existing dam, if any, or name of applicant or pond as appropriate.
   c. Name of town(s) in which the dam is located.
   d. Name of water course (river, stream, lake or pond) on which the dam is or will be located. If the dam is an offstream structure or on an unnamed watercourse, indicate that it is on an unnamed tributary of the nearest named watercourse.
   e. Drainage area in acres at the dam.
   f. Indicate type of dam, e.g., earthfill, concrete gravity, earthfill-stonewall, stone masonry, timber A-frame, etc.
   g. Surface area of impoundment in acres (A), at Normal Water Level (NWL) and with water level at Top of Dam.
   h. Storage in acre-foot (AF). NOTE: One acre-foot is equal to 43,560 cubic feet; 500,000 cubic feet is approximately 11.48 AF. Provide storage values for both NWL and top of dam, i.e., top of non-overflow part of dam or top of freeboard, conditions. Storage will be based on one of the following cases.

   Case I. Totally artificial (man-made) lakes, ponds, reservoirs, lagoons or other impoundments. Includes man-made dams constructed on beaver ponds. Storage, including accumulated sediments, controlled by the dam and any storage created by excavating below the lowest elevation of the dam foundation. If there is no dam above original ground elevation, e.g., a “dug pond,” lagoon,
etc., it is the total storage created by excavation below the lowest ground elevation along the periphery of the pond.

**Case II.** Dams at the outlets of natural lakes or ponds. Storage is total storage, including any accumulated sediments, controlled by the dam but does not include existing natural storage below the lowest foundation elevation of the dam. However, it does include any additional man-made storage created by dredging or enlarging a natural pond with a dam on it.

i. The maximum height is the vertical distance from the lowest point along the downstream toe of the dam (usually the original bed of the stream or watercourse) to the top of the non-overflow part of the structure. For impoundments without dams indicate N/A (not applicable).

j. Indicate, for existing lakes, ponds or dams if the existing normal water level will be raised or lowered and by how much. If there is no existing lake or pond or dam, indicate N/A.

k. Provide a brief narrative description of the project and its purpose.

l. Describe the method of operation. Include such things as any proposed manipulation of water levels and any diversions of water into or out of the pond.

**Item 6:** **Engineer.** List name, address, telephone, and Vermont P.E. license number for engineer providing design and construction supervision services. Sections 1080(4), 1083(b) and 1090 of the statute require that the dam owner retain the services of a professional engineer, registered in Vermont, who has experience in the design and investigation of dams to design and supervise construction or alteration of any dam requiring approval from the department under 1082.

It is desirable, but not necessary, that the design engineer also provide the required construction supervision. **Full time construction supervision and submittal of daily construction status reports is ordinarily required.**

**Item 7:** **Estimated Construction Cost.** Estimated construction cost – exclusive of cost of land.

**Item 8:** **Estimated Start and Completion Dates.** Indicate when you would like to begin the project and when it would be completed.

NOTE: For most projects the work should be scheduled to be completed during one construction season (generally April 15 – November 15). For projects that require more than one construction season, a longer construction period may be approved provided there are adequate provisions to safely “winter over” the uncompleted project. If project is to be phased, provide detailed schedule.

**Item 9:** **Financial Information.** Complete Schedule B.

**Item 10:** **Right of Entry.** Complete Schedule C.

**Item 11:** **Public Good.** Complete Schedule D.
Item 12: Documents and Schedules Attached.

A. The following items are required for all applications:

1. Location map. Show location of dam on section from U.S. Geological Survey topographic map.
2. Schedules A, B, C, and D.
3. Plans and Specifications. Complete and detailed engineering plans and specifications must accompany the application. Submit two (2) complete sets of 24 inch by 36 inch engineering plans and one (1) complete set of 11 inch by 17 inch engineering plans.

NOTE: Prior to submitting the application, the department encourages the applicant’s engineer to discuss preliminary design concepts and parameters before completing the detailed plans and specifications. Contact with state fish and wildlife, water quality and wetlands personnel is strongly recommended prior to preliminary design.

B. The following items are generally required for all new construction and most reconstruction and alterations.

1. Soils Information. Provide boring and test pit logs, laboratory analyses of soils for foundation, embankment, filters, spillways, etc. Provide filter design and stability analyses as appropriate. Filter gradation requirements should be designed in accordance with NRCS (formerly SCS), Part 633, National Engineering Handbook, Chapter 26, Gradation Design of Sand and Gravel Filters (May 1994 or later revisions), or other appropriate standard nationally recognized by the engineering profession as suitable for dams.
2. Hydrology and Hydraulics. Provide detailed H&H study of site and basin hydrology and project hydraulics showing adequate freeboard, spillway capacity and drain capacity to support downstream hazard classification using appropriate and generally accepted methodologies.
3. Storage and Surface Area Data. Provide area-capacity curves or tables for full range of storage controlled by the dam.
4. Breach Analysis. Provide breach analysis and inundation mapping for determination of downstream hazard classification, for sizing spillways and outlet works, and, where appropriate, for use in preparation of Engineering Action Plans (EAP).

The downstream hazard classification used by the department is the same as that used by the U.S. Army Corps of Engineers in Recommended Guidelines for Safety Inspections of Dams (ER 1110-2-106: 24 Mar 80, Chg. 1, page D-8). The classification used by the Soil Conservation Service (SCS) as given on page 1-1 of Technical Release 60 (Revised October 1985) is acceptable, but the classifications should be corrected with the Corps designations.
The breach analysis may be done by generally accepted method such as the National Weather Service (NWS) DAMBRK and FLDWAV models or Corps of Engineers HEC-1 Dam Break computer models. For further guidance, see the Federal Energy Regulatory Commission (FERC), *Engineering Guidelines for the Evaluation of Hydropower Projects, Appendix II-A, Dambreak Studies* October 1993. The NWS models are the preferred methodologies.

5. **Spillway Design Flood (SDF)**

SDF and outlet works capacities should be consistent with guidelines or service criteria established by Federal agencies such as the Corps of Engineers, Soil Conservation Service and the Bureau of Reclamation for a given size and hazard classification, with the following additional requirements:

- **SDF, as appropriate**, but in no case less than a routed Q100 (one hundred-year frequency) inflow (Ref: *FERC Engineering Guidelines . . .*, October 1993, Paragraph 2-3.3.).

- Freeboard, as appropriate, but not less than 1.5 feet with a routed Q100 inflows, and not less than 3.0 feet from principal spillway crest (usually NWL). Applies to all embankment dams and other dams where appropriate.

6. **Operation and Maintenance (O&M) Manual.** Prepare O&M manual for dam owner/operator. Include, as appropriate, project description, records, photos; operating practices for gates, spillways, etc.; maintenance practices; inspections, frequency for owner/operator and owner’s engineer; inspection check lists; recordkeeping, etc.

7. **First Filling Plan.** Provide a plan to be followed by the dam owner and his engineer to monitor dam during first filling following construction or modification.

8. **Emergency Action Plan (EAP).** An EAP is recommended for all dams, particularly Class I (high hazard) structures. An EAP is required for all new Class I and Class II dams. The EAP should be developed in coordination with the affected municipalities and be acceptable to them. Coordination with Vermont Emergency Management is also recommended.

**Item 13:** Application Fee Enclosed. Compute from fee Schedule and submit a check payable to State of Vermont.

**Item 14:** Certification. Sign, date and provide typed name and title. If more than one applicant, all must sign.
Dam Design

The department expects all dams will be designed in accordance with generally accepted, modern engineering practices by qualified and experienced professional engineers registered in the State of Vermont. Although, the department has not formally adopted specific design criteria, the following general standards are used by the department:

1. **Low level outlets.** All new and reconstructed dams must have an adequate low level (bottom) outlet that is operable from the surface and is of sufficient size to drain the reservoir. Slide gates or gate valves are preferred. "Flap valves" are unacceptable.

2. **Corrugated Galvanized Metal Pipe (CGMP).** CGMP is not acceptable for spillways, low level outlets or drains in new or reconstructed dams.

3. **Seepage Control.** The department places strong emphasis on adequate seepage control to prevent piping (internal erosion) and instability of embankments, structures, foundations and abutments of dams.

   All conduits and structures passing through earth dams must be protected by properly designed mineral filters. In accordance with modern practice, rigid anti-seep collars or diaphragms are no longer to be used on conduits.

   Mineral filter design should be in accordance with NRCS (SCS) Chapter 26, NEH (See Item 12, B-1) or other appropriate standard nationally recognized by the engineering profession as sustainable for dams.

   Filter fabrics should not be used to wrap piezometer screws or as filter material within or on the upstream face of dams, or within any portion of the embankment. (Ref: Corps of Engineers, EM 1110-2-1901, 9/30/86, *Seepage Analysis and Control for Dams*.)
Mail completed application to:

Department of Environmental Conservation  
Facilities Engineering Division  
Dam Safety Section  
103 South Main Street  
Waterbury, VT 05671-0511

Notes:  
(1) The department may request other information from the applicant it considers necessary to properly review the application.

(2) The department will have a notice of the completed application published in an area newspaper, request posting in the town clerk’s Office and will seek comments from state, municipal or regional agencies and other individuals or organizations who have requested a notice.

(3) The applicant is requested to provide the department with the names and addresses of any persons the applicant knows to have an interest in the application and would like to receive a notice.

(4) Under 10 V.S.A. Section 1083(a) notice of the application must be given by the applicant to governing body of the municipality or municipalities in which the dam or any part of the dam is to be located.

July 2009
STATE OF VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

INSPECTION OF DAMS

The Department of Environmental Conservation has for many years made routine safety inspections of non-federal, non-hydroelectric dams. Since 1982, the Department has been required to carry out periodic inspections of dams subject to its jurisdiction under provisions of 10 V.S.A. § 1105. This section reads as follows:

§ 1105. Inspection of dams

The state agency having jurisdiction shall employ an engineer to make periodic inspections of non-federal dams in the state to determine their condition and the extent, if any, to which they pose a potential or actual threat to life and property, or shall promulgate rules pursuant to chapter 25 of Title 3 to require an adequate level of inspection by an independent registered engineer experienced in the design and investigation of dams. The agency shall provide the owner with the findings of the inspection and any recommendations. - Added 1981, No. 242 (Adj. Sess.), § 13, amended 1985, No. 60

The Department classifies dams according to a dam’s potential for causing loss of life and property damage in the area downstream of the dam if it were to fail. The following Downstream Hazard Classification system is used by the Department. It is same as the U.S. Army Corps of Engineers system given in Recommended Guidelines for Safety Inspection of Dams (ER 1110-2-106, 25 Sept. 79, 24 Mar 80 Chg 1).

DOWNSTREAM HAZARD CLASSIFICATION OF DAMS

<table>
<thead>
<tr>
<th>Class</th>
<th>Hazard Category</th>
<th>Potential Loss of Life</th>
<th>Potential Economic Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Low</td>
<td>None expected (No permanent structures for human habitation)</td>
<td>Minimal (Undeveloped to occasional structures or agriculture)</td>
</tr>
<tr>
<td>2</td>
<td>Significant</td>
<td>Few (No urban developments and no more than a small number of inhabitable structures)</td>
<td>Appreciable (Notable agriculture, industry or structures)</td>
</tr>
<tr>
<td>1</td>
<td>High</td>
<td>More than few</td>
<td>Excessive (Extensive community, industry or agriculture)</td>
</tr>
</tbody>
</table>

Under the Corps system, the classifications are further described as follows:

(a)  LOW Hazard (Class 3)

Dams conforming to criteria for the low hazard potential category generally will be located in rural or agricultural areas where failure may damage farm buildings, limited agricultural land, or township and country roads.
(b) **SIGNIFICANT Hazard (Class 2)**

Significant hazard potential category structures will be those located in predominantly rural or agricultural areas where failure may damage isolated homes, secondary highways or minor railroads or cause interruption of use or service of relatively important public utilities.

(c) **HIGH Hazard (Class 1)**

Dams in the high hazard potential category will be those located where failure may cause serious damage to homes, extensive agricultural, industrial and commercial facilities, important public utilities, main highways or railroads.

Additional information:

1. The terminology HIGH, SIGNIFICANT, AND LOW hazard refers to the potential for damage or loss of life and does **not** refer to the condition of the dam. For example, a HIGH hazard (Class 1) dam may be in excellent condition and a LOW hazard (Class 3) dam may be in poor condition.

2. A dam’s classification may change from what it was when it was built or at the last inspection because of changes in downstream conditions. For example, a Class 3 (low hazard) dam may become a Class 2 (significant hazard) or Class 1 (high hazard) dam if some houses are built downstream that could be impacted by a failure. The classification could also change (either up or down) if a more detailed breach analysis is carried out that more accurately determines downstream damage potential.

3. It should not be assumed that the failure of a Class 3 (low hazard) dam would never be a threat to lives. Although direct loss of life (such as by flooding a house) is not expected, the failure could, for example, wash out a road and result in a fatal accident.

The Department bases its minimum periodic inspection frequency on the downstream hazard classification. The Department’s goal is to inspect dams as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Downstream Hazard Classification Category</th>
<th>Inspection Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Significant</td>
<td>1-5</td>
</tr>
<tr>
<td>3</td>
<td>Low</td>
<td>7-10</td>
</tr>
</tbody>
</table>

The Department may increase the inspection frequency when in its opinion more frequent or non-routine inspections are warranted. Reasons to increase the frequency or undertake non-routine inspections may include: (1) problems or concerns with the condition or safety of the dam; (2) following significant flood events, and (3) during and subsequent to impounding water following construction or reconstruction of the dam.
The inspections by the Department do not and are not intended to relieve the owner of the
dam of the owner’s legal duties, obligations or liabilities incidental to the ownership, operation,
maintenance, emergency preparedness or inspection of the dam. The owner should inspect or
have the dam inspected on a frequent basis so that routine maintenance may be undertaken as
needed and to monitor and/or identify any changes or conditions that could indicate problems
with the dam. Should any such conditions or changes occur the owner should contact an engineer
experienced with the design and investigation of dams. The engineer should evaluate the
significance of the change or condition so that the engineer can advise the owner accordingly.
Even if no changes are observed, the owner should have an experienced and qualified engineer
inspect and evaluate the dam on an appropriate periodic basis, e.g., annually, biannually, etc. The
inspections by the owner or owner’s engineer are independent of any inspections that may be
carried out by the Department.

The Department’s current policy is to inspect only those dams that are capable of
impounding more than 500,000 cubic feet. Although the statute does not limit size when
considering "unsafe" dams (10 V.S.A. § 1095), only those dams impounding more than 500,000
cubic feet require prior authorization to construct, alter or remove (10 V.S.A. § 1082).

The inspection program relies on the voluntary assistance of dam owners. Before an
inspection is made, a diligent effort will be made to contact the landowner for access permission.
The landowner may deny permission for inspection. Consult your attorney.

The purpose of the inspection is to investigate and determine the condition of the dam
and the extent, if any, to which it may pose a potential or actual threat to life and property. A
report on the findings of the inspection and any recommendations are provided the dam owner.
The report provides an assessment of the general condition of the dam which is based upon
available data and a visual inspection. Detailed investigations and analyses involving
topographic mapping, subsurface investigations, testing and detailed computational evaluations
or detailed hydrologic and hydraulic analyses are beyond the scope of the inspection, however,
the inspection may identify a need for further studies.

The reported condition of the dam is based on observations of field conditions at the time
of inspection along with data available to the Department. In cases where the reservoir was
lowered or drained prior to inspection, such action, while usually improving the stability and
safety of the dam, removes the normal load on the structure and may obscure certain conditions
which might otherwise be detectable if inspected under the normal operating environment of the
structure.

The safety of a dam depends on numerous and constantly changing internal and external
conditions, and is evolutionary in nature. It would be incorrect to assume that the present
condition of the dam will continue to represent the condition of the dam at some point in the
future. Only through continued care and inspection can there be any chance that unsafe
conditions are detected.

No dam can ever be considered to be completely "safe" (i.e., it can’t fail) even if it has
been well designed, constructed, operated and maintained. Even if it is considered that the
chance of a failure is remote, it is still a possibility and should not be ignored. All dams to some
degree, but old dams in particular, are unpredictable and can fail under conditions as or less
severe than they have survived in the past.
The scope of an inspection report does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is beyond the scope of the inspection program.

For further information contact:

Department of Environmental Conservation  
Facilities Engineering Division, Dam Safety and Hydrology Section  
103 South Main Street, Laundry Building  
Waterbury, Vermont 05671-0511  
Telephone: 802.241.3454  
Facsimile: 802.244.4516  

Revised August 2007
§ 1080. Definitions

As used in this chapter:

(1) "Department" means the department of environmental conservation.

(2) "Person" means any individual; partnership; company; corporation; association; joint venture; trust; municipality; the state of Vermont or any agency, department, or subdivision of the state, any federal agency, or any other legal or commercial entity.

(3) "Person in interest" means, in relation to any dam, a person who has riparian rights affected by that dam, a substantial interest in economic or recreational activity affected by the dam, or whose safety would be endangered by a failure of the dam.

(4) "Engineer" means a professional engineer registered under Title 26 who has experience in the design and investigation of dams.


§ 1081. Jurisdiction of department and public service board

(a) Unless otherwise provided, the powers and duties authorized by this chapter shall be exercised by the department, except that the public service board shall exercise those powers and duties over dams and projects that relate to or are incident to the generation of electric energy for public use or as a part of a public utility system.

(b) Transfer of jurisdiction. Jurisdiction over a dam is transferred from the department to the public service board whenever the Federal Energy Regulatory Commission grants a license to generate electricity at the dam or whenever the public service board receives an application for a certificate of public good for electricity generation at that dam. Jurisdiction is transferred from the public service board to the department whenever such a federal license expires or is otherwise lost, whenever such a certificate of public good is revoked or otherwise lost, or whenever the public service board denies an application for a certificate of public good.

(c) Upon transfer of jurisdiction as set forth above and upon written request, the state agency having former jurisdiction shall transfer copies of all records pertaining to the dam to the agency acquiring jurisdiction. (Amended 1959, No. 203; 1959, No. 329 (Adj. Sess.), § 39, eff. March 1, 1961; 1961, No. 100, § 2; 1981, No. 242 (Adj. Sess.), § 2.)
§ 1082. Authorization

(a) No person shall construct, enlarge, raise, lower, remodel, reconstruct, or otherwise alter any dam, pond or impoundment or other structure which is or will be capable of impounding more than 500,000 cubic feet of water or other liquid after construction or alteration, or remove, breach or otherwise lessen the capacity of an existing dam that is or was capable of impounding more than 500,000 cubic feet within or along the borders of this state where land in this state is proposed to be overflowed, or at the outlet of any body of water within this state, unless authorized by the state agency having jurisdiction so to do. However, in the matter of flood control projects where cooperation with the federal government is provided for by the provisions of section 1100 of this title that section shall control.

(b) For the purposes of this chapter, the volume a dam or other structure is capable of impounding is the volume of water or other liquid, including any accumulated sediments, controlled by the structure with the water or liquid level at the top of the nonoverflow part of the structure. (Amended 1975, No. 179 (Adj. Sess.), § 1; 1981, No. 242 (Adj. Sess.), § 3.)

§ 1083. Application

(a) Any person who proposes to undertake an action subject to regulation pursuant to section 1082 of this title shall apply in writing to the state agency having jurisdiction, and shall give notice thereof to the governing body of the municipality or municipalities in which the dam or any part of the dam is to be located. The application shall set forth:

(1) the location, the height, length and other dimensions and any proposed changes to any existing dam;

(2) the approximate area to be overflowed and the approximate number of, or any change in the number of cubic feet of water to be impounded;

(3) the plans and specifications to be followed in the construction, remodeling, reconstruction, altering, lowering, raising, removal, breaching, or adding to;

(4) any change in operation and maintenance procedures; and

(5) other information that the state agency having jurisdiction considers necessary to properly review the application.


§ 1083a. Agricultural dams

(a) Notwithstanding the provisions of sections 1082, 1083, 1084 and 1086 of this title, the owners of an agricultural enterprise who propose, as an integral and exclusive part of the enterprise, to construct or alter any dam, pond or impoundment or other structure requiring a permit under section 1083 shall apply to the natural resources conservation district in which his land is located. The natural resources conservation districts created under the
provisions of chapter 31 of this title shall be the state agency having jurisdiction and shall review and approve the applications in the same manner as would the department. The districts may request the assistance of the department for any investigatory work necessary for a determination of public good and for any review of plans and specifications as provided in section 1086.

(b) As used in this section, "agricultural enterprise" means any farm, including stock, dairy, poultry, forage crop and truck farms, plantations, ranches and orchards, which does not fall within the definition of "activities not engaged in for a profit" as defined in section 183 of the Internal Revenue Code and regulations relating thereto. The growing of timber does not in itself constitute farming.

(c) Notwithstanding the provisions of this section, jurisdiction shall revert to the department when there is a change in use or when there is a change in ownership which affects use. In those cases the department may, on its own motion, hold meetings in order to determine the effect on the public good and public safety. The department may issue an order modifying the terms and conditions of approval.

(d) The natural resources conservation districts may adopt any rules necessary to administer this chapter. The districts shall adhere to the requirements of chapter 25 of Title 3 in the adoption of those rules.

(e) Notwithstanding the provisions of chapter 7 of Title 3, the attorney general shall counsel the districts in any case where a suit has been instituted against the districts for any decision made under the provisions of this chapter. (Added 1975, No. 179 (Adj. Sess.), § 5; amended 1981, No. 242 (Adj. Sess.), § 5.)

§ 1084. Department of fish and wildlife; investigation

The commissioner of fish and wildlife shall investigate the potential effects on fish and wildlife habitats of any proposal subject to section 1082 of this title and shall certify the results to the state agency having jurisdiction prior to any hearing or meeting relating to the determination of public good and public safety. (Amended 1975, No. 179 (Adj. Sess.), § 3; 1981, No. 242 (Adj. Sess.), § 6; 1983, No. 158 (Adj. Sess.), eff. April 13, 1984.)

§ 1085. Notice of application

Upon receipt of the application required by section 1082 of this title, the state agency having jurisdiction shall give notice to all persons interested.

(1) For any project subject to its jurisdiction under this chapter, on the petition of 25 or more persons the department shall, or on its own motion it may, hold a public information meeting in a municipality in the vicinity of the proposed project to hear comments on whether the proposed project serves the public good and provides adequately for the public safety. Public notice shall be given by posting in the municipal offices of the towns in which the project will be completed and by publishing in a local newspaper at least 10 days before the meeting.

(2) For any project subject to its jurisdiction under this chapter, the public service board shall hold a hearing on the application. The purpose of the hearing shall be to determine
whether the project serves the public good as defined in section 1086 of this title and provides adequately for the public safety. The hearing shall be held in a municipality in the vicinity of the proposed project and may be consolidated with other hearings, including hearings under 30 V.S.A. § 248 concerning the same project. Notice shall be given at least 10 days before the hearing to interested persons by posting in the municipal offices of the towns in which the project will be completed and by publishing in a local newspaper. (Amended 1981, No. 242 (Adj. Sess.), § 7.)

§ 1086. Determination of public good; certificates

(a) "Public good" means the greatest benefit of the people of the state. In determining whether the public good is served, the state agency having jurisdiction shall give due consideration, among other things, to the effect the proposed project will have on:

(1) the quantity, kind, and extent of cultivated agricultural land that may be rendered unfit for use by or enhanced by the project, including both the immediate and long range agricultural land use impacts;

(2) scenic and recreational values;

(3) fish and wildlife;

(4) forests and forest programs;

(5) the need for a minimum water discharge flow rate schedule to protect the natural rate of flow and the water quality of the affected waters;

(6) the existing uses of the waters by the public for boating, fishing, swimming, and other recreational uses;

(7) the creation of any hazard to navigation, fishing, swimming, or other public uses;

(8) the need for cutting clean and removal of all timber or tree growth from all or part of the flowage area;

(9) the creation of any public benefits;

(10) the classification, if any, of the affected waters under chapter 47 of this title;

(11) any applicable state, regional or municipal plans;

(12) municipal grand lists and revenues;

(13) public safety; and

(14) in the case of proposed removal of a dam that formerly related to or was incident to the generation of electric energy, but which was not subject to a memorandum of understanding dated prior to January 1, 2006 relating to its removal, the potential for and value of future power production.
(b) If the state agency having jurisdiction finds that the proposed project will serve the public good, and, in case of any waters designated by the board as outstanding resource waters, will preserve or enhance the values and activities sought to be protected by designation, the agency shall issue its order approving the application. The order shall include conditions for minimum stream flow to protect fish and instream aquatic life, as determined by the agency of natural resources, and such other conditions as the agency having jurisdiction considers necessary to protect any element of the public good listed above. Otherwise it shall issue its order disapproving the application.

(c) The agency shall provide the applicant and interested parties with copies of its order.

(d) In the case of a proposed removal of a dam that is under the jurisdiction of the department and that formerly related to or was incident to the generation of electric energy but that was not subject to a memorandum of understanding dated before January 1, 2006 relating to its removal, the department shall consult with the department of public service regarding the potential for and value of future power production at the site. (Amended 1969, No. 281 (Adj. Sess.), § 10; 1975, No. 179 (Adj. Sess.), § 4; 1981, No. 242 (Adj. Sess.), § 8; 1987, No. 67, § 13; No. 76, § 18; 2005, No. 208 (Adj. Sess.), § 4.)

§ 1087. Review of plans and specifications

Upon receipt of an application, the state agency having jurisdiction shall employ a registered engineer experienced in the design and investigation of dams to investigate the property, review the plans and specifications, and make additional investigations as it considers necessary to ensure that the project adequately provides for the public safety. The engineer shall report his findings to the agency. (Amended 1981, No. 242 (Adj. Sess.), § 9.)


§ 1089. Employment of hydraulic engineer

With the approval of the governor, the state agency having jurisdiction may employ a competent hydraulic engineer to investigate the property, review the plans and specifications, and make such additional investigation as such agency shall deem necessary, and such engineer shall report to the agency his findings in respect thereto.

§ 1090. Construction supervision

The construction, alteration or other action authorized in section 1086 of this title shall be supervised by a registered engineer employed by the applicant. Upon completion of the authorized project, the engineer shall certify to the agency having jurisdiction that the project has been completed in conformance with the approved plans and specifications. (Amended 1981, No. 242 (Adj. Sess.), § 10.)


§ 1095. Unsafe dam; petition; hearing; emergency

(a) On receipt of a petition signed by not less than ten persons in interest or the legislative body of a municipality, the agency having jurisdiction shall, or upon its own motion it may,
institute investigations by an engineer as described in section 1087 of this title regarding the safety of any existing dam or portion of a dam, of any size. The agency may fix a time and place for hearing and shall give notice in the manner it directs to all parties interested. The engineer shall present his findings and recommendations at the hearing. After the hearing, if the agency finds that the dam or portion of the dam as maintained or operated is unsafe or is a menace to people or property above or below the dam, it shall issue an order directing reconstruction, repair, removal, breaching, draining or other action it considers necessary to make the dam safe.

(b) If, upon the expiration of such date as may be ordered, the owner of such dam has not complied with the order directing the reconstruction, repair, breaching, removal, draining or other action of such unsafe dam, the state agency having jurisdiction may petition the superior court in the county in which the dam is located to enforce its order or exercise the right of eminent domain to acquire such rights as may be necessary to effectuate a remedy as the public safety or public good may require. If the order has been appealed, the court may prohibit the exercise pending disposition of the appeal.

(c) If, upon completion of the investigation described in subsection (a), the state agency having jurisdiction considers the dam to present an imminent threat to human life or property it shall take whatever action it considers necessary to protect life and property and subsequently conduct the hearing described in subsection (a). (Amended 1959, No. 329 (Adj. Sess.), § 39, eff. March 1, 1961; 1961, No. 100, § 2; 1969, No. 281 (Adj. Sess.), § 12; 1981, No. 242 (Adj. Sess.), § 11.)


§ 1097. Survey of existing dams; orders for protection of salmon

The fish and wildlife board shall forthwith make a survey of all dams within the state which impound more than three hundred thousand cubic feet of water and determine if the operation of such dams adversely affects the propagation and preservation of salmon, or materially diminishes the amount of flow in portions of a stream likely to be used for such preservation and propagation of salmon. If the board determines that the operation of an existing dam does adversely affect the propagation and preservation of salmon or materially diminishes the flow of water over portions of stream likely to be used therefor, it shall order such changes in operation for such length of time or times as are reasonably necessary in its judgment to fully protect such preservation and propagation of salmon. Any order of the board made under this section shall be based upon facts found and stated. Appeal from an order of the board may be taken in the manner prescribed for appeals from the public service board as provided in chapter 1 of Title 30. (Amended 1959, No. 329 (Adj. Sess.), §§ 23(d), 39, eff. March 1, 1961; 1983, No. 158 (Adj. Sess.), eff. April 13, 1984.)

§ 1098. Removal of obstructions; appropriation

The department may contract for the removal of sandbars, debris or other obstructions from streams which the department finds that while so obstructed may be a menace in time of flood, or endanger property or life below, or the property of riparian owners. The expense of investigation and removal of the obstruction shall be paid by the state from funds provided
for that purpose. (Amended 1981, No. 242 (Adj. Sess.), § 14.)

§ 1099. Appeals

(a) Appeals of any act or decision of the department under this chapter shall be made in accordance with chapter 220 of this title.


§ 1100. Federal cooperation

As a basis for cooperation with the federal government and its duly established agencies in the matter of flood control, the state defines its policy with reference to flood control developments as follows:

(1) A flood control project, which shall contemplate as an incident thereof, the generation of electric energy, shall not be built on any waters within the state without the certificate of the public service board provided for in this chapter having first been obtained in the manner herein provided by the proper federal agency or authority, having in charge the building of such flood control project. Any modifications of flood control dams erected by authority of the federal government in this state shall not be made with a view to their utilization for the generation of electric energy, except by like authority first being obtained;

(2) Where such flood control project is strictly for flood control purposes, no village or city in this state shall be inundated, flooded, or destroyed thereby;

(3) Adequate compensation shall be made to any town whose grand list shall be substantially adversely affected by such strictly flood control project for the loss of its tax revenue;

(4) Where cultivated agricultural lands in excess of one hundred acres are to be taken for the purposes of a flood control project, or the recreational development of the state or the economy of the river basin involved may be affected thereby, the department, of its own motion, may, and upon petition to it by interested parties, shall, appoint a time and place for hearing in the vicinity of the flood control project, hold a public information meeting after giving notice to interested parties as it directs. Upon hearing, the department shall determine the effect the flood control project will have upon agricultural land uses or recreational values in this state, or upon the economy of the river basin involved, and report its findings and recommendations to the proper federal agency or authority having the flood control project in charge for its consideration and recognition. (Amended 1959, No. 329 (Adj. Sess.), § 39, eff. March 1, 1961; 1961, No. 100, § 2; 1981, No. 242 (Adj. Sess.), § 16.)


§ 1102. Federal receipts, distribution
All sums of money which the state receives from the United States under the provisions of section 701c-3 of Title 33 of the United States Code, as the same may be amended, being a portion of the rentals of property acquired and owned by the United States for purposes of flood control dams and reservoirs, shall be distributed to the municipality or political subdivision in which the dams and reservoirs are located. The department shall administer payment of money so received and the commissioner of finance and management shall issue his warrants on orders of the department. (1959, No. 35, § 1, eff. March 12, 1959; amended 1959, No. 328 (Adj. Sess.), § 8; 1961, No. 100, § 2; 1981, No. 242 (Adj. Sess.), § 17; 1983, No. 195 (Adj. Sess.), § 5(b).)

§ 1103. Approval for flood control dams

(a) No department or agency of the federal government shall construct any flood control dam which is within the state of Vermont, either in whole or in part, or cause any land within the state of Vermont to be overflowed through the operation of a flood control dam located outside the state, except with the approval of the governor and the general assembly.

(b) For purposes of this section "flood control dam" means any dam which has among its principal purposes the prevention or control of floods either within or without the state, or which is financed in whole or in part with funds appropriated, allocated or made available under a federal flood control program, excepting programs under Public Law 83-566, known as the Watershed Protection and Flood Prevention Act. (Added 1971, No. 167 (Adj. Sess.), § 3.)

1104. Repealed. 1989, No. 98, § 4(b)

§ 1105. Inspection of dams

The state agency having jurisdiction shall employ an engineer to make periodic inspections of nonfederal dams in the state to determine their condition and the extent, if any, to which they pose a potential or actual threat to life and property, or shall promulgate rules pursuant to chapter 25 of Title 3 to require an adequate level of inspection by an independent registered engineer experienced in the design and investigation of dams. The agency shall provide the owner with the findings of the inspection and any recommendations. (Added 1981, No. 242 (Adj. Sess.), § 13; amended 1985, No. 60.)

§ 1106. Unsafe dam revolving loan fund

(a) There is hereby established a special fund to be known as the Vermont unsafe dam revolving loan fund which shall be used to provide grants and loans to municipalities, nonprofit entities, and private individuals, pursuant to rules proposed by the agency of natural resources and enacted by the general assembly, for the reconstruction, repair, removal, breaching, draining, or other action necessary to reduce the threat of a dam or portion of a dam determined to be unsafe pursuant to section 1095 of this chapter.

(b) The fund created by this section shall be established and held separate and apart from any other funds or moneys of state and shall be used and administered exclusively for the purposes set forth in this section. The funds shall be invested in the same manner as permitted for investment of funds belonging to the state or held in the treasury. The fund shall consist of the following:
(1) Such sums as may be appropriated or transferred thereto from time to time by the
general assembly, the emergency board, or the joint fiscal committee during such times as
the general assembly is not in session.

(2) Principal and interest received from the repayment of loans made from the fund.

(3) Capitalization grants and awards made to the state by the United States of America for
the purposes for which the fund has been established.

(4) Interest earned from the investment of fund balances.

(5) Private gifts, bequests, and donations made to the state for the purposes for which the
fund has been established.

(6) Other funds from any public or private source intended for use for any of the purposes
for which the fund has been established.

(c) The secretary may bring an action under this subsection or other available state and
federal laws against the owner of the dam to seek reimbursement to the fund for all loans
made from the fund pursuant to this section. (Added 2003, No. 121 (Adj. Sess.), § 66, eff.
June 8, 2004.)
E.46. Virginia
Summary:
This guidance document specifies the procedures to be utilized by the Virginia Soil and Water Conservation Board in determining the adequacy of a dam break inundation zone analysis and map prepared in accordance with 4VAC50-20-54 and the adequacy of an incremental damage analysis conducted in accordance with 4VAC50-20-52.

Electronic Copy:
An electronic copy of this guidance in PDF format is available on the Regulatory TownHall under the Virginia Soil and Water Conservation Board at http://townhall.virginia.gov/L/GDocs.cfm.

Contact Information:
Please contact the Department of Conservation and Recreation’s Division of Dam Safety and Floodplain Management at dam@dcr.virginia.gov or by calling 804-371-6095 with any questions regarding the application of this guidance.

Disclaimer:
This document is provided as guidance and, as such, sets forth standard operating procedures for the Virginia Soil and Water Conservation Board and the Department of Conservation and Recreation that administers the program on behalf of the Board. This guidance provides a general interpretation of the applicable Code and Regulations but is not meant to be exhaustive in nature. Each situation may differ and may require additional interpretation of the Dam Safety Act and attendant regulations.

Dam Break Inundation Zone and Incremental Damage Analysis and Mapping Procedures

I. Background:
The Impounding Structure Regulations require an owner of a regulated dam to conduct a dam break analysis to support the appropriate hazard classification of the impounding structure in accordance with 4VAC50-20-40 (Hazard Potential Classification of Impounding Structures). Additionally, in accordance with Section 4VAC50-20-54 of the Impounding Structure Regulations, a dam break inundation zone map shall be developed that meets the requirements of the Dam Safety Act and the Impounding Structure Regulations for regulated dams with a High, Significant or Low Hazard Potential. The spillway design flood requirement of dams may also be reduced if it can be demonstrated through an incremental damage analysis in accordance with
4VAC50-20-52 that such a determination will not reduce the protection of public safety that would be afforded by using the spillway design flood that would otherwise by specified by Table 1. This guidance outlines the procedures that dam owners and their engineers should utilize to conduct dam break and incremental damage assessment analyses as well as to produce the associated maps.

II. Definitions (pursuant to § 10.1-604 and 4VAC50-20-30):
"Dam break inundation zone" means the area downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam.

III. Authority:
The Dam Safety Act in the Code of Virginia contains the following authorities applicable to this guidance:

§ 10.1-605. Promulgation of regulations by the Board.
The Board shall promulgate regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated.

The Impounding Structure Regulations contain the following authorities applicable to this guidance:

4VAC50-20-54. Dam break inundation zone mapping.
A. Dam break inundation zone maps shall be provided to the department to meet the requirements set out in Hazard Potential Classifications of Impounding Structures (4VAC50-20-40), Emergency Action Plan for High and Significant Potential Hazard Impounding Structures (4VAC50-20-175), and Emergency Preparedness for Low Hazard Potential Impounding Structures (4VAC50-20-177), as applicable.
B. The location of the end of the inundation mapping should be indicated where the water surface elevation of the dam break inundation zone and the water surface elevation of the spillway design flood during an impounding structure nonfailure event converge to within one foot of each other. The inundation maps shall be supplemented with water surface profiles showing the peak water surface elevation prior to failure and the peak water surface elevation after failure.
C. All inundation zone map(s), except those utilized in meeting the requirements of Emergency Preparedness for Low Hazard Potential Impounding Structures (4VAC50-20-177), shall be signed and sealed by a licensed professional engineer.
D. For determining the hazard potential classification, a minimum of the following shall be provided to the department:
   1. A sunny day dam break analysis utilizing the volume retained at the normal or typical water surface elevation of the impounding structure;
   2. A dam break analysis utilizing the spillway design flood with a dam failure;
   3. An analysis utilizing the spillway design flood without a dam failure; and
   4. For the purposes of future growth planning, a dam break analysis utilizing the probable maximum flood with a dam failure.
E. To meet the requirements of Emergency Preparedness set out in 4VAC50-20-177, all Low Hazard Potential impounding structures shall provide a simple map, acceptable to the department, demonstrating the general inundation that would result
from a dam failure. Such maps do not require preparation by a professional licensed engineer, however, it is preferred that the maps be prepared by a licensed professional engineer.

F. To meet the Emergency Action Plan requirements set out in 4VAC50-20-175, all owners of High and Significant Hazard Potential impounding structures shall provide dam break inundation map(s) representing the impacts that would occur with both a sunny day dam failure and a spillway design flood dam failure.

1. The map(s) shall be developed at a scale sufficient to graphically display downstream inhabited areas and structures, roads, public utilities that may be affected, and other pertinent structures within the identified inundation area. In coordination with the local organization for emergency management, a list of downstream inundation zone property owners and occupants, including telephone numbers may be plotted on the map or may be provided with the map for reference during an emergency.

2. Each map shall include the following statement: "The information contained in this map is prepared for use in notification of downstream property owners by emergency management personnel."


A. Impounding structures shall be classified in one of three hazard classifications as defined in subsection B of this section and Table 1.

B. For the purpose of this chapter, hazards pertain to potential loss of human life or damage to the property of others downstream from the impounding structure in event of failure or faulty operation of the impounding structure or appurtenant facilities. Hazard potential classifications of impounding structures are as follows:

1. High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. "Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways.

2. Significant Hazard Potential is defined where an impounding structure failure may cause the loss of life or appreciable economic damage. "May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads, personal property, and agricultural interests. "Secondary roadways" include, but are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways.

3. Low Hazard Potential is defined where an impounding structure failure would result in no expected loss of life and would cause no more than minimal economic damage. "No expected loss of life" means no loss of human life is anticipated.
C. The hazard potential classification shall be proposed by the owner and shall be subject to approval by the board. To support the appropriate hazard classification, dam break analysis shall be conducted by the owner's engineer. Present and planned land-use for which a development plan has been officially approved by the locality in the dam break inundation zones downstream from the impounding structure shall be considered in determining the classification.

D. Impounding structures shall be subject to reclassification by the board as necessary.

4VAC50-20-52. Incremental damage analysis.

A. When appropriate, the spillway design flood requirement may be reduced by the board in accordance with this section.

B. The owner's engineer may proceed with an incremental damage analysis. Once the owner's engineer has determined the required spillway design flood through application of Table 1, further analysis may be performed to evaluate the limiting flood condition for incremental damages. Site-specific conditions should be recognized and considered. This analysis may be used to lower the spillway design flood. In no situation shall the allowable reduced level be less than the level at which the incremental increase in water surface elevation downstream due to failure of an impounding structure is no longer considered to present an additional downstream threat. This engineering analysis will need to present water surface elevations at each structure that may be impacted downstream of the dam. An additional downstream threat to persons or property is presumed to exist when water depths exceed two feet or when the product of water depth (in feet) and flow velocity (in feet per second) is greater than seven.

C. The spillway design flood shall not be reduced below the minimum threshold values as determined by Table 1.

D. The required spillway design flood shall be subject to reclassification by the board as necessary to reflect changed conditions at the impounding structure and in the dam break inundation zone.

IV. Discussion and Interpretation:

**Dam Break Analysis and Inundation Zone Mapping**

The Impounding Structure Regulations require an owner of a regulated dam to conduct a dam break analysis to support the appropriate hazard classification of the impounding structure in accordance with 4VAC50-20-40 (Hazard Potential Classification of Impounding Structures). Additionally, in accordance with Section 4VAC50-20-54 of the Impounding Structure Regulations, a dam break inundation zone map shall be developed that meets the requirements of the Dam Safety Act and the Impounding Structure Regulations for regulated dams with a High, Significant or Low Hazard Potential. This section requires that dam break inundation zone maps shall be provided to the department to meet the requirements set out in Hazard Potential Classifications of Impounding Structures (4VAC50-20-40), Emergency Action Plan for High and Significant Potential Hazard Impounding Structures (4VAC50-20-175), and Emergency Preparedness for Low Hazard Potential Impounding Structures (4VAC50-20-177), as applicable. All dam break inundation zone maps shall be signed and sealed by a professional engineer licensed in the Commonwealth of Virginia (unless solely developed to satisfy the requirements
of 4VAC50-20-177 which allows the owner to develop a simple dam break inundation map acceptable to the director, demonstrating the general inundation that would result from an impounding structure failure. Such maps required pursuant to this section do not require preparation by a professional licensed engineer; however, maps prepared by a licensed professional engineer are preferred and are additionally required to satisfy §§ 4VAC50-20-40 and 4VAC50-20-54.)

A dam break analysis using an approved hydrologic/hydraulic computer model shall be conducted by the dam owner’s professional engineer. The modeling effort must conform to the intended use of the chosen computer model. Mixing the criteria of one procedure, listed in 4VAC50-20-320 (Acceptable design procedures and references) with criteria from another procedure, unless otherwise mentioned, is prohibited. Compute modeling must generate appropriate inflow hydrographs which are routed through the dam and downstream of the dam. Some computer models that are acceptable include HEC-1, HEC-HMS, HEC-RAS and the NRCS computer models TR-60 with TR-66. Other computer models may be used if approved by the DCR Regional Engineer prior to submitting the results to the Division of Dam Safety and Floodplain Management. Present and planned land-use for which a development plan has been officially approved by the locality in the dam break inundation zones downstream from the impounding structure shall be considered when conducting the dam break analysis.

For the validation of the hazard potential of a dam and the development of an Emergency Action Plan, at a minimum, the following shall be reflected on each map using an approved hydrologic/hydraulic computer model and shown on one map (numerous sheets are allowed to accommodate scale):

1. Sunny day dam break with the starting water surface elevation at the normal or typical water surface elevation of the impounding structure. If the impounding structure was designed and built for flood control, the starting water surface elevation shall be at the crest of the auxiliary or emergency spillway.
2. Dam failure during the required spillway design flood. An overtopping failure shall be modeled if the emergency spillway is unable to pass the spillway design flood without overtopping the crest of the dam. A piping failure shall be modeled if the emergency spillway has enough capacity to pass the required spillway design flood without overtopping the crest of the dam.
3. Routing the spillway design flood through the dam without any failure.
4. Dam failure during the Probable Maximum Flood.

Topographic information, including TINS, that show at a minimum ten-foot contour elevations shall be used to develop the hydrologic/hydraulic computer model downstream of the dam, including cross sections at potential damage locations (homes, businesses, roads, utilities, etc.) downstream of the dam. The dam owner’s engineer must develop reliable cross sections to input into the computer model. If adequate topographic information is not available, the dam owner must provide an alternative method for identifying potential damage locations that must be approved by the DCR Regional Engineer, prior to initiating the evaluation. Topography may be a component of the submitted inundation map; however, map clutter must be avoided. If the topography is not submitted on the inundation map, a copy of the topographical information or
TINS used shall be submitted with the engineering analysis. Paper copies of all hydrologic and hydraulic computer model runs shall be provided to the Regional Engineer.

The owner’s engineer shall use sanctioned engineering criteria and sound professional judgment for the worst case storm conditions in the selection of:

a. Dam failure parameters
b. Rainfall distributions
c. Flood routing procedures and coefficients
d. Use of available topography and supporting field surveys
e. Development of SCS Curve Numbers
f. Development of spillway rating curves and area-capacity curves
g. Determination of the Time of Concentration and/or lag time
h. Other steps used during the modeling and analysis of flood conditions in the watershed and downstream of the impounding structure.

The judgments and the engineering criteria used by the dam owner’s engineer shall be reviewed and approved by the DCR Regional Engineer for appropriateness. The DCR Regional Engineer will provide specific guidance via written correspondence to the dam owner should the judgments or the use of the engineering criteria be determined to be inappropriate. If the map is acceptable, a statement of confirmation that the map appears to be in conformance with the regulations will also be provided to the owner.

The computer model shall be extended to a point downstream of the impounding structure where the water surface elevations of the spillway design flood with and without dam failure converge to within one foot of each other or to the last impacted structure caused by a sunny-day dam failure, whichever is farthest downstream.

The following shall be clearly marked at each potential damage location on each map:

a. Cross Section number and distance downstream from the dam to the nearest tenth of a mile
b. Relative time of travel, in minutes, of the first flood waters associated with a dam failure to reach the impact location
c. Relative time of travel, in minutes, of the peak flood level associated with a dam failure to reach the impact location
d. Maximum depth of water with a dam failure at each impact location in feet (depth of water on the structure)

The map lines delineating the inundation areas shall be drawn in such thickness (solid, dashed or dotted lines in black) to identify the inundation limits as the main feature of the map. The lines shall not obliterate the location of structures, or features which are shown as being inundated. The map shall also identify the scale and show the north arrow on each map sheet.

Inundation maps may have color in the background and shall be at a scale where impacted structures downstream may be clearly seen. The maps should not utilize color-coding of the inundation lines since the maps will often be copied on black and white reproduction equipment. If the inundation area is too large to be shown on one map, an index map shall be included which
shows the full extent of the inundation area and the outline of the detailed maps with an identifier for each map sheet. Impacted structures (homes, businesses, roads, utilities, etc) shall be clearly shown and if cross-hatching is used it must not obscure the structures. The physical addresses and contact persons may be located on a separate attachment to avoid clutter. This information will be used to aid emergency responders in quickly locating impacted structures and conducting evacuations. Inundation maps shall not be produced in a size larger than 11” by 17” and the final size must be folded to a size of 8 1/2” by 11”. The inundation maps shall be submitted to the DCR Regional Engineer electronically in a Windows compatible image format and as a set of paper maps. Acceptable digital image formats consist of JPEG, TIF, BMP, GIF, PNG, or EMF files. Adobe software constructed PDFs are also acceptable. Image resolution should be sufficient to view and read the necessary information noted above.

A narrative describing the accuracy and limitation of the information supplied on the inundation maps, including reference to the datum used, shall be provided to the DCR Regional Engineer. Since local officials are likely to use the maps for evacuation purposes, the following note shall be attached to each map: “Mapping of flooded areas and flood wave travel times are approximate. Timing and extent of actual inundation may differ from the information presented on this map.”

The hazard potential classification shall be proposed by the dam owner and shall be subject to reclassification by the Virginia Soil and Water Conservation Board, upon review of the information submitted by the dam owner and the owner’s engineer and any pertinent information regarding potential impacts downstream of the dam caused by a failure of the dam.

**Incremental Damage Assessment**

Once a dam owner has had the consulting engineer complete the Dam Break Inundation Zone Analysis and Map (Map) and concluded a determination of the hazard classification and, once the hazard classification has been reviewed and accepted by the appropriate Regional Engineer; the Spillway Design Flood (SDF) would then be identified in Table 1 of the Impounding Structure Regulations (4VAC50-20-50). Should the dam owner wish to consider lowering the SDF through an Incremental Damage Analysis (IDA), the consulting engineer must then perform the following procedures. However, as noted in Table 1 of the Impounding Structure Regulations an SDF less than the Minimum Threshold will not be accepted.

1. Identify the Required SDF
   Once the hazard classification is determined, Table 1 will identify the required SDF. If the dam owner decides to have the consulting engineer perform an incremental damage analysis, the computer models previously used to determine the inundation and subsequent hazard classification must be used to identify the flood event at which no significant increase in damage will occur due to a dam failure. This process may start with the required SDF or with the Minimum Threshold for IDA (Minimum Threshold), see Table 1.

2. Have Models Showing all Requirements with Backup Calculations
   The consulting engineer must have at a minimum, hydrologic computer models for the Sunny-Day Dam Failure, Spillway Design Flood With a Dam Failure, Spillway Design Flood Without a
Dam Failure and the Probable Maximum Flood With a Dam Failure. These models must be routed downstream of the dam to a point in which the maximum water surface elevations during the SDF with a Dam Failure and the SDF without a Dam Failure converge to within one foot of each other or to the last impacted structure cause by a sunny-day dam failure, whichever is farthest downstream.

3. Prepare the Map
The results of the models are plotted onto the Map to demonstrate inundation expected by each event. All homes, buildings, roads and other impacted facilities shall be shown on the map.

4. Use IDA to Determine if the SDF can be Reduced
If it can be shown that the aforementioned list of potentially impacted facilities would, at some lesser flood compared to the SDF, be severely damaged due to floods associated storm flows without a dam failure then the owner can have the consulting engineer adjust the input storm in the computer models in an attempt to identify at what storm event that a dam failure would not significantly add to damaged facilities or threats to life downstream.

When structures, such as homes, businesses, and utilities buildings are identified in the inundation zone, the consulting engineer can determine significant impact to that structure if, during a dam failure, the water depth will equal or exceed two feet above the ground/building connection. If the product of the depth of water on a structure in feet and the velocity of water flowing at that location in feet per second equals seven (7) or more, then the structure is considered significantly impacted and projects the probable loss of life. If the depth of water is less than two feet on the structure and the product of the total water depth and the velocity of water at the structure is less than seven (7) during any dam failure, the structure would not be considered threatened nor would result in probable loss of life.

5. Determination of the Adjusted SDF
An IDA should always result in the same answer no matter whether you start at the SDF or at the Minimum Threshold working toward the Adjusted SDF. The Adjusted SDF should represent the maximum flood at which the dam will provide maximum flood protection downstream and no further damages would be expected with larger flood events with a dam failure.

The dam owner may choose to have the engineer design the emergency spillway to the Adjusted SDF or some flood event larger than the adjusted SDF that would consider potential increases in hazard classification due to future development downstream of the dam.

The dam owner’s consulting engineer will need to provide one set of paper copies of the computer model results and an electronic copy on diskette. Profiles, calculations and other supporting information used to determine an adjusted SDF shall be submitted to the Dam Safety Regional Engineer for review and acceptance.

Dam Safety’s acceptance of an adjusted SDF does not guarantee that any future development will not place new increased spillway capacity requirements on the dam owner.
For a Secondary roadway (secondary highway, low-volume urban street, service road and other low-volume roadway) located below a dam the hazard classification may be significant requiring a SDF of $\frac{1}{2}$ PMF (see roadways guidance for additional information on how roadways may impact hazard classification). If the dam owner desires, an IDA may be performed that would identify at what flood event (between the $\frac{1}{2}$ PMF and the 100-Year Flood) the computed water surface elevation for the flood event without a dam failure would result in a water level at or just below the roadway surface edge without a dam failure. With this storm event, if a dam failure would overtop the roadway by four (4) inches or more, it could lead to possible loss of life of persons in vehicles on the roadway or loss of the roadway itself. If the dam failure does not overtop the roadway for the Sunny-Day Failure and storm events up to the PMF with a dam failure, then the dam should be classified as Low Hazard, if there are no other impacted structures or facilities, should the dam fail. If the roadway is a major roadway (interstate, primary highway, high-volume urban street or other high-volume roadway) then the incremental damage analysis would start at PMF and could result in a SDF no less than the $\frac{1}{2}$ PMF.

If there are several roadways below a dam, then the roadway that results in the largest spillway design flood applies.

If a secondary or low volume roadway crosses the dam then the SDF would usually be at a minimum the $\frac{1}{2}$ PMF (see roadways guidance for additional information on how roadways may impact hazard classification) and no IDA would be permitted for a dam with a significant hazard classification. If a major roadway crosses the dam then the SDF would be the PMF and no IDA would be permitted.

In cases where there are other facilities below the dam along with roadways, the impact that creates the highest hazard classification shall dictate. If permitted, the owner may choose to have the consulting engineer perform an IDA in the hopes of lowering the SDF.

V Adoption, Amendments, and Repeal:

This document was adopted by the Board on XXXX, 2010 and may be amended or repealed as necessary by the Board.
CHAPTER 249

An Act to amend and reenact § 10.1-605 of the Code of Virginia, relating to dam safety.

Approved April 8, 2010

Be it enacted by the General Assembly of Virginia:

1. That § 10.1-605 of the Code of Virginia is amended and reenacted as follows:

   § 10.1-605. Promulgation of regulations by the Board.
   A. The Board shall promulgate regulations to ensure that impounding structures in the
      Commonwealth are properly and safely constructed, maintained and operated. Dam safety regulations
      promulgated by the State Water Control Board shall remain in full force until amended in accordance
      with applicable procedures.
   B. The Board's Impounding Structure Regulations shall not require any impounding structure in
      existence or under a construction permit prior to July 1, 2010, that is currently classified as high
      hazard, or is subsequently found to be high hazard through reclassification, to upgrade its spillway to
      pass a rainfall event greater than the maximum recorded within the Commonwealth, which shall be
      deemed to be 90 percent of the probable maximum precipitation.
      Additionally, such an impounding structure shall be determined to be in compliance with the spillway
      requirements of the regulations provided that (i) the impounding structure will pass two-thirds of the
      reduced probable maximum precipitation requirement described in this subsection and (ii) the dam
      owner certifies annually that such impounding structure meets each of the following conditions:
      1. The owner has a current emergency action plan that is approved by the Board and that is
         developed and updated in accordance with the regulations;
      2. The owner has exercised the emergency action plan in accordance with the regulations and
         conducts a table-top exercise at least once every two years;
      3. The Department has verification that both the local organization for emergency management and
         the Virginia Department of Emergency Management have on file current emergency action plans and
         updates for the impounding structure;
      4. That conditions at the impounding structure are monitored on a daily basis and as dictated by the
         emergency action plan;
      5. The impounding structure is inspected at least annually by a professional engineer and all
         observed deficiencies are addressed within 120 days of such inspection;
      6. The owner has a dam break inundation zone map developed in accordance with the regulations
         that is acceptable to the Department;
      7. The owner is insured in an amount that will substantially cover the costs of downstream property
         losses to others that may result from a dam failure; and
      8. The owner shall post the dam's emergency action plan on his website, or upon the request of the
         owner, the Department or another state agency responsible for providing emergency management
         services to citizens agrees to post the plan on its website. If the Department or another state agency
         agrees to post the plan on its website, the owner shall provide the plan in a format suitable for posting.
      A dam owner who meets the conditions of subdivisions 1 through 8, but has not provided record
      drawings to the Department for his impounding structure, shall submit a complete record report
      developed in accordance with the construction permit requirements of the Impounding Structure
      Regulations, excluding the required submittal of the record drawings.
   2. That the Virginia Soil and Water Conservation Board may amend its Impounding Structure
      Regulations to conform with the provisions of this act through a regulatory process that is exempt
      from the requirements of the Administrative Process Act (§ 2.2-4000 et seq.) of the Code of
      Virginia.
   3. That an emergency exists and this act is in force from its passage.

Be it enacted by the General Assembly of Virginia:
1. That §§ 10.1-605, 10.1-607.1, and 10.1-609 of the Code of Virginia are amended and reenacted as follows:

§ 10.1-605. Promulgation of regulations by the Board; guidance document.
A. The Board shall promulgate regulations to ensure that impounding structures in the Commonwealth are properly and safely constructed, maintained and operated. Dam safety regulations promulgated by the State Water Control Board shall remain in full force until amended in accordance with applicable procedures.
B. The Board’s regulations shall establish an incremental damage analysis procedure that permits the spillway design flood requirement for an impounding structure to be reduced to the level at which dam failure shall not significantly increase downstream hazard to life or property, provided that the spillway design flood requirement shall not be reduced to below the 100-year flood event for high or significant hazard impounding structures, or to below the 50-year flood event for low hazard potential impounding structures.
C. The Board shall consider the impact of limited-use or private roadways with low traffic volume and low public safety risk that are downstream from or across an impounding structure in the determination of the hazard potential classification of an impounding structure.

§ 10.1-607.1. Criteria for designating a dam as unsafe.
A. Designation of a dam as unsafe shall be based on one or more of the following findings:
1. The dam has serious deficiencies in its design or construction or has a physical condition that if left unaddressed could result in a failure that may result in loss of life or significant damage to downstream property.
2. The design, construction, operation, or maintenance of the dam is such that its expected performance during flooding conditions threatens the structural integrity of the dam.
B. After completion of the safety inspections pursuant to § 10.1-607, or as otherwise informed of an unsafe condition, the Department shall take actions in accordance with § 10.1-608 or 10.1-609 depending on the degree of hazard and imminence of failure caused by the unsafe condition.

A. Within a reasonable time after completion of a safety inspection of an impounding structure authorized by § 10.1-607, the Board shall issue a report to the owner of the impounding structure containing its findings and recommendations for correction of any deficiencies which could threaten life or property if not corrected. Owners who have been issued a report containing recommendations for correction of deficiencies shall undertake to implement the recommendations contained in the report according to the schedule of implementation contained in the report. If an owner fails or refuses to commence or diligently implement the recommendations for correction of deficiencies according to the schedule contained in an issued report, the Director shall have the authority to issue an administrative order directing the owner to commence implementation and completion of such recommendations according to the schedule contained in an issued report. The Board shall determine if the submitted plan and schedule are sufficient to address deficiencies. A timely filed petition shall stay the effect of the administrative order. The hearing shall be conducted before the Board or a designated member thereof pursuant to § 2.2-4019. The Board shall have the authority to affirm, modify, amend or cancel the administrative order. Any owner aggrieved by a decision of the Board after a hearing shall have the right to judicial review of the final Board decision pursuant to the provisions of the Administrative Process Act (§ 2.2-4000 et seq.).
B. The provisions of subsection A of this section notwithstanding, if the Director determines, after the report is issued, that changed circumstances justify reclassifying the deficiencies of an impounding structure as an imminent danger to life or property, the Director may proceed directly under § 10.1-613 for enforcement of his order, and the owner shall have the opportunity to contest the fact based upon...
which the administrative order was issued.

C. The Director, upon a determination that there is an unsafe condition at an impounding structure, is authorized to cause the lowering or complete draining of such impoundment until the unsafe condition has been corrected at the owner's expense and prior to any authorization to refill.

An owner who fails to comply with the provisions contained in an administrative order of the Department shall be subject to procedures set out in § 10.1-613 and the penalties authorized under §§ 10.1-613.1 and 10.1-613.2.

D. No persons, other than those authorized to maintain an impounding structure, shall interfere with the operation of an impounding structure.
Part I
General

4VAC50-20-10. Authority.

This chapter is promulgated by the Virginia Soil and Water Conservation Board in accordance with the provisions of the Dam Safety Act, Article 2, Chapter 6, Title 10.1 (§ 10.1-604 et seq.), of the Code of Virginia.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 1.1, eff. February 1, 1989.


A. This chapter provides for the proper and safe design, construction, operation and maintenance of impounding structures to protect public safety. This chapter shall not be construed or interpreted to relieve the owner or operator of any impoundment or impounding structure of any legal duties, obligations or liabilities incident to ownership, design, construction, operation or maintenance.

B. Approval by the board of proposals for an impounding structure shall in no manner be construed or interpreted as approval to capture or store waters. For information concerning approval to capture or store waters, see Chapter 8 (§ 62.1-107) of Title 62.1 of the Code of Virginia, and other provisions of law as may be applicable.

C. In promulgating this chapter, the board recognizes that no impounding structure can ever be completely "fail-safe," because of incomplete understanding of or uncertainties associated with natural (earthquakes and floods) and manmade (sabotage) destructive forces; with material behavior and response to those forces; and with quality control during construction.

D. All engineering analyses required by this chapter, including but not limited to, plans, specifications, hydrology, hydraulics and inspections shall be conducted or overseen by and bear the seal of a professional engineer licensed to practice in Virginia.

E. Design, inspection and maintenance of impounding structures shall be conducted utilizing...
competent, experienced, engineering judgment that takes into consideration factors including but not limited to local topography and meteorological conditions.

F. The forms noted in this chapter are available from the department at the department's website.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 1.2, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.


The following words and terms when used in this chapter shall have the following meanings unless the context clearly indicates otherwise:

"Acre-foot" means a unit of volume equal to 43,560 cubic feet or 325,853 gallons (equivalent to one foot of depth over one acre of area).

"Agricultural purpose" means the production of an agricultural commodity as defined in § 3.1-249.27 of the Code of Virginia that requires the use of impounded waters.

"Agricultural purpose dams" means impounding structures which are less than 25 feet in height or which create a maximum impoundment smaller than 100 acre-feet, and operated primarily for agricultural purposes.

"Alteration" means changes to an impounding structure that could alter or affect its structural integrity. Alterations include, but are not limited to, changing the height or otherwise enlarging the dam, increasing normal pool or principal spillway elevation or physical dimensions, changing the elevation or physical dimensions of the emergency spillway, conducting necessary structural repairs or structural maintenance, or removing the impounding structure. Structural maintenance does not include routine maintenance.

"Alteration permit" means a permit required for any alteration to an impounding structure.

"Board" means the Virginia Soil and Water Conservation Board.

"Conditional Operation and Maintenance Certificate" means a certificate required for impounding structures with deficiencies.

"Construction" means the construction of a new impounding structure.

"Construction permit" means a permit required for the construction of a new impounding structure.
"Dam break inundation zone" means the area downstream of a dam that would be inundated or otherwise directly affected by the failure of a dam.

"Department" means the Virginia Department of Conservation and Recreation.

"Design flood" means the calculated volume of runoff and the resulting peak discharge utilized in the evaluation, design, construction, operation and maintenance of the impounding structure.

"Director" means the Director of the Department of Conservation and Recreation or his designee.

"Drill" means a type of emergency action plan exercise that tests, develops, or maintains skills in an emergency response procedure. During a drill, participants perform an in-house exercise to verify telephone numbers and other means of communication along with the owner's response. A drill is considered a necessary part of ongoing training.

"Emergency Action Plan or EAP" means a formal document that recognizes potential impounding structure emergency conditions and specifies preplanned actions to be followed to minimize loss of life and property damage. The EAP specifies actions the owner must take to minimize or alleviate emergency conditions at the impounding structure. It contains procedures and information to assist the owner in issuing early warning and notification messages to responsible emergency management authorities. It shall also contain dam break inundation zone maps as required to show emergency management authorities the critical areas for action in case of emergency.

"Emergency Action Plan Exercise" means an activity designed to promote emergency preparedness; test or evaluate EAPs, procedures, or facilities; train personnel in emergency management duties; and demonstrate operational capability. In response to a simulated event, exercises should consist of the performance of duties, tasks, or operations very similar to the way they would be performed in a real emergency. An exercise may include but not be limited to drills and tabletop exercises.

"Emergency Preparedness Plan" means a formal document prepared for Low Hazard impounding structures that provides maps and procedures for notifying owners of downstream property that may be impacted by an emergency situation at an impounding structure.

"Freeboard" means the vertical distance between the maximum water surface elevation associated with the spillway design flood and the top of the impounding structure.

"Height" means the hydraulic height of an impounding structure. If the impounding structure spans a stream or watercourse, height means the vertical distance from the natural bed of the stream or watercourse measured at the downstream toe of the impounding structure to the top of the impounding
structure. If the impounding structure does not span a stream or watercourse, height means the vertical distance from the lowest elevation of the downstream limit of the barrier to the top of the impounding structure.

"Impounding structure" or "dam" means a man-made structure, whether a dam across a watercourse or structure outside a watercourse, used or to be used to retain or store waters or other materials. The term includes: (i) all dams that are 25 feet or greater in height and that create an impoundment capacity of 15 acre-feet or greater, and (ii) all dams that are six feet or greater in height and that create an impoundment capacity of 50 acre-feet or greater. The term "impounding structure" shall not include: (a) dams licensed by the State Corporation Commission that are subject to a safety inspection program; (b) dams owned or licensed by the United States government; (c) dams operated primarily for agricultural purposes which are less than 25 feet in height or which create a maximum impoundment capacity smaller than 100 acre-feet; (d) water or silt retaining dams approved pursuant to § 45.1-222 or § 45.1-225.1 of the Code of Virginia; or (e) obstructions in a canal used to raise or lower water.

"Impoundment" means a body of water or other materials the storage of which is caused by any impounding structure.

"Life of the impounding structure" and "life of the project" mean that period of time for which the impounding structure is designed and planned to perform effectively, including the time required to remove the structure when it is no longer capable of functioning as planned and designed.

"Maximum impounding capacity" means the volume of water or other materials in acre-feet that is capable of being impounded at the top of the impounding structure.

"Normal or typical water surface elevation" means the water surface elevation at the crest of the lowest ungated outlet from the impoundment or the elevation of the normal pool of the impoundment if different than the water surface elevation at the crest of the lowest ungated outlet. For calculating sunny day failures for flood control impounding structures, stormwater detention impounding structures, and related facilities designed to hold back volumes of water for slow release, the normal or typical water surface elevation shall be measured at the crest of the auxiliary or emergency spillway.

"Operation and Maintenance Certificate" means a certificate required for the operation and maintenance of all impounding structures.

"Owner" means the owner of the land on which an impounding structure is situated, the holder of an easement permitting the construction of an impounding structure and any person or entity agreeing to
maintain an impounding structure. The term "owner" may include the Commonwealth or any of its political subdivisions, including but not limited to sanitation district commissions and authorities, any public or private institutions, corporations, associations, firms or companies organized or existing under the laws of this Commonwealth or any other state or country, as well as any person or group of persons acting individually or as a group.

"Planned land use" means land use that has been approved by a locality or included in a master land use plan by a locality, such as in a locality's comprehensive land use plan.

"Spillway" means a structure to provide for the controlled release of flows from the impounding structure into a downstream area.

"Stage I Condition" means a flood watch or heavy continuous rain or excessive flow of water from ice or snow melt.

"Stage II Condition" means a flood watch or emergency spillway activation or impounding structure overtopping where a failure may be possible.

"Stage III Condition" means an emergency spillway activation or impounding structure overtopping where imminent failure is probable.

"Sunny day dam failure" means the failure of an impounding structure with the initial water level at the normal reservoir level, usually at the lowest ungated principal spillway elevation or the typical operating water level.

"Tabletop Exercise" means a type of emergency action plan exercise that involves a meeting of the impounding structure owner and the state and local emergency management officials in a conference room environment. The format is usually informal with minimum stress involved. The exercise begins with the description of a simulated event and proceeds with discussions by the participants to evaluate the EAP and response procedures and to resolve concerns regarding coordination and responsibilities.

"Top of the impounding structure" means the lowest point of the nonoverflow section of the impounding structure.

"Watercourse" means a natural channel having a well-defined bed and banks and in which water normally flows.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

A. Impounding structures shall be classified in one of three hazard classifications as defined in subsection B of this section and Table 1.

B. For the purpose of this chapter, hazards pertain to potential loss of human life or damage to the property of others downstream from the impounding structure in event of failure or faulty operation of the impounding structure or appurtenant facilities. Hazard potential classifications of impounding structures are as follows:

1. High Hazard Potential is defined where an impounding structure failure will cause probable loss of life or serious economic damage. "Probable loss of life" means that impacts will occur that are likely to cause a loss of human life, including but not limited to impacts to residences, businesses, other occupied structures, or major roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, major roadways, railroads, personal property, and agricultural interests. "Major roadways" include, but are not limited to, interstates, primary highways, high-volume urban streets, or other high-volume roadways.

2. Significant Hazard Potential is defined where an impounding structure failure may cause the loss of life or appreciable economic damage. "May cause loss of life" means that impacts will occur that could cause a loss of human life, including but not limited to impacts to facilities that are frequently utilized by humans other than residences, businesses, or other occupied structures, or to secondary roadways. Economic damage may occur to, but not be limited to, building(s), industrial or commercial facilities, public utilities, secondary roadways, railroads, personal property, and agricultural interests. "Secondary roadways" include, but are not limited to, secondary highways, low-volume urban streets, service roads, or other low-volume roadways.

3. Low Hazard Potential is defined where an impounding structure failure would result in no expected loss of life and would cause no more than minimal economic damage. "No expected loss of life" means no loss of human life is anticipated.

C. The hazard potential classification shall be proposed by the owner and shall be subject to approval by the board. To support the appropriate hazard classification, dam break analysis shall be conducted by the owner's engineer. Present and planned land-use for which a development plan has been officially
approved by the locality in the dam break inundation zones downstream from the impounding structure shall be considered in determining the classification.

D. Impounding structures shall be subject to reclassification by the board as necessary.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 1.4, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.


A. In accordance with the definitions provided by § 10.1-604 of the Code of Virginia and 4VAC50-20-30, an impounding structure shall be regulated if the impounding structure is 25 feet or greater in height and creates a maximum impounding capacity of 15 acre-feet or greater, or the impounding structure is six feet or greater in height and creates a maximum impounding capacity of 50 acre-feet or greater and is not otherwise exempt from regulation by the Code of Virginia. Impounding structures exempted from this chapter are those that are:

1. Licensed by the State Corporation Commission that are subject to a safety inspection program;
2. Owned or licensed by the United States government;
3. Operated primarily for agricultural purposes that are less than 25 feet in height or that create a maximum impoundment capacity smaller than 100 acre-feet;
4. Water or silt-retaining dams approved pursuant to § 45.1-222 or 45.1-225.1 of the Code of Virginia; or
5. Obstructions in a canal used to raise or lower water.

Impounding structures of regulated size and not exempted shall be constructed, operated and maintained such that they perform in accordance with their design and purpose throughout the life of the project. For impounding structures, the spillway(s) capacity shall perform at a minimum to safely pass the appropriate spillway design flood as determined in Table 1. For the purposes of utilizing Table 1, Hazard Potential Classification shall be determined in accordance with 4VAC50-20-40.

TABLE 1

Impounding Structure Regulations
Applicable to all impounding structures that are 25 feet or greater in height and that create a maximum impounding capacity of 15 acre-feet or greater, and to all impounding structures that are six feet or greater in height and that create a maximum impounding capacity of 50 acre-feet or greater and is not otherwise exempt from regulation by the Code of Virginia.

<table>
<thead>
<tr>
<th>Hazard Potential</th>
<th>Spillway Design Flood (SDF)</th>
<th>Minimum Threshold for Incremental Damage Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class of Dam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>PMF^c</td>
<td>.50 PMF</td>
</tr>
<tr>
<td>Significant</td>
<td>.50 PMF</td>
<td>100-YR^d</td>
</tr>
<tr>
<td>Low</td>
<td>100-YR^d</td>
<td>50-YR^e</td>
</tr>
</tbody>
</table>

B. The spillway design flood (SDF) represents the largest flood that need be considered in the evaluation of the performance for a given project. The impounding structure shall perform so as to safely pass the appropriate SDF. Reductions in the established SDF may be evaluated through the use of incremental damage analysis pursuant to 4VAC50-20-52. The SDF established for an impounding structure shall not be less than those standards established elsewhere by state law or regulations, including but not limited to the Virginia Stormwater Management Program (VSMP) Permit Regulations (4VAC50-60). Due to potential for future development in the dam break inundation zone that would necessitate higher spillway design flood standards or other considerations, owners may find it advisable to consider a higher spillway design flood standard than is required.

C. PMF: Probable Maximum Flood is the flood that might be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The PMF is derived from the current probable maximum precipitation (PMP) available from the National Weather Service, NOAA. In some cases, a modified PMF may be calculated utilizing local topography, meteorological conditions, hydrological conditions, or PMP values supplied by NOAA. Any deviation in the application of established developmental procedures must be explained and justified by the owner's engineer. The owner's engineer must develop PMF hydrographs for 6-, 12-, and 24-hour durations. The hydrograph that creates the largest peak outflow is to be used to determine capacity for nonfailure and failure analysis. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

D. 100-Yr: 100-year flood represents the flood magnitude expected to be equaled or exceeded on the average of once in 100 years. It may also be expressed as an exceedence probability with a 1.0% chance of being equaled or exceeded in any given year. Present and planned land-use conditions shall be
considered in determining the runoff characteristics of the drainage area.

E: 50-Yr: 50-year flood represents the flood magnitude expected to be equaled or exceeded on the average of once in 50 years. It may also be expressed as an exceedence probability with a 2.0% chance of being equaled or exceeded in any given year. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 1.5, eff. February 1, 1989; amended, Virginia Register Volume 18, Issue 14, eff. July 1, 2002; Volume 24, Issue 25, eff. September 26, 2008; Errata, 25:3 VA.R. 542 October 13, 2008.

4VAC50-20-51. Special criteria for certain low hazard impounding structures.

A. Notwithstanding the requirements of this chapter, should the failure of a low hazard potential impounding structure cause no expected loss of human life and no economic damage to any property except property owned by the impounding structure owner, then the owner may follow the below requirements instead of the requirements specified in this chapter:

1. No map required pursuant to 4VAC50-20-54 shall be required to be developed for the impounding structure should a licensed professional engineer certify that the impounding structure is a low hazard potential impounding structure and eligible to utilize the provisions of this section;

2. The spillway design flood for the impounding structure is recommended as a minimum 50-year flood; however, no specific spillway design flood shall be mandatory for an impounding structure found to qualify under the requirements of this section;

3. No emergency preparedness plan prepared pursuant to 4VAC50-20-177 shall be required. However, the impounding structure owner shall notify the local emergency services coordinator in the event of a failure or emergency condition at the impounding structure;

4. An owner shall perform inspections of the impounding structure annually in accordance with the requirements of 4VAC50-20-105. No inspection of the impounding structure by a licensed professional engineer shall be required, however, so long as the owner certifies at the time of operation and maintenance certificate renewal that conditions at the impounding structure and downstream are unchanged since the last inspection conducted by a licensed professional
engineer; and

5. No certificate or permit fee established in this chapter shall be applicable to the impounding structure.

B. Any owner of an impounding structure electing to utilize the requirements of subsection A of this section shall otherwise comply with all other requirements of this chapter applicable to low hazard impounding structures.

C. The owner shall notify the department immediately of any change in circumstances that would cause the impounding structure to no longer qualify to utilize the provisions of this section.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-52. Incremental damage analysis.

A. When appropriate, the spillway design flood requirement may be reduced by the board in accordance with this section.

B. The owner's engineer may proceed with an incremental damage analysis. Once the owner's engineer has determined the required spillway design flood through application of Table 1, further analysis may be performed to evaluate the limiting flood condition for incremental damages Site-specific conditions should be recognized and considered. This analysis may be used to lower the spillway design flood. In no situation shall the allowable reduced level be less than the level at which the incremental increase in water surface elevation downstream due to failure of an impounding structure is no longer considered to present an additional downstream threat. This engineering analysis will need to present water surface elevations at each structure that may be impacted downstream of the dam. An additional downstream threat to persons or property is presumed to exist when water depths exceed two feet or when the product of water depth (in feet) and flow velocity (in feet per second) is greater than seven.

C. The spillway design flood shall not be reduced below the minimum threshold values as determined by Table 1.

D. The required spillway design flood shall be subject to reclassification by the board as necessary to reflect changed conditions at the impounding structure and in the dam break inundation zone.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-54. Dam break inundation zone mapping.

A. Dam break inundation zone maps shall be provided to the department to meet the requirements set out in Hazard Potential Classifications of Impounding Structures (4VAC50-20-40), Emergency Action Plan for High and Significant Potential Hazard Impounding Structures (4VAC50-20-175), and Emergency Preparedness for Low Hazard Potential Impounding Structures (4VAC50-20-177), as applicable.

B. The location of the end of the inundation mapping should be indicated where the water surface elevation of the dam break inundation zone and the water surface elevation of the spillway design flood during an impounding structure nonfailure event converge to within one foot of each other. The inundation maps shall be supplemented with water surface profiles showing the peak water surface elevation prior to failure and the peak water surface elevation after failure.

C. All inundation zone map(s), except those utilized in meeting the requirements of Emergency Preparedness for Low Hazard Potential Impounding Structures (4VAC50-20-177), shall be signed and sealed by a licensed professional engineer.

D. For determining the hazard potential classification, a minimum of the following shall be provided to the department:

1. A sunny day dam break analysis utilizing the volume retained at the normal or typical water surface elevation of the impounding structure;

2. A dam break analysis utilizing the spillway design flood with a dam failure;

3. An analysis utilizing the spillway design flood without a dam failure; and

4. For the purposes of future growth planning, a dam break analysis utilizing the probable maximum flood with a dam failure.

E. To meet the requirements of Emergency Preparedness set out in 4VAC50-20-177, all Low Hazard Potential impounding structures shall provide a simple map, acceptable to the department, demonstrating the general inundation that would result from a dam failure. Such maps do not require preparation by a professional licensed engineer, however, it is preferred that the maps be prepared by a licensed professional engineer.

F. To meet the Emergency Action Plan requirements set out in 4VAC50-20-175, all owners of High
and Significant Hazard Potential impounding structures shall provide dam break inundation map(s) representing the impacts that would occur with both a sunny day dam failure and a spillway design flood dam failure.

1. The map(s) shall be developed at a scale sufficient to graphically display downstream inhabited areas and structures, roads, public utilities that may be affected, and other pertinent structures within the identified inundation area. In coordination with the local organization for emergency management, a list of downstream inundation zone property owners and occupants, including telephone numbers may be plotted on the map or may be provided with the map for reference during an emergency.

2. Each map shall include the following statement: "The information contained in this map is prepared for use in notification of downstream property owners by emergency management personnel."

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-58. Local government notifications.

For each certificate issued, the impounding structure owner shall send a copy of the certificate to the appropriate local government(s) with planning and zoning responsibilities. A project description and the map(s) required under 4VAC50-20-54 showing the area that could be affected by the impounding structure failure shall be submitted with the certificate. The department will provide a standard form cover letter for forwarding the certificate copy and accompanying materials.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-59. Reporting.

For the purposes of categorizing and reporting information to national and other dam safety databases, impounding structure size shall be classified as noted in Table 2.

| Table 2 |
### Impounding Structure Regulations

<table>
<thead>
<tr>
<th>Maximum Impounding Capacity (Ac-Ft)</th>
<th>Height (Ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large ≥ 50,000</td>
<td>≥ 100</td>
</tr>
<tr>
<td>Medium ≥ 1,000 &amp; &lt; 50,000</td>
<td>≥ 40 &amp; &lt; 100</td>
</tr>
<tr>
<td>Small ≥ 15 &amp; &lt; 1,000</td>
<td>≥ 6 &amp; &lt; 40</td>
</tr>
</tbody>
</table>

**Statutory Authority**

§ 10.1-605 of the Code of Virginia.

**Historical Notes**

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

### Part II

**Permit Requirements**

**4VAC50-20-60. Required permits.**

A. No person or entity shall construct or begin to construct a new impounding structure until the board has issued a construction permit.

B. No person or entity shall alter or begin to alter an existing impounding structure until the board has issued an alteration permit. If an owner or the owner's engineer has determined that circumstances are impacting the integrity of the impounding structure that could result in the imminent failure of the impounding structure, temporary repairs may be initiated prior to approval from the board. The owner shall notify the department within 24 hours of identifying the circumstances impacting the integrity of the impounding structure. Such emergency notification shall not relieve the owner of the need to obtain an alteration permit as soon as may be practicable, nor shall the owner take action beyond that necessary to address the emergency situation.

C. When the owner submits an application to the board for any permit to construct or alter an impounding structure, the owner shall also inform the local government jurisdiction or jurisdictions that might be affected by the permit application.

D. In evaluating construction and alteration permit applications the director shall use the design criteria and standards referenced in 4VAC50-20-320.

**Statutory Authority**

§ 10.1-605 of the Code of Virginia.

**Historical Notes**

Derived from VR625-01-00 § 2.1, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25,
eff. September 26, 2008.

4VAC50-20-70. Construction permits.

A. Prior to preparing the complete design report for a Construction Permit, applicants may submit a preliminary design report to the department to determine if the project concept is acceptable to the department. The preliminary design report should contain, at a minimum, a general description of subdivisions 1 through 12 of subsection B of this section and subdivisions 1 and 2 of this subsection:

1. Proposed design criteria and a description of the size of the impounding structure, ground cover conditions, extent of current upstream development within the watershed and the hydraulic, hydrological and structural features, geologic conditions and the geotechnical engineering assumptions used to determine the foundation, impoundment rim stability and materials to be used.

2. Preliminary drawings of a general nature, including cross sections, plans and profiles of the impounding structure, proposed pool levels and types of spillway(s).

B. An applicant for a Construction Permit shall submit a design report. A form for the design report is available from the department (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures). The design report shall be prepared in accordance with 4VAC50-20-240. The design report is a required element of a complete application for a Construction Permit and shall include the following information:

1. Project information including a description of the proposed construction, name of the impounding structure, inventory number if available, name of the reservoir, and the purpose of the reservoir.

2. The proposed hazard potential classification in conformance with Table 1 of 4VAC50-20-50.

3. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude.

4. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication.

5. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number.

6. Impounding structure data including type of material (earth, concrete, masonry or other) and the
following design configurations:

a. Top of impounding structure (elevation);
b. Downstream toe – lowest (elevation);
c. Height of impounding structure (feet);
d. Crest length – exclusive of spillway (feet);
e. Crest width (feet);
f. Upstream slope (horizontal to vertical); and
g. Downstream slope (horizontal to vertical).

7. Reservoir data including the following:

a. Maximum capacity (acre-feet);
b. Maximum pool (elevation);
c. Maximum pool surface area (acres);
d. Normal capacity (acre-feet);
e. Normal pool (elevation);
f. Normal pool surface area (acres); and
g. Freeboard (feet).

8. Spillway data including the type, construction material, design configuration, and invert elevation for the low level drain, the principal spillway, and the emergency spillway.

9. Watershed data including drainage area (square miles); type and extent of watershed development; time of concentration (hours); routing procedure; spillway design flood used and state source; design inflow hydrograph volume (acre-feet), peak inflow (cfs), and rainfall duration (hours); and freeboard during passage of the spillway design flood (feet).

10. A description of properties located in the dam break inundation zone downstream from the site of the proposed impounding structure, including the location and number of structures, buildings, roads, utilities and other property that would be endangered should the impounding structure fail.

11. Evidence that the local government or governments have been notified of the proposal by the owner to build an impounding structure.

12. Maps showing the location of the proposed impounding structure that include: the county or city in which the proposed impounding structure would be located, the location of roads and
access to the site, and the outline of the impoundment. Existing aerial photographs or existing topographic maps may be used for this purpose.

13. A report of the geotechnical investigations of the foundation soils, bedrock, or both and of the materials to be used to construct the impounding structure.

14. Design assumptions and analyses sufficient to indicate that the impounding structure will be stable during its construction and during the life of the impounding structure under all conditions of impoundment operations, including rapid filling, flood surcharge, seismic loadings, and rapid drawdown of the impoundment.

15. Evaluation of the stability of the impoundment rim area to safeguard against impoundment rim slides of such magnitude as to create waves capable of overtopping the impounding structure and evaluation of rim stability during seismic activity.

16. Design assumptions and analyses sufficient to indicate that seepage in, around, through or under the impounding structure, foundation and abutments will be reasonably and practically controlled so that internal or external forces or results thereof will not endanger the stability and integrity of the impounding structure. The design report shall also include information on graded filter design.

17. Calculations and assumptions relative to hydraulic and structural design of the spillway or spillways and energy dissipater or dissipaters. Spillway capacity shall conform to the criteria of Table 1 and 4VAC50-20-52.

18. Provisions to ensure that the impounding structure and appurtenances will be protected against unacceptable deterioration or erosion due to freezing and thawing, wind, wave action, and rain or any combination thereof.

19. Other pertinent design data, assumptions and analyses commensurate with the nature of the particular impounding structure and specific site conditions, including when required by this chapter, a plan and water surface profile of the dam break inundation zone.

20. A description of the techniques to be used to divert stream flow during construction so as to prevent hazard to life, health and property, including a detailed plan and procedures to maintain a stable impounding structure during storm events, a drawing showing temporary diversion devices, and a description of the potential impoundment during construction. Such diversion plans shall also be in accordance with applicable environmental laws.
21. A plan for project construction monitoring and quality control testing to confirm that construction materials and performance standards meet the design requirements set forth in the specifications.

22. Plans and specifications as required by 4VAC50-20-310.

23. Certification by the owner's engineer that the information provided pursuant to this subsection is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal.

24. Owner's signature certifying receipt of the information provided pursuant to this subsection.

C. A plan of construction is a required element of a complete permit application for a Construction Permit and shall include:

1. A construction sequence with milestones.

2. Elements of the work plan that should be considered include, but are not limited to, foundation and abutment treatment, stream or river diversion, excavation and material fill processes, phased fill and compaction, testing and control procedures, construction of permanent spillway and drainage devices.

3. The erosion and sediment control plan, as approved by the local government, which minimizes soil erosion and sedimentation during all phases of construction.

4. The stormwater management plan or stormwater management facility plan, as approved by the local government, if the impounding structure is a stormwater management best management practice.

D. A Temporary Emergency Action Plan is a required element of a complete application for a Construction Permit and shall include:

1. A notification list of state and local emergency response agencies;

2. Provisions for notification of potentially affected residences and structures;

3. Construction site evacuation routes; and

4. Any other special notes particular to the project.

E. Within 120 days of receipt of a complete Construction Permit Application the board shall act on the application. If the application is not acceptable, the director shall inform the applicant within 60 days of receipt and shall explain what changes are required for an acceptable application. A complete Construction Permit Application consists of the following:
1. A final design report, submitted on the department form (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures), with attachments as needed, and certified by the owner and the owner's engineer;

2. A plan of construction that meets the requirements of subsection C of this section; and

3. A Temporary Emergency Action Plan that meets the requirements of subsection D of this section.

F. Prior to and during construction the owner shall provide the director with any proposed changes from the approved design, plans, specifications, or plan of construction. Approval shall be obtained from the director prior to the construction or installation of any changes that will affect the integrity or impounding capacity of the impounding structure.

G. The Construction Permit shall be valid for the plan of construction specified in the Construction Permit Application.

H. Construction must commence within two years after the permit is issued. If construction does not commence within two years after the permit is issued, the permit shall expire, except that the applicant may petition the board for extension of the two-year period and the board may extend such period for good cause with an appropriately updated plan of construction and Temporary Emergency Action Plan.

I. The board, the director, or both may take any necessary action consistent with the Dam Safety Act (§ 10.1-604 et seq. of the Code of Virginia) if any terms of this section or of the permit are violated, if the activities of the owner are not in accordance with the approved plans and specifications, if construction is conducted in a manner hazardous to downstream life or property, or for other cause as described in the Act.

J. Within 90 days after completion of the construction of an impounding structure, the owner shall submit:

1. A complete set of record drawings signed and sealed by a licensed professional engineer and signed by the owner:

2. A complete Record Report (Record Report for Virginia Regulated Impounding Structures) signed and sealed by a licensed professional engineer and signed by the owner that includes:
   a. Project information including the name and inventory number of the structure, name of the reservoir, and whether the report is associated with a new or old structure;
   b. Location of the impounding structure including the city or county, number of feet or miles
upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude;
c. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
d. Information on the design report, including who it was prepared by, the date of design report preparation, whether it was for new construction or for an alteration, and the permit issuance date;
e. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number;
f. Impounding structure data including type of material (earth, concrete, masonry or other) and the following configurations:
(1) Top of impounding structure (elevation);
(2) Downstream toe – lowest (elevation);
(3) Height of impounding structure (feet);
(4) Crest length – exclusive of spillway (feet);
(5) Crest width (feet);
(6) Upstream slope (horizontal to vertical); and
(7) Downstream slope (horizontal to vertical).
g. Reservoir data including the following:
(1) Maximum capacity (acre-feet);
(2) Maximum pool (elevation);
(3) Maximum pool surface area (acres);
(4) Normal capacity (acre-feet);
(5) Normal pool (elevation);
(6) Normal pool surface area (acres); and
(7) Freeboard (feet).
h. Spillway data including the type, construction material, design configuration, and invert elevation for the low level drain, the principal spillway, and the emergency spillway; a description of the low level drain and principal spillway including dimensions, trash guard
information, and orientation of intake and discharge to impounding structure if looking downstream; and a description of the emergency spillway including dimensions and orientation to impounding structure if looking downstream;

i. Watershed data including drainage area (square miles); type and extent of watershed development; time of concentration (hours); routing procedure; spillway design flood used and state source; design inflow hydrograph volume (acre-feet), peak inflow (cfs), and rainfall duration (hours); and freeboard during passage of the spillway design flood (feet);

j. Impounding structure history including the date construction was completed, who it was designed by and the date, who it was built by and the date, who performed inspections and dates, description of repairs, and confirmation as to whether the impounding structure has ever been overtopped;

k. A narrative describing the impounding structure procedures for operation, maintenance, filling, emergency action plan implementation, and structure evaluation;

l. A narrative describing the hydraulic and hydrologic data on the spillway design flood, hydrologic records, flood experience, flood potential, reservoir regulation, and comments or recommendations regarding these attributes;

m. A narrative describing stability of the foundation and abutments, embankment materials, and a written evaluation of each;

n. A complete set of record drawings signed and sealed by a licensed professional engineer and signed by the owner;

o. Certification by the owner's engineer that the information provided pursuant to subdivision J 2 of this section is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal; and

p. Owner's signature certifying receipt of the information provided pursuant to subdivision J 2 of this section.

3. Certification from the licensed professional engineer who has monitored construction of the impounding structure during construction that, to the best of the engineer's judgment, knowledge and belief, the impounding structure and its appurtenances were constructed in conformance with the plans, specifications, drawings and other requirements approved by the board;
4. Operation and Maintenance Certificate Application (Operation and Maintenance Certificate Application for Virginia Regulated Impounding Structures) in accordance with 4VAC50-20-105; and
5. Emergency Action Plan or Emergency Preparedness Plan in accordance with 4VAC50-20-175 or 4VAC50-20-177.

K. Upon completion of construction, the impoundment may be filled upon board issuance of an Operation and Maintenance Certificate.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 2.2, eff. February 1, 1989; amended, Virginia Register Volume 18, Issue 14, eff. July 1, 2002; Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-80. Alterations permits.

A. Alterations which would potentially affect the structural integrity of an impounding structure include, but are not limited to, changing the height or otherwise enlarging the dam, increasing normal pool or principal spillway elevation or physical dimensions, changing the elevation or physical dimensions of the emergency spillway, conducting necessary repairs or structural maintenance, or removing the impounding structure. Structural maintenance does not include routine maintenance.

B. An applicant for an Alteration Permit shall submit a design report. A form for the design report is available from the department (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures). The design report shall be prepared in accordance with 4VAC50-20-240. The design report shall include, but not be limited to, the following information:

1. Project information including a description and benefits of the proposed alteration, name of the impounding structure, inventory number if available, name of the reservoir, and the purpose of the reservoir.

2. The hazard potential classification in conformance with Table 1 in 4VAC50-20-50.

3. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude.

4. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication.
5. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number.

6. Impounding structure data including type of material (earth, concrete, masonry or other) and the following configurations (note both existing and design configurations for each):
   a. Top of impounding structure (elevation);
   b. Downstream toe – lowest (elevation);
   c. Height of impounding structure (feet);
   d. Crest length – exclusive of spillway (feet);
   e. Crest width (feet);
   f. Upstream slope (horizontal to vertical); and
   g. Downstream slope (horizontal to vertical).

7. Reservoir data including the following (note both existing and design configurations for each):
   a. Maximum capacity (acre-feet);
   b. Maximum pool (elevation);
   c. Maximum pool surface area (acres);
   d. Normal capacity (acre-feet);
   e. Normal pool (elevation);
   f. Normal pool surface area (acres); and
   g. Freeboard (feet).

8. Spillway data including the type, construction material, design configuration, and invert elevation for the low level drain, the principal spillway, and the emergency spillway.

9. Watershed data including drainage area (square miles); type and extent of watershed development; time of concentration (hours); routing procedure; spillway design flood used and state source; design inflow hydrograph volume (acre-feet), peak inflow (cfs), and rainfall duration (hours); and freeboard during passage of the spillway design flood (feet).

10. Evidence that the local government has been notified of the alteration and repair plan.

11. Plans and specifications as required by 4VAC50-20-310. The plan view of the impounding structure site should represent all significant structures and improvements that illustrate the location of all proposed work.
12. A report of the geotechnical investigations of the foundation soils, bedrock, or both in the areas affected by the proposed alterations and of the materials to be used to alter the impounding structure.

13. Design assumptions and analyses sufficient to indicate that the impounding structure will be stable during the alteration of the impounding structure under all conditions of reservoir operations.

14. Calculations and assumptions relative to design of the improved spillway or spillways, if applicable.

15. Provisions to ensure that the impounding structure and appurtenances during the alteration will be protected against unacceptable deterioration or erosion due to freezing and thawing, wind, wave action and rain or any combination thereof.

16. Other pertinent design data, assumptions and analyses commensurate with the nature of the particular impounding structure and specific site conditions, including when required by this chapter, a plan and water surface profile of the dam break inundation zone.

17. If applicable, a description of the techniques to be used to divert stream flow during alteration work so as to prevent hazard to life, health and property, including a detailed plan and procedures to maintain a stable impounding structure during storm events, a drawing showing temporary diversion devices, and a description of the potential impoundment during the alteration. Such diversion plans shall be in accordance with the applicable environmental laws.

18. A plan for project construction monitoring and quality control testing to confirm that materials used in the alteration work and that performance standards meet the design requirements set forth in the specifications.

19. Certification by the owner's engineer that the information provided pursuant to this subsection is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal.

20. Owner's signature certifying receipt of the information provided pursuant to this subsection.

C. A plan of construction is a required element of complete permit application and shall include:

1. A construction sequence with milestones.

2. Elements of the work plan that should be considered include, but are not limited to, foundation and abutment treatment, excavation and material fill processes, phased fill and compaction, testing and control procedures, construction of permanent spillway and drainage devices, if applicable.
3. The erosion and sediment control plan, as approved by the local government, which minimizes soil erosion and sedimentation during all phases of construction.

D. Within 120 days of receipt of a complete Alteration Permit Application, the board shall act on the application. If the application is not acceptable, the director shall inform the applicant within 60 days of receipt and shall explain what changes are required for an acceptable application. A complete Alteration Permit Application consists of the following:

1. A final design report with attachments as needed, and certified by the owner;
2. A plan of construction that meets the requirements of subsection C of this section;
3. Any necessary interim provisions to the current Emergency Action Plan or Emergency Preparedness Plan. Interim provisions shall be submitted to the local organization for emergency management, the Virginia Department of Emergency Management, and the department; and
4. If the owner is requesting the deregulation of an impounding structure, the application shall specify whether the impounding structure is to be removed so that the impounding structure is incapable of storing water, either temporarily or permanently; or whether the impounding structure is to be altered in such a manner that either the height or storage capacity of the impounding structure causes the impounding structure to be of less than regulated size.

E. During the alteration work, the owner shall provide the director with any proposed changes from the approved design, plans, specifications, or a plan of construction. Approval shall be obtained from the director prior to the alteration or installation of any changes that will affect the integrity or impounding capacity of the impounding structure.

F. The Alteration Permit shall be valid for the construction sequence with milestones specified in the approved Alteration Permit Application.

G. Work identified in the Alteration Permit must commence within the time frame identified in the Alteration Permit. If work does not commence within the prescribed time frame, the permit shall expire, except that the applicant may petition the board for extension of the prescribed time frame and the board may extend such period for good cause with an updated construction sequence with milestones.

H. The board, the director, or both may take any necessary action consistent with the Dam Safety Act (§ 10.1-604 et seq. of the Code of Virginia) if any terms of this section or of the permit are violated, if the activities of the owner are not in accordance with the approved plans and specifications, if the alteration is conducted in a manner hazardous to downstream life or property, or for other cause as described in the
Act.

I. Within 90 days after completion of the alteration of an impounding structure, the owner shall submit a complete Record Report. A form for the Record Report is available from the department (Record Report for Virginia Regulated Impounding Structures). The Record Report shall be signed and sealed by a licensed professional engineer and signed by the owner and shall be sent to the department indicating that the modifications made to the structural features of the impounding structure have been completed. This report is not required when the Alteration Permit has been issued for the removal of an impounding structure. The Record Report shall include the following:

1. Project information including the name and inventory number of the structure, name of the reservoir, and whether the report is associated with a new or old structure;

2. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude;

3. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;

4. Information on the design report, including who it was prepared by, the date of design report preparation, whether it was for new construction or for an alteration, and the permit issuance date;

5. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number;

6. Impounding structure data including type of material (earth, concrete, masonry or other) and the following configurations:
   a. Top of impounding structure (elevation);
   b. Downstream toe – lowest (elevation);
   c. Height of impounding structure (feet);
   d. Crest length – exclusive of spillway (feet);
   e. Crest width (feet);
   f. Upstream slope (horizontal to vertical); and
   g. Downstream slope (horizontal to vertical).

7. Reservoir data including the following:
a. Maximum capacity (acre-feet);
b. Maximum pool (elevation);
c. Maximum pool surface area (acres);
d. Normal capacity (acre-feet);
e. Normal pool (elevation);
f. Normal pool surface area (acres); and
g. Freeboard (feet).

8. Spillway data including the type, construction material, design configuration, and invert elevation for the low level drain, the principal spillway, and the emergency spillway; a description of the low level drain and principal spillway including dimensions, trash guard information, and orientation of intake and discharge to impounding structure if looking downstream; and a description of the emergency spillway including dimensions and orientation to impounding structure if looking downstream;

9. Watershed data including drainage area (square miles); type and extent of watershed development; time of concentration (hours); routing procedure; spillway design flood used and state source; design inflow hydrograph volume (acre-feet), peak inflow (cfs), and rainfall duration (hours); and freeboard during passage of the spillway design flood (feet);

10. Impounding structure history including the date construction was completed, who it was designed by and the date, who it was built by and the date, who performed inspections and dates, description of repairs, and confirmation as to whether the impounding structure has ever been overtopped;

11. A narrative describing the impounding structure procedures for operation, maintenance, emergency action plan implementation, and structure evaluation;

12. A narrative describing the hydraulic and hydrologic data on the spillway design flood, hydrologic records, flood experience, flood potential, reservoir regulation, and comments or recommendations regarding these attributes;

13. A narrative describing stability of the foundation and abutments, embankment materials, and a written evaluation of each;

14. A complete set of record drawings signed and sealed by a licensed professional engineer and signed by the owner;
15. Certification by the owner's engineer that the information provided pursuant to this subsection is true and correct in their professional judgment. Such certification shall include the engineer's signature, printed name, Virginia number, date, and the engineer's Virginia seal; and

16. Owner's signature certifying receipt of the information provided pursuant to this subsection.

J. For altered impounding structures, a certification from a licensed professional engineer who has monitored the alteration of the impounding structure that, to the best of the engineer's judgment, knowledge, and belief, the impounding structure and its appurtenances were altered in conformance with the plans, specifications, drawings and other requirements approved by the board.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 2.3, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-90. Transfer of permits.

A. Prior to the transfer of ownership of a permitted impounding structure the permittee shall notify the director in writing and the new owner shall file a transfer notification with the department. A form for the transfer notification is available from the department (Transfer of Impounding Structure Notification form Past Owner to New Owner). The new owner shall amend the existing permit application as necessary and shall certify to the director that he is aware of and will comply with all of the requirements and conditions of the permit.

B. The transfer notification shall include the following required information:

1. Project information including the name and inventory number of the structure, name of the reservoir, and impoundment hazard classification;

2. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude;

3. Type of certificates and permits to be transferred including effective date and expiration date of all certificates and permits;

4. Past owner's name, mailing address, and residential and business telephone numbers;
5. New owner's name, mailing address, and residential and business telephone numbers;
6. Request to transfer certification statement signed and dated by the past owner;
7. Certification of compliance with permit or certificate with all said terms and conditions signed and dated by the new owner; and
8. Contact information updates for Emergency Action Plan or Emergency Preparedness Plan provided by the new owner. Such updates shall include the name, mailing address, and residential and business telephone numbers for the impounding structure owner, impounding structure operator, rainfall and staff gage observer, and alternate observer.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 2.4, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-100. (Repealed.)

Historical Notes
Derived from VR625-01-00 § 3.1, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

Part III
Certificate Requirements

4VAC50-20-105. Regular Operation and Maintenance Certificates.

A. A Regular Operation and Maintenance Certificate is required for an impounding structure. Such six-year certificates shall include the following based on hazard classification:

1. High Hazard Potential Regular Operation and Maintenance Certificate;
2. Significant Hazard Potential Regular Operation and Maintenance Certificate; or

B. The owner of an impounding structure shall apply for the renewal of the six-year Regular Operation and Maintenance Certificate 90 days prior to its expiration. If a Regular Operation and Maintenance Certificate is not renewed as required, the board shall take appropriate enforcement action.

C. Any owner of an impounding structure that does not have a Regular Operation and Maintenance
Certificate or any owner renewing a Regular Operation and Maintenance Certificate shall file an Operation and Maintenance Certificate Application. A form for the application is available from the department (Operation and Maintenance Certificate Application for Virginia Regulated Impounding Structures). Such application shall be signed by the owner and signed and sealed by a licensed professional engineer. The following information shall be submitted on or with the application:

1. The application shall include the following required information:
   a. The name of structure and inventory number;
   b. The proposed hazard potential classification;
   c. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
   d. An operating plan and schedule including a narrative on the operation of control gates and spillways and the impoundment drain;
   e. For earthen embankment impounding structures, a maintenance plan and schedule for the embankment, principal spillway, emergency spillway, low-level outlet, impoundment area, downstream channel, and staff gages;
   f. For concrete impounding structures, a maintenance plan and schedule for the upstream face, downstream face, crest of dam, galleries, tunnels, abutments, spillways, gates and outlets, and staff gages;
   g. An inspection schedule for operator inspection, maintenance inspection, technical safety inspection, and overtopping situations;
   h. A schedule including the rainfall amounts, emergency spillway flow levels or storm event that initiates the Emergency Action or Preparedness Plan and the frequency of observations;
   i. A statement as to whether or not the current hazard potential classification for the impounding structure is appropriate and whether or not additional work is needed to make an appropriate hazard potential designation;
   j. For newly constructed or recently altered impounding structures, a certification from a licensed professional engineer who has monitored the construction or alteration of the impounding structure that, to the best of the engineer's judgment, knowledge, and belief, the impounding structure and its appurtenances were constructed or altered in conformance with the plans, specifications, drawings and other requirements approved by the board;
k. Certification by the owner’s engineer that the Operation and Maintenance Certificate Application information provided pursuant to subdivision 1 of this subsection is true and correct in their professional judgment. Such certification shall include the engineer’s signature, printed name, Virginia number, date, and the engineer’s Virginia seal; and

l. Owner’s signature certifying the Operation and Maintenance Certificate Application information provided pursuant to subdivision 1 of this subsection and that the operation and maintenance plan and schedule shall be conducted in accordance with this chapter.

2. An Inspection Report (Annual Inspection Report for Virginia Regulated Impounding Structures) in accordance with subsection E of this section;

3. An Emergency Action Plan in accordance with 4VAC50-20-175 or an Emergency Preparedness Plan in accordance with 4VAC50-20-177 and evidence that the required copies of such plan have been submitted to the local organization for emergency management and the Virginia Department of Emergency Management; and

4. Any additional analysis determined necessary by the director, the board or the owner’s engineer to address public safety concerns. Such additional analysis may include, but not be limited to, seismic stability, earthen spillway integrity, adequate freeboard allowance, stability assessment of the impoundment’s foundation, potential liquefaction of the embankment, overturning or sliding of a concrete structure and other structural stress issues.

D. If the Operation and Maintenance Certificate Application submittal is found to be not complete, the director shall inform the applicant within 30 days and shall explain what changes are required for an acceptable submission. Within 60 days of receipt of a complete application the board shall act upon the application. Upon finding that the impounding structure as currently operating is in compliance with this chapter, the board shall issue a Regular Operation and Maintenance Certificate. Should the board find that the impounding structure as currently operating is not in compliance with this chapter, the board may deny the permit application or issue a Conditional Operation and Maintenance Certificate in accordance with 4VAC50-20-150.

E. Inspections shall be performed on an impounding structure annually.

1. Inspection Reports (Annual Inspection Report for Virginia Regulated Impounding Structures) signed and sealed by a licensed professional engineer shall be submitted to the department in accordance with the following schedule:
a. For a High Hazard Potential impounding structure, every two years,
b. For a Significant Hazard Potential impounding structure, every three years,
c. For a Low Hazard Potential impounding structure, every six years.

In years when an Inspection Report signed and sealed by a licensed professional engineer is not required, an owner shall submit the Annual Inspection Report for Virginia Regulated Impounding Structures.

2. The Inspection Report shall include the following required information:
   a. Project information including the name and inventory number of structure, name of the reservoir, and purpose of the reservoir;
   b. City or county where the impounding structure is located;
   c. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
   d. Owner's engineer's name, firm, professional engineer Virginia number, mailing address, and business telephone number;
   e. Inspection observation of the impounding structure including the following:
      (1) Earthen embankment information including any embankment alterations; erosion; settlement, misalignments or cracks; seepage and seepage flow rate and location;
      (2) Upstream slope information including notes on woody vegetation removed, rodent burrows discovered, and remedial work performed;
      (3) Intake structure information including notes on deterioration of concrete structures, exposure of rebar reinforcement, need to repair or replace trash rack, any problems with debris in the reservoir, and whether the drawdown valve operated;
      (4) Abutment contacts including notes on seepage and seepage flow rate and location;
      (5) Earthen emergency spillway including notes on obstructions to flow and plans to correct, rodent burrows discovered, and deterioration in the approach or discharge channel;
      (6) Concrete emergency spillway including notes on the deterioration of the concrete, exposure of rebar reinforcement, any leakage below concrete spillway, and obstructions to flow and plans to correct;
      (7) Downstream slope information including notes on woody vegetation removed, rodent
burrows discovered, whether seepage drains are working, and any seepage or wet areas;

(8) Outlet pipe information including notes on any water flowing outside of discharge pipe through the impounding structure and a description of any reflection or damage to the pipe;

(9) Stilling basin information including notes on the deterioration of the concrete, exposure of rebar reinforcement, deterioration of the earthen basin slopes, repairs made, and any obstruction to flow;

(10) Gates information including notes on gate malfunctions or repairs, corrosion or damage, and whether any gates were operated and if so how often and to what extreme;

(11) Reservoir information including notes on new developments upstream of the dam, slides or erosion of lake banks, and general comments to include silt, algae, or other influence factors;

(12) Instruments information including any reading of instruments and any installation of new instruments; and

(13) General information including notes on new development in the downstream dam break inundation zone that would impact hazard classification or spillway design flood requirements, the maximum stormwater discharge or peak elevation during the previous year, whether general maintenance was performed and when, and actions that need to be completed before the next inspection.

f. Evaluation rating of the impounding structure and appurtenances (excellent, good, or poor), general comments, and recommendations;

g. Certification by the owner and date of inspection; and

h. Certification and seal by the owner's engineer and date of inspection, as applicable.

F. The owner of an impounding structure shall notify the department immediately of any change in the use of the area downstream that would impose hazard to life or property in the event of failure.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-110. (Repealed.)

Historical Notes
Derived from VR625-01-00 § 3.2, eff. February 1, 1989; repealed, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-120. (Repealed.)

Historical Notes

Derived from VR625-01-00 § 3.3, eff. February 1, 1989; repealed, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-125. Delayed effective date for Spillway Design Flood requirements for impounding structures.

A. If an impounding structure has been determined to have an adequate spillway capacity prior to September 26, 2008, and is currently operating under a Regular Operation and Maintenance Certificate, but will now require spillway modifications due to changes in these regulations, the owner shall submit to the board an Alteration Permit Application in accordance with 4VAC50-20-80 to address spillway capacity at the time of the expiration of their Regular Operation and Maintenance Certificate or by September 26, 2011, whichever is later. The Alteration Permit Application shall contain a construction sequence with milestones for completing the necessary improvements within five years of Alteration Permit issuance. The board may approve an extension of the prescribed time frame for good cause. Should the owner be able to demonstrate that no spillway capacity change is necessary, the impounding structure may be found to be in compliance with this chapter.


C. If circumstances warrant more immediate repairs to the impounding structure, the board may direct alterations to the spillway to be completed sooner.

D. During this delay period, owners are required to address other deficiencies that may exist that are not related to the spillway design flood.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes
4VAC50-20-130. (Repealed.)

Historical Notes
Derived from VR625-01-00 § 3.4, eff. February 1, 1989; repealed, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-140. (Repealed.)

Historical Notes
Derived from VR625-01-00 § 3.5, eff. February 1, 1989; repealed, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-150. Conditional operation and maintenance certificate.

A. During the review of any Operation and Maintenance Certificate Application (Operation and Maintenance Certificate Application for Virginia Regulated Impounding Structures) completed in accordance with 4VAC50-20-105 should the director determine that the impounding structure has nonimminent deficiencies, the director may recommend that the board issue a Conditional Operation and Maintenance Certificate.

B. The Conditional Operation and Maintenance Certificate for High, Significant, and Low Hazard Potential impounding structures shall be for a maximum term of two years. This certificate will allow the owner to continue normal operation and maintenance of the impounding structure, and shall require that the owner correct the deficiencies on a schedule approved by the board.

C. A Conditional Certificate may be extended in accordance with the procedures of 4VAC50-20-155 provided that Inspection Reports (Annual Inspection Report for Virginia Regulated Impounding Structures) are on file, and the board determines that the owner is proceeding with the necessary corrective actions.

D. Once the deficiencies are corrected, the board shall issue a Regular Operation and Maintenance Certificate based upon the impounding structure's meeting the requirements of 4VAC50-20-105.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 3.6, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25,
eff. September 26, 2008.


The board may extend an Operation and Maintenance Certificate for impounding structures provided that the owner submits a written request justifying an extension, the amount of time needed to comply with the requirements set out in the current Operation and Maintenance Certificate, and any required fees. The owner must have demonstrated substantial and continual progress towards meeting the requirements of the certificate in order to receive an extension.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-160. Additional operation and maintenance requirements.

A. The owner of an impounding structure shall not, through action or inaction, cause or allow such structure to impound water following receipt of a written report from the owner's engineer that the impounding structure will not safely impound water.

B. In accordance with § 10.1-609.2 of the Code of Virginia, impounding structure owners shall not permit the growth of trees and other woody vegetation and shall remove any such vegetation from the slopes and crest of embankments and the emergency spillway area, and within a distance of 25 feet from the toe of the embankment and abutments of the dam.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 3.7, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-165. Agricultural exemption.

A. Impounding structures operated primarily for agricultural purposes that are less than 25 feet in height or that create a maximum impoundment capacity smaller than 100 acre-feet are exempt from the Impounding Structure Regulations.

B. An owner covered by an agricultural exemption pursuant to § 10.1-604 of the Code of Virginia and
4VAC50-20-30 may validate such exemption by submitting an Agricultural Exemption Report (Agricultural Exemption Report for Impounding Struct ures). The Agricultural Exemption Report shall include the following information:

1. Project information including the name and inventory number of the structure and name of the reservoir;
2. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude;
3. Owner's name or representative if corporation, mailing address, residential and business telephone numbers, and other means of communication;
4. The impounding structure height in feet and the maximum impounding capacity in acre-feet;
5. A list of the agricultural functions for which the impoundment supplies water;
6. The date of validation; and
7. The owner's signature validating that the impoundment is operated primarily for agricultural purposes and is exempt from the regulations.

C. The Agricultural Exemption Report may be verified by the department through a site visit.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-170. Transfer of certificates.

A. Prior to the transfer of ownership of an impounding structure the certificate holder shall notify the director in writing and the new owner shall file a transfer notification with the department. A form for the transfer notification is available from the department (Transfer of Impounding Structure Notification from Past Owner to New Owner). The new owner may elect to continue the existing operation and maintenance certificate for the remaining term or he may apply for a new certificate in accordance with 4VAC50-20-105. If the owner elects to continue the existing certificate, he shall certify to the director that he is aware of and will comply with all of the requirements and conditions of the certificate.

B. The transfer notification shall include the following required information:
1. Project information including the name and inventory number of the structure, name of the reservoir, and impoundment hazard classification;

2. Location of the impounding structure including the city or county, number of feet or miles upstream or downstream of a highway and the highway number, name of the river or the stream, and the latitude and longitude;

3. Type of certificates and permits to be transferred including effective date and expiration date of all certificates and permits;

4. Past owner's name, mailing address, and residential and business telephone numbers;

5. New owner's name, mailing address, and residential and business telephone numbers;

6. Request to transfer certification statement signed and dated by the past owner;

7. Certification of compliance with permit or certificate with all said terms and conditions signed and dated by the new owner; and

8. Contact information updates for Emergency Action Plan or Emergency Preparedness Plan provided by the new owner. Such updates shall include the name, mailing address, and residential and business telephone numbers for the impounding structure owner, impounding structure operator, rainfall and staff gage observer, and alternate observer.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 3.8, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-175. Emergency Action Plan (EAP) for High and Significant Hazard Potential impounding structures.

A. In order to protect life during potential emergency conditions at an impounding structure, and to ensure effective, timely action is taken should an impounding structure emergency occur, an EAP shall be required for each High and Significant Hazard Potential impounding structure. The EAP shall be coordinated with the Department of Emergency Management in accordance with § 44-146.18 of the Code of Virginia. The EAP required by these regulations shall be incorporated into local and interjurisdictional emergency plans pursuant to § 44-146.19 of the Code of Virginia.
B. It is the impounding structure owner’s responsibility to develop, maintain, exercise, and implement a site-specific EAP.

C. An EAP shall be submitted every six years. The EAP shall be submitted with the owner’s submittal of their Regular Operation and Maintenance Certificate application (Operation and Maintenance Certificate Application for Virginia Regulated Impounding Structures).

D. The owner shall update and resubmit the EAP immediately upon becoming aware of necessary changes to keep the EAP workable. Should an impounding structure be reclassified, an EAP in accordance with this section shall be submitted.

E. A drill shall be conducted annually for each high or significant hazard impounding structure. To the extent practicable, the drill should include a face-to-face meeting with the local emergency management agencies responsible for any necessary evacuations to review the EAP and ensure the local emergency management agencies understand the actions required during an emergency. A table-top exercise shall be conducted once every six years, although more frequent table-top exercises are encouraged. Drills and table-top exercises for multiple impounding structures may be performed in combination if the involved parties are the same. Owners shall certify to the department annually that a drill, a table-top exercise, or both has been completed and provide any revisions or updates to the EAP or a statement that no revisions or updates are needed.

F. Impounding structure owners shall test existing monitoring, sensing, and warning equipment at remote or unattended impounding structures at least twice per year or as performed by the Virginia Department of Emergency Management pursuant to § 10.1-609.1 of the Code of Virginia and maintain a record of such tests.

G. An EAP shall contain the following seven basic elements unless otherwise specified in this subsection.

1. Notification chart. A notification chart shall be included for all classes of impounding structures that shows who is to be notified, by whom, and in what priority. The notification chart shall include contact information providing 24-hour telephone coverage for all responsible parties including, but not limited to, the impounding structure operator or manager, state and local emergency management officials, local police or sheriffs’ departments, and the owner’s engineer. The notification chart shall also identify the process by which downstream property owners will be notified, and what party or parties will be responsible for making such notifications.
2. Emergency Detection, Evaluation, and Classification. The EAP shall include a discussion of the procedures for timely and reliable detection, evaluation, and classification of emergency situations considered to be relevant to the project setting and impounding features. Each relevant emergency situation is to be documented to provide an appropriate course of action based on the urgency of the situation. Where appropriate, situations should address impounding structure failures that are imminent or in progress, a situation where the potential for impounding structure failure is rapidly developing, and a situation where the threat is slowly developing.

3. Responsibilities. The EAP shall specify responsibilities for EAP-related tasks. The EAP shall also clearly designate the responsible party for making the decision that an emergency condition no longer exists at the impounding structure. The EAP shall include procedures and the responsible parties for notifying to the extent possible any known local occupants, owners, or lessees of downstream properties potentially impacted by the impounding structure's failure.

4. Preparedness. The EAP shall include a section that describes preparedness actions to be taken both before and following development of emergency conditions.

5. Dam Break Inundation Maps. The EAP shall include dam break inundation maps developed in accordance with 4VAC50-20-54.

6. Appendices. The appendices shall contain information that supports and supplements the material used in the development and maintenance of the EAP such as analyses of impounding structure failure floods; plans for training, exercising, updating, and posting the EAP; and other site-specific concerns.

7. Certification. The EAP shall include a section that identifies all parties with assigned responsibilities in the EAP pursuant to subdivision 3 of this subsection. This will include certification that the EAP has been received by these parties. The preparer's name, title, and contact information shall be printed in this section. The preparer's signature shall also be included in the certification section. The local organization for emergency management shall provide the owner and the department with any deficiencies they may note.

H. The development of the EAP shall be coordinated with all entities, jurisdictions, and agencies that would be affected by an impounding structure failure or that have statutory responsibilities for warning, evacuation, and postflood actions. Consultation with state and local emergency management officials at appropriate levels of management responsible for warning and evacuation of the public shall occur to
ensure that there is awareness of their individual and group responsibilities. The owner shall also coordinate with the local organization for emergency management to identify properties that upon failure of the impounding structure would result in economic impacts.

I. The EAP, or any updates to an existing EAP, shall be submitted to the department, the local organization for emergency management, and the Virginia Department of Emergency Management. Two copies shall be provided to the department.

J. The following format shall be used as necessary to address the requirements of this section.

   Title Page/Cover Sheet
   Table of Contents
   I. Certifications
   II. Notification Flowchart
   III. Statement of Purpose
   IV. Project Description
   V. Emergency Detection, Evaluation, and Classification
   VI. General Responsibilities Under the EAP
      A. Impounding Structure Owner Responsibilities
      B. Responsibility for Notification
      C. Responsibility for Evacuation
      D. Responsibility for Termination and Follow-Up
      E. EAP Coordinator Responsibility
   VII. Preparedness
   VIII. Inundation Maps
   IX. Appendices
      A. Investigation and Analyses of Impounding Structure Failure Floods
      B. Plans for Training, Exercising, Updating, and Posting the EAP
      C. Site-Specific Concerns

Statutory Authority
§ 10.1-605 of the Code of Virginia.
Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.


Low Hazard impounding structures shall provide information for emergency preparedness to the department, the local organization for emergency management and the Virginia Department of Emergency Management. A form for the submission is available from the department (Emergency Preparedness Plan for Low Hazard Virginia Regulated Impounding Structures). The information shall include, but not be limited, to the following:

1. Name of the impounding structure, inventory number, city or county, latitude, and longitude;
2. Owner's name, mailing address, residential and business telephone numbers, and other means of communication. Contact information shall provide for 24-hour telephone contact capability;
3. Impounding structure operator's name, mailing address, residential and business telephone numbers, and other means of communication. Contact information shall provide for 24-hour telephone contact capability;
4. Rainfall and staff gage observer's name, mailing address, residential and business telephone numbers, and other means of communication. Contact information shall provide for 24-hour telephone contact capability;
5. Contact information for alternate operator and alternate rainfall and staff gage observer, if applicable;
6. Contact information for the local dispatch center nearest impounding structure including address and 24-hour telephone number;
7. City or county emergency services coordinator's name, mailing address, residential and business telephone numbers, and other means of communication;
8. A procedure and the responsible parties for notifying to the extent possible any known local occupants, owners, or lessees of downstream properties potentially impacted by the impounding structure's failure;
9. A discussion of the procedures for timely and reliable detection, evaluation, and classification of emergency situations considered to be relevant to the project setting and impounding features. Each relevant emergency situation is to be documented to provide an appropriate course of action based on the urgency of the situation;
10. A simple dam break inundation map acceptable to the director, demonstrating the general inundation that would result from an impounding structure failure. Such maps required pursuant to this section do not require preparation by a professional licensed engineer; however, maps prepared by a licensed professional engineer are preferred;

11. Identification of public roads downstream noting the highway number and distance below the impounding structure. If roads exist, contact information for the resident Virginia Department of Transportation engineer or city or county engineer including address and 24-hour telephone numbers;

12. Amount of rainfall that will initiate a Stage II Condition in inches per six hours, inches per 12 hours, and inches per 24 hours and a Stage III Condition in inches per six hours, inches per 12 hours, and inches per 24 hours;

13. Amount of flow in the emergency spillway that will initiate a Stage II Condition in feet (depth of flow) and a Stage III Condition in feet (depth of flow);

14. Staff gage location and description; the frequency of observations by the rainfall or staff gage observer under a Stage I Condition, and Stage II Condition, and a Stage III Condition; and a clear description of an access route and means of travel during flood conditions to the impounding structure;

15. Evacuation procedures including notification, monitoring, evacuation, and reporting processes and responsibilities;

16. Evidence that the required copies of such plan have been submitted to the local organization for emergency management and the Virginia Department of Emergency Management; and

17. Certification of the plan by the owner.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

Part IV

Procedures

4VAC50-20-180. Inspections.
A. The director may make inspections during construction, alteration or operation and maintenance as deemed necessary to ensure that the impounding structure is being constructed, altered or operated and maintained in compliance with the permit or certificate issued by the board. The director shall provide the owner a copy of the findings of these inspections. The department's inspection does not relieve the owner from the responsibility of providing adequate inspection during construction, alteration, or operation and maintenance. During the maintenance, construction, or alteration of any impounding structure or reservoir, the director shall require the owner to perform, at the owner's expense, such work or tests as necessary to obtain information sufficient to enable the director to determine whether conformity with the plans and specifications approved by the certificate is being secured.

B. Periodic inspections during construction or alteration shall be conducted under the direction of a licensed professional engineer who shall provide for monitoring, review of contractor submittals, and appropriate confirmatory testing of all facets of construction affecting the safety of the impounding structure in accordance with the construction or alteration permit issued by the board.

C. Required inspections during operation and maintenance shall be conducted under the supervision of a licensed professional engineer at intervals designated under 4VAC50-20-105.

D. Every owner shall provide for an inspection by a licensed professional engineer after overtopping of the impounding structure or after flows cause damage to the emergency spillway. A copy of the findings of each inspection with the engineer's recommendations shall be filed with the board within a reasonable period of time not to exceed 30 days subsequent to completion of the inspection.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 4.1, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-190. Right to informal fact-finding proceeding or hearing.

Any owner aggrieved by an action taken by the director or by the board without hearing, or by inaction of the director or the board, under the provisions of this chapter, may demand in writing an informal fact-finding proceeding pursuant to § 2.2-4019 of the Code of Virginia or a formal hearing pursuant to § 2.2-4020 of the Code of Virginia. A formal hearing may be granted only with the consent of the board.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 4.2, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-200. Enforcement.

The provisions of this chapter may be enforced by the board, the director, or both in any manner consistent with the provisions of the Dam Safety Act (§ 10.1-604 et seq. of the Code of Virginia).

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 4.3, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.


A. When the board needs to satisfy questions of safety regarding plans and specifications, construction, alteration, or operation and maintenance, or when requested by the owner, the board may appoint a consulting committee to report to it with respect to those questions of the impounding structure's safety. Such a committee shall consist of two or more consultants, none of whom have been associated with the impounding structure.

B. The costs and expenses incurred by the consulting committee, if appointed at the request of an owner, shall be paid by the owner.

C. The costs and expenses incurred by the consulting committee, if initiated by the board, shall be paid by the board.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 4.4, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-220. Unsafe conditions.

A. No owner shall maintain an unsafe impounding structure. Designation of an impounding structure
as unsafe shall be made in accordance with § 10.1-607.1 of the Code of Virginia.

B. Imminent danger.

1. If an owner or the owner's engineer has determined that circumstances are impacting the integrity of the impounding structure that could result in the imminent failure of the impounding structure, temporary repairs may be initiated prior to approval from the board. The owner shall notify the department within 24 hours of identifying the circumstances impacting the integrity of the impounding structure. Such emergency notification shall not relieve the owner of the need to obtain an alteration permit as soon as may be practicable, nor shall the owner take action beyond that necessary to address the emergency situation.

2. When the director finds that an impounding structure is unsafe and constitutes an imminent danger to life or property, he shall immediately notify the Virginia Department of Emergency Management and confer with the owner who shall activate the Emergency Action Plan or Emergency Preparedness Plan if appropriate to do so. The owner of an impounding structure found to constitute an imminent danger to life or property shall take immediate corrective action to remove the imminent danger as required by § 10.1-608 of the Code of Virginia.

C. Nonimminent danger. The owner of an impounding structure who has been issued findings and recommendations, by the board, for the correction of deficiencies that may threaten life or property if not corrected, shall undertake to implement the recommendations for correction of deficiencies according to a schedule of implementation contained in that report as required by § 10.1-609 of the Code of Virginia.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 4.5, eff. February 1, 1989; amended, Virginia Register Volume 18, Issue 14, eff. July 1, 2002; Volume 24, Issue 25, eff. September 26, 2008.


A. Upon receipt of a complaint alleging that the person or property of the complainant is endangered by the construction, alteration, maintenance or operation of an impounding structure, the director shall cause an inspection of the structure, unless the data, records and inspection reports on file with the board are found adequate to determine if the complaint is valid.

B. If the director finds that an unsafe condition exists, the director shall proceed under the provisions
of §§ 10.1-608 and 10.1-609 of the Code of Virginia to render the extant condition safe.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 4.6, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

Part V

Design Requirements

4VAC50-20-240. Design of structures.

A. The owner shall complete all necessary investigations prior to submitting the design report (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures). The design report shall contain those components outlined in 4VAC50-20-70 for construction activities or those outlined in 4VAC50-20-80 for alteration activities. The scope and degree of precision required is a matter of engineering judgment based on the complexities of the site and the hazard potential classification of the proposed structure.

B. Surveys shall be made with sufficient accuracy to locate the proposed construction site and to define the total volume of storage in the impoundment. Locations of center lines and other horizontal and vertical controls shall be shown on a map of the site. The area downstream and upstream from the proposed impounding structure shall be investigated in order to delineate the areas and extent of potential damage in case of failure or backwater due to flooding.

C. The drainage area shall be determined. Present and planned land-use conditions shall be considered in determining the runoff characteristics of the drainage area. The most severe of these conditions shall be included in the design calculations which shall be submitted as part of the design report.

D. The geotechnical engineering investigation shall consist of borings, test pits and other subsurface explorations necessary to adequately define the existing conditions. The investigations shall be performed so as to appropriately define the soil, rock and ground water conditions.

E. All construction materials shall be adequately researched and selected so as to ensure that their as constructed behavior will reasonably conform to design criteria. If on-site materials are to be utilized, they shall be located and determined to be adequate in quantity and quality.
4VAC50-20-250. (Repealed.)

Historical Notes

Derived from VR625-01-00 § 5.2, eff. February 1, 1989; repealed, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-260. Spillway design.

A. Every impounding structure shall have a spillway system with adequate capacity to discharge the design flood without endangering the safety of the impounding structure.

B. Vegetated earth or an unlined emergency spillway may be approved when the applicant demonstrates that it will pass the spillway design flood without jeopardizing the safety of the impounding structure (such as by allowance of overtopping of a structure not designed to permit overtopping). In no case shall impounding structure owners permit the growth of trees and other woody vegetation in the emergency spillway area.

C. Lined emergency spillways shall include design criteria calculations, plans and specifications for suitable energy dissipators and for spillways that include crest control structures, chutes, walls, panel lining, sills, blocks, and miscellaneous details. All joints shall be reasonably water-tight and placed on a foundation capable of sustaining applied loads without undue deformation. Provision shall be made for handling under seepage and uplift pressures from the foundation which might adversely affect the structural integrity and structural stability of the impounding structure.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 5.3, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.
A. It will be assumed that principal spillways and regulating outlets provided for special functions will operate to normal design discharge capabilities during the spillway design flood, provided appropriate analyses show:

1. That control gates and structures are suitably designed to operate reliably under maximum heads for durations likely to be involved and risks of blockage by debris are minimal;

2. That access roads and passages to gate regulating controls would be safely passable by operating personnel under spillway design flood conditions; and

3. That there are no substantial reasons for concluding that outlets would not operate safely to full design capacity during the spillway design flood.

B. If there are reasons to doubt that any of the above basic requirements might not be adequately met under spillway design flood conditions, the "dependable" discharge capabilities of regulating outlets shall be assumed to be less than 100% of design capacities, generally as outlined in the following subsections C through G of this section.

C. Any limitations in safe operating heads, maximum velocities to be permitted through structures or approach channels, or other design limitations shall be observed in establishing "dependable" discharge rating curves to be used in routing the spillway design flood hydrograph through the reservoir.

D. If intakes to regulating outlets are likely to be exposed to significant quantities of floating debris, sediment depositions or ice hazards prior to or during major floods, the dependable discharge capability during the spillway design flood shall be assumed to be zero.

E. If access roads or structural passages to operating towers or controls are likely to be flooded or otherwise unusable during the spillway design flood, the dependable discharge capability of regulating outlets will be assumed to be zero for the periods of time during which such conditions might exist.

F. Any deficiencies in discharge performance likely to result from delays in the operation of gates before attendants could be reasonably expected to reach the control must be taken into account when estimating "dependable" discharge capabilities assumptions in routing the spillway design flood through the impoundment. Reports on design studies shall indicate the allowances made for possible delays in initiating gate operations. Normally, for projects located in small basins, where critical spillway design flood inflows may occur within several hours after intense precipitation, outflows through any regulating outlets that must be opened after the flood begins shall be assumed to be zero for an appropriate period of time subsequent to the beginning of intense rainfall.
G. All gates, valves, conduits and concrete channel outlets shall be designed and constructed to prevent significant erosion or damage to the impounding structure or to the downstream outlet or channel.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 5.4, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

**4VAC50-20-280. Drain requirements.**

All new impounding structures regardless of their hazard potential classification, shall include a device to permit draining of the impoundment within a reasonable period of time as determined by the owner's licensed professional engineer. Existing drains on impounding structures shall be kept operational. When practicable, existing impounding structures shall be retrofitted with devices to permit draining.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 5.5, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

**4VAC50-20-290. Life of the impounding structure.**

Components of the impounding structure, the outlet works, drain system and appurtenances shall be durable and maintained or replaced in keeping with the design and planned life of the impounding structure.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from VR625-01-00 § 5.6, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

**4VAC50-20-300. Additional design requirements.**

A. Flood routings shall start at or above the elevation of the crest of the lowest ungated outlet. Freeboard determination and justification must be addressed by the owner's engineer.
B. All elements of the impounding structure shall conform to sound engineering practice. Safety factors, design standards and design references that are used shall be included with the design report.

C. Inspection devices may be required by the director for use by inspectors, owners or the director in conducting inspections in the interest of structural integrity during and after completion of construction and during the life of the impounding structure.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from VR625-01-00 § 5.7, eff. February 1, 1989; amended, Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-310. Plans and specifications.

The plans and specifications for a proposed impounding structure required in 4VAC50-20-70 for construction activities and in 4VAC50-20-80 for alteration activities shall consist of a detailed engineering design report (Design Report for the Construction or Alteration of Virginia Regulated Impounding Structures) and engineering drawings and specifications, with the following as a minimum:

1. The name of the project; the name of the owner; classification of the impounding structure as set forth in this chapter; designated access to the project and the location with respect to highways, roads, streams and existing impounding structures and impoundments that would affect or be affected by the proposed impounding structure.

2. Cross-sections, plans, profiles, logs of test borings, laboratory and in situ test data, drawings of principal and emergency spillways, impounding structures, outlet works, drain system and appurtenances, and other project components in sufficient detail to indicate clearly the extent and complexity of the work to be performed.

3. Contract drawings should include, but not be limited to, foundation and abutment treatment, stream or river diversion, excavation and material fill processes, phased fill and compaction and drainage devices.

4. The erosion and sediment control plan, as approved by the local government, which minimizes soil erosion and sedimentation during all phases of construction or alteration.

5. Technical specifications, as may be required to describe the materials, performance, and methods of the construction and construction quality control for the project.
4VAC50-20-320. Acceptable design procedures and references.

To ensure consistency of approach, within the major engineering disciplines of hydrology, hydraulics, soils and foundations, structures, and general civil design, criteria and approaches from multiple sources shall not be mixed for developing the design of a given feature or facility without approval of the director. In all cases the owner's engineer shall identify the source of the criteria.

The following are acceptable as design procedures and references:

1. The design procedures, manuals and criteria used by the United States Army Corps of Engineers.
2. The design procedures, manuals and criteria used by the United States Department of Agriculture, Natural Resources Conservation Service.
3. The design procedures, manuals and criteria used by the United States Department of the Interior, Bureau of Reclamation.
4. The design procedures, manuals and criteria used by the United States Department of Commerce, National Weather Service.
5. The design procedures, manuals and criteria used by the United States Federal Energy Regulatory Commission.
6. Other design procedures, manuals and criteria that are accepted as current, sound engineering practices, as approved by the director prior to the design of the impounding structure.
A. Manuals, guidance, and criteria used by the Federal Emergency Management Agency, including the following:


B. Manuals, guidance, and forms provided by the department. Such materials may be located on the department's website at: http://www.dcr.virginia.gov.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

Part VI
Fees

4VAC50-20-340. Authority to establish fees.

Under § 10.1-613.5 of the Code of Virginia, the board is authorized to establish and collect application fees for the administration of the dam safety program, administrative review, certifications, and the repair and maintenance of impounding structures. The fees will be deposited into the Dam Safety, Flood Prevention and Protection Assistance Fund.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-350. Fee submittal procedures.

A. Effective September 26, 2008, fees for all application submittals required pursuant to 4VAC50-20-370 through 4VAC50-20-390 are due prior to issuance of a certificate or permit. No application for an Operation and Maintenance Certificate or a Construction Permit will be acted upon by the board without
full payment of the required fee per § 10.1-613.5 of the Code of Virginia.

B. Fees shall be paid by check, draft or postal money order payable to the Treasurer of Virginia, or submitted electronically (if available), and must be in U.S. currency, except that agencies and institutions of the Commonwealth of Virginia may submit Interagency Transfers for the amount of the fee. All fees shall be sent to the following address (or submitted electronically, if available): Virginia Department of Conservation and Recreation, Division of Finance, Accounts Payable, 203 Governor Street, 4th Floor, Richmond, Virginia 23219.

C. All fee payments shall be accompanied by the following information:

1. Applicant name, address and daytime phone number.

2. The name of the impounding structure, and the impounding structure location.

3. The type of application or report submitted.

4. Whether the submittal is for a new permit or certificate issuance or permit or certificate reissuance.

5. The amount of fee submitted.

6. Impounding structure identification number, if applicable.

D. No permit fees remitted to the department shall be subject to refund except as credits provided for in 4VAC50-20-390 C.

**Statutory Authority**

§ 10.1-605 of the Code of Virginia.

**Historical Notes**

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

**4VAC50-20-360. Fee exemptions.**

Impounding structures owned by Virginia Soil and Water Conservation Districts shall be exempt from all fees associated with this part in accordance with § 10.1-613.5 of the Code of Virginia. There will be no fee assessed for a low hazard impounding structure exempted from fees pursuant to 4VAC50-20-51 or for the decommissioning of an impounding structure.

**Statutory Authority**

§ 10.1-605 of the Code of Virginia.

**Historical Notes**
4VAC50-20-370. Construction Permit application fees.

A. Any application form submitted pursuant to 4VAC50-20-70 for permitting a proposed impounding structure construction after September 26, 2008, shall be accompanied by a payment as determined in subsection B of this section.

B. Fees shall be as follows:
   1. $2,500 for High or Significant Hazard Potential impounding structures.
   2. $1,000 for Low Hazard Potential impounding structures.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.


A. Any application for a six-year Regular Operation and Maintenance Certificate after September 26, 2008, except as otherwise exempted, shall be accompanied by a payment as determined in subsection B of this section.

B. Fees for High, Significant, or Low Hazard Potential impounding structures shall be as follows:
   1. $600 for High Hazard Potential.
   2. $600 for Significant Hazard Potential.
   3. $300 for Low Hazard Potential.

C. Fees for extension of Regular Operation and Maintenance Certificates shall be $250 per year or portion thereof.

Statutory Authority
§ 10.1-605 of the Code of Virginia.

Historical Notes
Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.


A. Fees for issuance of a Conditional Operation and Maintenance Certificate shall be as follows:
1. For a certificate for more than one year but no more than two years: $300.

2. For a certificate for one year or less: $150.

B. The fee for an extension of a Conditional Operation and Maintenance Certificate shall be $250 per year or portion thereof.

C. The board may allow a partial credit towards the Regular Operation and Maintenance Certificate fee if the owner of the impounding structure has completed, to the director's satisfaction, the conditions of the Conditional Certificate prior to its expiration.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.

4VAC50-20-400. Incremental Damage Analysis review fees.

Should the department determine that outside expertise to assist with the review of an incremental damage analysis is necessary, the applicant shall be responsible for the cost of such outside expertise. Such costs shall be agreed upon in advance by the department and the applicant.

Statutory Authority

§ 10.1-605 of the Code of Virginia.

Historical Notes

Derived from Virginia Register Volume 24, Issue 25, eff. September 26, 2008.
NAVIGATING DAM SAFETY RULES IN VIRGINIA

Greg Zamensky, P.E., Black & Veatch Corporation

Introduction

For decades, the probable maximum flood (PMF) and fractions thereof have been the dominant spillway design criterion used by state dam safety agencies for high and significant hazard potential dams throughout the United States. The methodologies used to compute the PMF vary with topography and climate and were last updated in the late 1980s. Regardless, the PMF has always been a theoretical event. As such, the PMF does not have a definable recurrence interval (i.e., 100-year event, 500-year event, etc.), however, some estimates put the recurrence interval of the PMF at between a 100,000 and 1,000,000-year event. The immense size of the PMF and the lack of an understandable return period lead most dam owners and many engineers to question the reasonableness of the criterion.

In Virginia, the use of the PMF led one politically connected dam owner to nearly undermine the entire state dam safety program. Along the way, the dam safety legislation and regulations underwent several iterations of extensive revisions; some laws were clearly positive while others left the dam safety community perplexed. Since then, dam owners as well as engineering consultants have scrambled to stay abreast of the regulatory changes to understand how the regulations affect their dams.

Virginia has maintained a strong dam safety program for over 20 years, beginning with the inception of dam safety legislation in 1989. The Department of Conservation and Recreation, Dam Safety Division (DCR) oversees dam safety in the Commonwealth and administers the applicable regulations. In September 2008, the Virginia Impounding Structure Regulations were revised from top to bottom after several years of debate between regulators, legislators, engineers, and the public. Between September 2008 and April 2009, before the ink was even dry on these revised regulations, several pieces of new legislation were drafted that once again changed the dam safety landscape in Virginia. As of June 2010, the dam safety community in Virginia continues to monitor the situation as regulators struggle to provide updated regulations and guidance documents to clarify the application of these new laws.

In the meantime, dam owners and consultants cautiously try to navigate the obscure regulations and hope that future guidance includes insightful discussion across the industry—discussion that focuses on setting reasonable standards for selection of appropriate spillway design floods.
Regulatory and Legislative Changes

The Virginia Dam Safety Act was originally passed into law under Article 2, Chapter 6, Title 10.1 of the Code of Virginia. The Virginia Impounding Structure Regulations (§4VAC50-20) became effective February 1, 1989. These regulations were recodified in 1997 and reprinted 2004.

Until the September 2008 revisions, no changes to the impounding structure regulations had occurred since the late 1980s except to update the definition of “regulated dams” to conform to the 2001 legislative change in definition (Chapter 92 (SB1166) of the 2001 Virginia Acts of Assembly). Over the decades, the management of dams evolved to include factors that were not considered in the 1980 legislation. For example, the residential and commercial populations near existing dams have increased, which in turn increased public safety concerns. Similarly, engineering and technology and methodologies have advanced over the decades, creating a host of approaches that were unavailable at the time the current law was drafted. Given the evolution of the dams practice and the community issues surrounding existing dams, it was determined that a substantive review of these regulations would be prudent, and that amendments may be necessary.

The significant revisions to the Virginia Dam Safety Act during the 2006 legislative session (Chapter 30 (HB597) of the 2006 Virginia Acts of Assembly) necessitated updates to the regulations to reflect the revised and enhanced powers and authorities. It has also been determined that the administration and implementation of the Dam Safety Program could be improved through regulatory updates and that the intent and procedures embodied within the regulations could be clarified to benefit the regulated community and the public.

A Technical Advisory Committee (TAC) composed of public and private dam owners, regulators, consultants, and contractors was impaneled in 2006 to develop the revised Impounding Structure Regulations. Formation of the TAC was influenced by a politically connected, private dam owner who was faced with costly spillway upgrades necessitated by building downstream that resulted in a change to the hazard potential classification. Although the dam was well maintained, construction of homes downstream, resulted in a high hazard potential classification, requiring that the spillway pass the full PMF versus the previous requirement of about 50 percent of the PMF.

While the TAC and DCR considered changes to the Impounding Structure Regulations, the Virginia legislature focused on protecting dam owners whose dams are located upstream from large, newly constructed communities. Developers’ actions downstream affect dams upstream, often requiring dam owners to undergo costly upgrades to protect newly established downstream populations. In March 2008, the Governor signed House Bill 837 that provided
this protection, to a point. The bill requires dam owners to submit dam break inundation maps to their local jurisdiction’s planning and zoning group. The bill provides localities with the authority to address development in dam break inundation zones. The bill directs developers to assist dam owners with dam upgrades (100 percent of the design cost and 50 percent of the construction cost) that are required as a direct result of the developer’s proposed building in the dam break inundation zone.

After nearly three years, numerous public input periods, and several draft documents, the TAC and DCR produced revised regulations. Released in September 2008, the changes were substantial and affected nearly every regulated dam in the Commonwealth. Some of the more substantial issues affecting dam owners include:

1. Revising the dam hazard potential classification system;
2. Specifying that spillway design requirements are applicable to all state regulated dams;
3. Modifying the spillway design requirements to enhance public safety and reduce subjectivity (eliminate Section 130 exception from previous regulations);
4. Allowing for the potential reduction of the spillway design flood requirement through an incremental damage assessment (IDA) for all qualified dams;
5. Establishing dam break inundation zone mapping requirements;
6. Expanding emergency action plan requirements for High and Significant Hazard Potential dams and emergency preparedness plan requirements for Low Hazard Potential dams;
7. Establishing permit application fees for the administration of the Dam Safety Program that will create a stream of revenue sufficient to support an additional dam safety engineer;
8. Removing the forms that are incorporated by reference and move reporting standards into the regulations;
9. Creating new definitions or modifying current definitions;
10. Reorganizing, clarifying, and expanding sections related to permitting procedures; and
11. Updating sections related to inspections, enforcement, and unsafe conditions.

Most thought these changes were wholly appropriate; however, they did not relieve the aforementioned private dam owner of his responsibility to upgrade their spillway. Under the revised regulations, the private dam owner remained obligated to safely pass the full PMF. Further, the prospect of an IDA resulting in a lowered spillway design flood was negligible given the location of the homes downstream. So, once again, changes to the dam safety laws were sought.
Not surprisingly, the dam safety landscape in Virginia changed again in January 2010 when two new dam safety bills were introduced to the Virginia legislature: Senate Bill 276 and House Bill 438. The original version of Senate Bill 276 would have allowed dam owners to ignore safety concerns issued by DCR until the Commonwealth was able to fund any and all repairs needed to satisfy the dam safety regulations. Inexplicably, Senate Bill 276 passed both the Virginia House and Senate and was sent to the Governor’s office for his signature. The original text was as follows:

“Until such time as adequate funding is available through the Dam Safety….Fund….., the [Board] shall continue to issue conditional operation and maintenance certificates for any existing impoundment that does not comply with dam safety regulations so long as the owner of the impoundment has adopted a dam safety emergency action plan…..”, Senate Bill 276, January 27, 2010

As written, the law would have completely undermined dam safety in Virginia. Justifiably, the Governor’s office received intense pressure to reject the bill, including pleas from the American Society of Civil Engineers and the Association for State Dam Safety Officials. The Governor elected to send the bill back to the House for revision based on these and other comments. The amended Senate Bill 276 and House Bill 438, as signed by the Governor, provide potentially significant relief from the 2008 regulations for some dam owners. In summary, these bills provide the following major elements:

**Senate Bill 276** – The maximum rainfall event to be used for evaluating all impounding structures and spillways built or permitted prior to July 1, 2010, shall be 90 percent of the probable maximum precipitation (PMP), reduced from 100 percent of the PMP. The maximum precipitation can be further reduced (to 60 percent of the PMP) for some qualified structures, if the owner can satisfy eight provisions including having a DCR-accepted EAP that is tested; daily inspections of the impounding structure; and insurance in an amount that will substantially cover property losses due to a dam failure. It is the insurance provision of the bill that the vast majority of dam owners can not satisfy.

The last line of the one page bill indicates “that this act is in force from its passage”. As a result, DCR did not have the opportunity to interpret the legislation and modify the Impounding Structure Regulations accordingly. Therefore, interested dam owners must approach not just their Regional Dam Safety Engineer from DCR, but others including the Dam Safety Manager and the DCR Director to discuss their opportunity to apply the bill. As fate would have it, the aforementioned private dam owner can satisfy these provisions and, therefore, can take advantage of the relief provided.
**House Bill 438** – The minimum spillway design flood for high hazard potential dams as identified through an IDA is reduced from 0.50PMF to the 100-year storm event. Limited-use or private roadways with low traffic volume shall be considered when determining the hazard potential classification of an impounding structure.

In January 2010, DCR issued a series of guidance documents to help owners and engineers interpret the rule changes including Dam Break Inundation Zone and Incremental Damage Analysis and Mapping Procedure; Roadways on or Below Impounding Structures; Special Low Hazard Impounding Structure Requirements; and Impounding Structure Hazard Potential Classifications. Given a date of January 14, 2010, these documents do not yet consider the implications of Senate Bill 276 or House Bill 438. Although these “Working Drafts” are available on DCR’s website, they are not yet approved by the Virginia Soil and Water Conservation Board. Revised guidance documents are currently being reviewed by DCR. Release of the guidance documents is expected to occur sometime in the summer of 2010.

**Dam Owner's Perspectives**

Every owner in Virginia with a regulated impounding structure is affected by the aforementioned legislative and regulatory changes. The following section describes three cases studies of owners and their situation relative to the changing dam safety landscape. Considering none of these owners have fully navigated the process, the owner and dam names will be kept anonymous.

**DAM A**

Dam A and the impoundment are owned and operated by a city’s utilities department as a surface water supply source. DCR classified Dam A as Class II structure, or having a significant hazard potential classification. Dam A, built in 1960, is a mass concrete structure with a central spillway capable of passing about 25 percent of the PMF before overtopping the remainder of the dam. The dam is well maintained and, as a result of the Section 130 Exception in the older dam safety regulations, the city held a Regular Operation & Maintenance (O&M) Certificate that expired in 2009. In late 2008, the city began planning for renewal of their O&M Certificate and contracted Black & Veatch to provide a comprehensive safety evaluation of the impounding structure that included hydrologic modeling, hydraulic modeling, stability evaluation, hazard classification, and foundation scour analysis.

The city was provided a Regular Certificate in 2003 through the Section 130 Exception of the dam safety regulations even though the spillway capacity was considerably less than the allowed range for a Class II structure (e.g., 0.50PMF to PMF). The revised regulations promulgated in 2008 removed the Section 130 Exception. Therefore, the city recognized that their next certificate renewal submission would not only require documentation demonstrating
a Significant Hazard Potential classification, but would also require justification for a lesser spillway capacity than required (e.g., an IDA).

Black & Veatch studies revealed that Dam A should be classified as a high hazard potential structure with more than 20 homes within the dam break inundation limits. Stability analyses indicated the mass concrete dam was stable even under the PMF loading condition. However, foundation scour evaluations revealed an erodible zone at the dam foundation if the dam were overtopped. Based on hydrologic modeling, precipitation in excess of the 500-year storm event is necessary to create sufficient overtopping to cause potential foundation scour. Nonetheless, relatively minor upgrades were needed to protect the foundation materials from potential scour to satisfy dam safety requirements.

The city accepted the study’s conclusions and submitted a certificate renewal package in accordance with the 2008 dam safety regulations with provisions for installing the upgrades in the near future. Considering the new regulations and legislative changes, the city’s choices to navigate the dam safety rules included:

**Table 1: Dam A - City Regulatory Decisions**

<table>
<thead>
<tr>
<th>Choice Presented to the City</th>
<th>Source</th>
<th>City’s Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazard potential classification determination. Hazard classification process not clearly defined in regulations.</td>
<td>Draft guidance for hazard potential classification, January 14, 2010 (not available at the time). Dam owners partially protected from downstream construction changing the SDF (House Bill 837, 2008)</td>
<td>Due to the potential for additional building downstream, the city chose to rehabilitate the dam as a High Hazard structure to avoid any future changes.</td>
</tr>
<tr>
<td>Perform IDA to potentially reduce the SDF from the PMF to as low as the 0.50PMF</td>
<td>IDA permitted by the 2008 regulations (4VAC50-20-52)</td>
<td>Based on review of the PMF dam break inundation maps, the city elected to not pursue an IDA.</td>
</tr>
<tr>
<td>Perform IDA to potentially reduce the SDF from the PMF to as low as the 100-year storm</td>
<td>SDF as low as the 100-year storm for high hazard structure by House Bill 438</td>
<td>Based on review of the PMF dam break inundation maps, the city elected to not pursue an IDA.</td>
</tr>
<tr>
<td>Reduce the extent of the upgrade at the dam from the PMF to 90 percent of the PMP</td>
<td>Reduced maximum storm for structures permitted before July 1, 2010 by Senate Bill 276</td>
<td>The city is considering, but the reduction is small</td>
</tr>
<tr>
<td>Reduce the extent of the upgrade at the dam from the PMF to 60 percent of the PMP</td>
<td>Reduced SDF allowed if other provisions are met by Senate Bill 276</td>
<td>The city is not willing to insure downstream property owners</td>
</tr>
</tbody>
</table>
DAM B

Dam B and the impoundment are owned and operated by a private home owners association as a recreational facility. DCR classified Dam B as a Class I impounding structure, or having a high hazard potential based on the 2008 regulations. Built in 1971, Dam B is a 100-foot-high zoned embankment dam with an off-channel spillway. The spillway is capable of passing about 20 percent of the PMF before dam overtopping begins. Considering the default SDF is the PMF (as defined in the 2004 regulations and the 2008 regulations), DCR issued the owner a Conditional O&M Certificate based on an inadequate spillway.

Due to very limited funding and continuous attrition of their board members, the owner struggled to develop or execute a definitive plan to address the spillway inadequacy. Consulting engineering firms had been working with the owner regarding the dam and spillway since 2006. Cognizant of the owner’s financial situation, DCR provided several extensions to the Conditional Certificate and the 2008 regulation changes provided the owner even more time to develop a way forward.

In 2009, the owner engaged Black & Veatch to evaluate spillway upgrade alternatives to manage the PMF and satisfy dam safety regulations. In November 2009, the owner selected their preferred option; in January 2010, with a wary eye to the proposed legislative changes, Black & Veatch began final design. In April 2010, Senate Bill 276 was signed by the Governor causing the owner and Black & Veatch to mutually stop work to assess the applicability of the bill’s provisions. After several discussions, DCR told the owner that they could apply for the large reduction in SDF described in Senate Bill 276. Although the owner has received no official paperwork from DCR, all correspondence with DCR indicate acceptance of the application. Based on these correspondences, in May 2010, the owner directed Black & Veatch to redesign the preferred alternative to meet the provisions of Senate Bill 276.
Table 2: Dam B - Owner Regulatory Decisions

<table>
<thead>
<tr>
<th>Choice Presented to the Owner</th>
<th>Source</th>
<th>Owner's Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform IDA to potentially reduce the SDF from the PMF to as low as the 0.50PMF</td>
<td>IDA permitted by the 2008 regulations (4VAC50-20-52)</td>
<td>The owner elected to fund a preliminary IDA that revealed reduction of the SDF was not likely due to location of downstream occupied structures.</td>
</tr>
<tr>
<td>Perform IDA to potentially reduce the SDF from the PMF to as low as the 100-year storm</td>
<td>SDF as low as the 100-year storm for high hazard structure by House Bill 438</td>
<td>Preliminary IDA (above) revealed SDF reduction not likely.</td>
</tr>
<tr>
<td>Reduce the extent of the upgrade at the dam from the PMF to 90 percent of the PMP</td>
<td>Reduced maximum storm for structures permitted before July 1, 2010 by Senate Bill 276</td>
<td>The owner is automatically granted this reduction and accepts it.</td>
</tr>
<tr>
<td>Reduce the extent of the upgrade at the dam from the PMF to 60 percent of the PMP</td>
<td>Reduced SDF allowed if other provisions are met by Senate Bill 276</td>
<td>The owner elected to take the opportunity to potentially reduce the size (i.e., cost) of the spillway upgrades.</td>
</tr>
</tbody>
</table>

**DAM C**

Dam C is owned and operated by a city’s public works department because a major roadway passes across the dam’s crest. The reservoir is owned by a private institution. DCR classified Dam C as Class II structure, or having a significant hazard potential classification. Dam C, built in 1934, is a zoned embankment, about 35 feet high, with an off-channel spillway capable of passing about 10 percent of the PMF before overtopping of the dam. Even with an inadequate spillway according to the regulations, the city held a Regular O&M Certificate that expired in 2010 as a result of the Section 130 Exception from the 2004 dam safety regulations. An O&M Certificate renewal application is due to DCR by the end of 2010.

The city recognized that the 2008 regulations require a certificate renewal submission to include background data and computations supporting a reduced SDF that they did not have. In addition, the submission requires verification of the hazard potential classification. Due to downstream construction over the past 20 years, the city suspected that Dam C should be classified as a high hazard potential structure rather than a significant hazard structure. In 2009, the city began planning for renewal of their O&M Certificate by contracting Black &
Veatch to provide a safety evaluation of the impounding structure that included hydrologic modeling, hydraulic modeling, hazard classification, and rehabilitation alternatives development, if needed.

Black & Veatch completed the studies confirming Dam C as a high hazard potential structure with a spillway capacity significantly less than that required—10 percent of the PMF versus 50 to 100 percent of the PMF. An IDA requested by the city re-established the SDF to be the PMF; no reduction in the SDF was possible. Therefore, Black & Veatch prepared dam and spillway upgrade alternatives including embankment armoring, spillway expansion, and decommissioning.

By the end of 2010, the city will submit an O&M Certificate renewal package that describes the dam’s issues, most notably an inadequate spillway, and their planned way forward in addressing the issues.

**Table 3: Dam C - City Regulatory Decisions**

<table>
<thead>
<tr>
<th>Choice Presented to the City</th>
<th>Source</th>
<th>City’s Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform IDA to potentially reduce the SDF from the PMF to as low as the 0.50PMF</td>
<td>IDA permitted by the 2008 regulations (4VAC50-20-52)</td>
<td>The city elected to fund a preliminary IDA that revealed reduction of the SDF was not likely due to location of downstream occupied structures.</td>
</tr>
<tr>
<td>Perform IDA to potentially reduce the SDF from the PMF to as low as the 100-year storm</td>
<td>SDF as low as the 100-year storm for high hazard structure by House Bill 438</td>
<td>Preliminary IDA (above) revealed SDF reduction not likely.</td>
</tr>
<tr>
<td>Reduce the extent of the upgrade at the dam from the PMF to 90 percent of the PMP</td>
<td>Reduced maximum storm for structures permitted before July 1, 2010 by Senate Bill 276</td>
<td>The city is automatically granted this reduction and accepts it, although the reduction provides only minor relief.</td>
</tr>
<tr>
<td>Reduce the extent of the upgrade at the dam from the PMF to 60 percent of the PMP</td>
<td>Reduced SDF allowed if other provisions are met by Senate Bill 276</td>
<td>The city is not willing to insure downstream property owners.</td>
</tr>
</tbody>
</table>
Conclusions

Through the influence of one local, politically connected, private dam owner, the dam safety rules in Virginia changed significantly in September 2008 and have continued to evolve since that point. In fact, the landscape is changing so rapidly that DCR representatives have been unable to compose guidance documents that provide their interpretation of the new rules.

Dam owners are left to wander through the collection of regulations, legislation, and draft guidance documents to find the optimal way forward considering their specific situation. Some dam owners are waiting for the dust to settle regarding DCR's interpretation of the new rules. Others are forging ahead with decisions trusting that the rules won’t change again.

When you step back through the legislative changes and regulatory changes over the past five years and the reasonable or unreasonable justifications of the single dam owner, you find the core issue – the PMF. The PMF is a standard long used by the dam safety industry, but rarely brought to the forefront of political discourse.

Faced with shrinking budgets, many dam owners need to make difficult decisions and prioritize their expenditures based on public safety considerations. Some dam owners are questioning the reasonableness of regulations that require protection against the 100,000-year storm event (PMF) and only a 2,500-year earthquake event. The debate will continue and amplify in the upcoming years as states are faced with dam owners unable to pay for large spillway expansions. Public policy meets public safety.

References


Chapter 491 of the Code of Virginia as amended by House Bill 837, March 2008

Chapter 249 of the Code of Virginia as amended by Senate Bill 276, April 2010

Chapter 270 of the Code of Virginia as amended by House Bill 438, April 2010

