



ENERGY AND ENVIRONMENT CABINET
Department for Environmental Protection
DIVISION OF WATER

Kentucky Dam Design Requirements

DEP 4_030_1

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Design requirements for dams located in the Commonwealth of Kentucky shall be based on the hazard classification of the dam as established in 401 KAR 4:030. Each of the following stated criteria indicates whether the limit is a maximum or minimum limit and is not to be construed as being satisfactory design criteria for or at all sites. Professional judgment, best accepted practice, state laws and administrative regulations, investigations, and/or analyses may dictate more conservative criteria.

This document includes the following Sections:

Section 1. Hydrologic & Hydraulic Report

Section 2. Geotechnical Exploration and Stability Analysis Report

Section 2.1 Geotechnical and Stability Requirements

Section 2.2. Slope Stability.

Section 2.3. Seismic Design Requirements.

Section 3. Earthen Embankment Requirements

Section 4. Principal Spillway Requirements

Section 5. Auxiliary Spillway Requirements

Section 6. Dam Hazard Classification Report

Section 7. Emergency Action Plan

Section 1. Hydrologic & Hydraulic Report

The Hydrologic & Hydraulic Report must include all hydraulic capacity requirements and information included in this section.

Spillways (see also: Sections 6 and 7) A dam must have sufficient spillway capacity to store or

pass the design storm based on the hazard classification of the structure as established in 401 KAR 4:030.

1. A reservoir routing analysis for the reservoir and spillways must include:

- a. Inflow hydrographs;
- b. Hydrologic parameters;
- c. Stage storage curves; and
- d. Stage discharge curves and routings. Input and output results must be clearly labeled and identified.

2. The required design storm must be calculated using the minimum hydrologic criteria for development of each hydrograph as established in this section.

a. Auxiliary Spillway Hydrograph:

High Hazard $P_C = 0.38\text{PMP}$

Significant Hazard $P_B = 0.26\text{PMP}$

Low Hazard $P_A = P_{100}$

b. Freeboard Hydrograph:

High Hazard $P_C = \text{PMP}$

Significant Hazard $P_B = 0.5\text{PMP}$

Low Hazard $P_A = 0.25\text{PMP}$

Where:

P is the 6-hour design rainfall;

P_{100} is the 6-hour, 100-year precipitation as established by the National Weather Service;

NOAA Atlas 14-Point Precipitation Frequency Estimates

(https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html); and

PMP is the 6-hour Probable Maximum Precipitation as established in Table A.

TABLE A - PMP 6-hour Probable Maximum Precipitation By County

<u>ADAIR</u>	<u>28.7</u>	<u>GRANT</u>	<u>27.7</u>	<u>MCCREARY</u>	<u>28.9</u>
<u>ALLEN</u>	<u>28.9</u>	<u>GRAVES</u>	<u>28.9</u>	<u>MEADE</u>	<u>28.2</u>
<u>ANDERSON</u>	<u>28.1</u>	<u>GRAYSON</u>	<u>28.5</u>	<u>MENIFEE</u>	<u>28.2</u>
<u>BALLARD</u>	<u>28.7</u>	<u>GREEN</u>	<u>28.6</u>	<u>MERCER</u>	<u>28.3</u>
<u>BARREN</u>	<u>28.8</u>	<u>GREENUP</u>	<u>27.7</u>	<u>METCALFE</u>	<u>28.8</u>
<u>BATH</u>	<u>28</u>	<u>HANCOCK</u>	<u>28.2</u>	<u>MONROE</u>	<u>28.9</u>
<u>BELL</u>	<u>28.9</u>	<u>HARDIN</u>	<u>28.3</u>	<u>MONGOMERY</u>	<u>28.1</u>
<u>BOONE</u>	<u>27.5</u>	<u>HARLAN</u>	<u>28.8</u>	<u>MORGAN</u>	<u>28.2</u>
<u>BOURBON</u>	<u>28</u>	<u>HARRISON</u>	<u>27.9</u>	<u>MUHLENBERG</u>	<u>28.6</u>
<u>BOYD</u>	<u>27.9</u>	<u>HART</u>	<u>28.6</u>	<u>NELSON</u>	<u>28.3</u>
<u>BOYLE</u>	<u>28.4</u>	<u>HENDERSON</u>	<u>28.3</u>	<u>NICHOLAS</u>	<u>27.9</u>
<u>BRACKEN</u>	<u>27.7</u>	<u>HENRY</u>	<u>27.9</u>	<u>OHIO</u>	<u>28.5</u>
<u>BREATHITT</u>	<u>28.4</u>	<u>HICKMAN</u>	<u>29</u>	<u>OLDHAM</u>	<u>27.9</u>
<u>BRECKINRIDGE</u>	<u>28.3</u>	<u>HOPKINS</u>	<u>28.6</u>	<u>OWEN</u>	<u>27.8</u>
<u>BULLITT</u>	<u>28.2</u>	<u>JACKSON</u>	<u>28.5</u>	<u>OWSLEY</u>	<u>28.5</u>
<u>BUTLER</u>	<u>28.7</u>	<u>JEFFERSON</u>	<u>28</u>	<u>PENDLETON</u>	<u>27.7</u>
<u>CALDWELL</u>	<u>28.7</u>	<u>JESSAMINE</u>	<u>28.2</u>	<u>PERRY</u>	<u>28.6</u>
<u>CALLOWAY</u>	<u>29</u>	<u>JOHNSON</u>	<u>28.2</u>	<u>PIKE</u>	<u>28.4</u>
<u>CAMPBELL</u>	<u>27.5</u>	<u>KENTON</u>	<u>27.5</u>	<u>POWELL</u>	<u>28.2</u>
<u>CARLISLE</u>	<u>28.9</u>	<u>KNOTT</u>	<u>28.5</u>	<u>PULASKI</u>	<u>28.7</u>
<u>CARROLL</u>	<u>27.7</u>	<u>KNOX</u>	<u>28.8</u>	<u>ROBERTSON</u>	<u>27.8</u>
<u>CARTER</u>	<u>27.9</u>	<u>LARUE</u>	<u>28.4</u>	<u>ROCKCASTLE</u>	<u>28.5</u>
<u>CASEY</u>	<u>28.6</u>	<u>LAUREL</u>	<u>28.7</u>	<u>ROWAN</u>	<u>28</u>
<u>CHRISTIAN</u>	<u>28.9</u>	<u>LAWRENCE</u>	<u>28.1</u>	<u>RUSSELL</u>	<u>28.8</u>
<u>CLARK</u>	<u>28.1</u>	<u>LEE</u>	<u>28.4</u>	<u>SCOTT</u>	<u>27.9</u>
<u>CLAY</u>	<u>28.6</u>	<u>LESLIE</u>	<u>28.7</u>	<u>SHELBY</u>	<u>28</u>
<u>CLINTON</u>	<u>28.9</u>	<u>LETCHER</u>	<u>28.6</u>	<u>SIMPSON</u>	<u>28.9</u>
<u>CRITTENDEN</u>	<u>28.6</u>	<u>LEWIS</u>	<u>27.8</u>	<u>SPENCER</u>	<u>28.1</u>
<u>CUMBERLAND</u>	<u>28.9</u>	<u>LINCOLN</u>	<u>28.5</u>	<u>TAYLOR</u>	<u>28.5</u>
<u>DAVIESS</u>	<u>28.3</u>	<u>LIVINGTON</u>	<u>28.6</u>	<u>TODD</u>	<u>28.9</u>
<u>EDMONSON</u>	<u>28.7</u>	<u>LOGAN</u>	<u>28.9</u>	<u>TRIGG</u>	<u>28.9</u>
<u>ELLIOTT</u>	<u>28</u>	<u>LYON</u>	<u>28.8</u>	<u>TRIMBLE</u>	<u>27.8</u>
<u>ESTILL</u>	<u>28.3</u>	<u>MADISON</u>	<u>28.3</u>	<u>UNION</u>	<u>28.4</u>
<u>FAYETTE</u>	<u>28.1</u>	<u>MAGOFFIN</u>	<u>28.3</u>	<u>WARREN</u>	<u>28.8</u>
<u>FLEMING</u>	<u>27.9</u>	<u>MARION</u>	<u>28.4</u>	<u>WASHINGTON</u>	<u>28.3</u>
<u>FLOYD</u>	<u>28.4</u>	<u>MARSHALL</u>	<u>28.8</u>	<u>WAYNE</u>	<u>28.9</u>
<u>FRANKLIN</u>	<u>28</u>	<u>MARTIN</u>	<u>28.2</u>	<u>WEBSTER</u>	<u>28.5</u>
<u>FULTON</u>	<u>29</u>	<u>MASON</u>	<u>27.7</u>	<u>WHITLEY</u>	<u>28.9</u>
<u>GALLATIN</u>	<u>27.7</u>	<u>MCCLEAN</u>	<u>28.5</u>	<u>WOLFE</u>	<u>28.3</u>
<u>GARRARD</u>	<u>28.3</u>	<u>MCCRACKEN</u>	<u>28.7</u>	<u>WOODFORD</u>	<u>28.1</u>

(Source: National Oceanic and Atmospheric Administration Hydrometeorological Report No. 51, June 1978)

3. Rainfall reduction must be determined by area-point ratios for areal adjustment of rainfall amount for the watershed established in Table B.

Table B - Rainfall Reduction Area-Point Ratios

<u>Area</u> <u>(square</u> <u>miles)</u>	<u>Area/point</u> <u>ratio for 1</u> <u>day</u>	<u>Area/point</u> <u>ratio for 10</u> <u>days</u>	<u>Area</u> <u>(square</u> <u>miles)</u>	<u>Area/point</u> <u>ratio for 1</u> <u>day</u>	<u>Area/point</u> <u>ratio for 10</u> <u>days</u>
<u>10 or less</u>	<u>1.000</u>	<u>1.000</u>	<u>80</u>	<u>0.937</u>	<u>0.968</u>
<u>15</u>	<u>.978</u>	<u>.991</u>	<u>100</u>	<u>.932</u>	<u>.966</u>
<u>20</u>	<u>.969</u>	<u>.986</u>	<u>120</u>	<u>.928</u>	<u>.964</u>
<u>25</u>	<u>.964</u>	<u>.983</u>	<u>140</u>	<u>.925</u>	<u>.962</u>
<u>30</u>	<u>.960</u>	<u>.981</u>	<u>160</u>	<u>.922</u>	<u>.961</u>
<u>35</u>	<u>.957</u>	<u>.979</u>	<u>180</u>	<u>.920</u>	<u>.960</u>
<u>40</u>	<u>.953</u>	<u>.977</u>	<u>200</u>	<u>.918</u>	<u>.959</u>
<u>50</u>	<u>.948</u>	<u>.974</u>	<u>250</u>	<u>.914</u>	<u>.957</u>
<u>60</u>	<u>.944</u>	<u>.972</u>	<u>300</u>	<u>.911</u>	<u>.956</u>

(Source: Natural Resources Conservation Service (NRCS) Earth Dams and Reservoirs TR-60, July 2005)

4. The inflow design flood must determine the spillway capacity established in this section.

5. Structures in Series: Dams in a series arrangement must be designed to safely handle the discharge from the entire watershed above the structure with no consideration of the discharge attenuation of upper structures. High and Significant Hazard Dams in series that are newly constructed must also be designed to safely contain or pass calculated breach flows of upper structures without overtopping.

6. All hydrologic routings specified in this section shall, at a minimum, be conducted under

Antecedent Moisture Condition II.

Section 2. Geotechnical Exploration and Stability Analysis Report

Section 2.1 Geotechnical and Stability Requirements

A geotechnical investigation is required for dams classified High Hazard or Significant Hazard for a new dam, modification to an existing dam, or an existing dam exhibiting structural instability. It must be performed under the direction of a qualified, licensed geotechnical engineer as established in KRS 151.293(10) and include all information in this section.

(a) A geotechnical investigation must include:

1. A geotechnical evaluation of material properties in a dam and its appurtenances.
2. A geological assessment of a dam and reservoir site must address:
 - a. Regional geologic setting;
 - b. Local and site geology;
 - c. Geologic suitability of the dam foundation and reservoir area;
 - d. Slope stability and seepage potential of the reservoir, rim, and abutment areas;
 - e. Seismic history and potential for seismic activity; and
 - f. Other geological hazards posed by the site or proposed construction.

(b). A foundation investigation for a dam classified High Hazard or Significant Hazard must include:

1. Drilling to a depth of one and one-half (1.5) times the height of the dam unless bedrock is encountered or at least ten (10) feet into the foundation bedrock;
2. Logs of borings and test pits that must include:
 - a. A detailed, written description of each sample and stratum encountered;
 - b. Observations of the drilling action;
 - c. Drilling and sampling methods; and

d. Any other observations necessary to develop a detailed understanding of subsurface conditions;

3. Standard penetration or other field density tests;
4. Field and laboratory classification of soils;
5. Measurement of the water level in each drilled hole;
6. In-situ permeability tests;
7. Gradation testing of foundation materials, including the location of proposed drains;
8. A determination of liquefaction potential; and
9. A determination of whether clay-type foundation materials exhibit residual strength properties.

(c) Documentation of suitability of proposed borrow materials or other material sources to be used in construction of a new dam or modification to an existing dam that is classified High Hazard or Significant Hazard must include:

1. Standard index tests and soil classification of all materials;
2. Compressibility tests of soils;
3. Consolidation tests of soils;
4. Permeability of placed materials;
5. Shear strength or dynamic shear strength testing of natural and placed materials;
6. Proctor Compaction tests; and
7. Identification of potentially dispersive clays.

Section 2.2. Slope Stability

(a) Embankment loading conditions under a long-term steady-state condition shall assume the:

1. Phreatic line originating at the elevation of the auxiliary spillway crest for an embankment dam with one or more auxiliary spillways; and
2. Phreatic line originating at maximum design pool elevation for an embankment dam

without an auxiliary spillway.

(b) Factor of Safety requirements established in this section shall apply to upstream and downstream slopes of an embankment. Slope stability analysis must demonstrate that the embankment design achieves a:

1. Factor of Safety of 1.5 for long-term steady state;
2. Factor of Safety of 1.3 for end of construction;
3. Factor of Safety of 1.2 for upstream slope rapid drawdown; and
4. Factor of Safety of 1.0 for an earthquake under steady-state seepage conditions.

Section 2.3. Seismic Design Requirements

Seismic stability must be evaluated for all concrete dams and High and Significant Hazard embankment dams. The level of analysis required must be commensurate with the known and anticipated site conditions and the level of effort given to developing input parameters. In general, analyses should start at a screening level and progress to more detailed analyses only when necessary.

Seismic stability analyses shall be based on the principles provided in Earthquake Analyses and Design of Dams (FEMA-65, Federal Guidelines for Dam Safety, FEMA, 2005) or Earthquake Design and Evaluation for Civil Works Projects (Engineering Regulation 1110-2-1806, U.S. Army Corps of Engineers, 2016).

Section 3. Earthen Embankment Requirements

(a) Freeboard. Earth embankments must be high enough to prevent overtopping during the required design storm and must incorporate the following freeboard requirements:

1. New High hazard dams shall be constructed with a minimum three (3) feet of freeboard above the maximum water surface elevation attained during the design storm.

2. Existing High hazard dams that are to be modified or repaired shall be constructed with a minimum one (1) foot of freeboard above the maximum water surface elevation attained during the design storm.

3. Significant hazard dams that are to be newly constructed, modified, or repaired shall be constructed with a minimum one (1) foot of freeboard above the maximum water surface elevation attained during the design storm.

(b) Crest width. The minimum crest width shall be equal to $(H+35)/5$. Where: H = Height of dam

(c) Side slopes.

1. Dams that are to be newly constructed shall have a maximum horizontal to vertical side slope ratio of three (3) feet to one (1) foot.

2. Dams that are to be modified or repaired shall have side slope ratios designed to meet the slope stability requirements as directed by Section 2.2, but in no case shall be steeper than two (2) feet to one (1) foot.

(d) Wave erosion protection. Protection against wave erosion by riprap or other structural measures must be provided for dams where vegetation will not provide effective control and dams with fluctuating normal water levels. Protection shall extend from the lowest drawdown elevation that presents an erosion hazard up to one (1) foot above the crest of the auxiliary spillway or top of dam.

(e) Construction materials.

1. Embankments must be constructed of earthen material that is free from roots, brush, organic matter, construction waste, and other debris that could affect the integrity of the completed structure.

2. Construction material must be tested for density, shear strength, liquid and plastic limits,

and optimum moisture content to confirm conformance with the approved design specifications and geotechnical requirements specified in section 2.c.

3. The source of construction materials and available quantities must be identified.
4. Sampling of construction materials must demonstrate consistent quality and soil characteristics.

(f) Seepage and piping control.

1. Seepage analysis must be performed for High and Significant hazard dams. The analysis must include quantification of the anticipated seepage beneath and around the dam. Seepage through the abutments and foundation must be minimized through adequate treatment. Foundation and abutment seepage must be controlled through filtered exits to prevent piping and internal erosion.
2. An internal drainage system must be designed and installed to:
 - a. Collect, filter, and control seepage through the embankment;
 - b. Reduce the elevation of the phreatic line;
 - c. Reduce the potential for internal erosion; and
 - d. Safely route seepage out of the embankment for measurement, as needed, and discharge.
3. A drain outlet must be:
 - a. Visible and unsubmerged under normal operating conditions,
 - b. Unobstructed;
 - c. Able to discharge freely in a location where flow rates can be measured, such as galleries, manholes, vaults, or headwalls; and
 - d. Protected with an animal guard when conduits are utilized.
4. Drainage conduits must be inspected for damage during fill placement and immediately after construction to ensure proper functionality and conformance to approved design requirements.

(g) Drawdown system.

1. All regulated dams must be constructed with a drawdown system.
2. The design engineer shall determine the required discharge capacity of the drawdown facility based on consideration of the reservoir characteristics and operational needs of the facility.
3. The drawdown facility shall be designed to pass water through the structure in sufficient quantity to satisfy the needs of downstream users, lower pool elevation for maintenance and operational requirements and empty the reservoir; and
4. The drawdown facility must be located on the upstream side of the dam and must preclude any pressurized conduits within the dam under normal operating conditions.

(h) Erosion and surface drainage.

1. Surface drainage control devices including vegetated slopes, benches, groin ditches, and collection channels must be installed to protect the dam and its appurtenances from the effects of erosion.
2. Riprap and other measures that prevent erosion must be installed.
3. A surface drainage control device must be designed to exit beyond the downstream toe of an embankment in a natural drain-way capable of carrying the design flow without excessive erosion.
4. A hydraulic structure must be designed to control the velocity of water to prevent erosion.
5. Earthen, vegetated, and rip rap lined channels are prohibited on the embankment structure and must be constructed in natural ground away from the embankment.

(i) Foundation preparation. The foundation of an embankment must be prepared for construction by clearing all organic and other unacceptable material, and construction of a foundation cutoff into rock as specified by the design engineer.

(j) Utilities.

1. Under embankments. Pipelines, cables, and conduits located within the footprint of an embankment foundation must be relocated outside of the embankment footprint.
2. Within embankments. Pipelines, cables, and conduits located within the embankment structure are prohibited, unless the proposed line is encased in concrete or otherwise treated to be made absolutely watertight against leakage out of the line for the entire distance through which the conduit being enclosed is within the embankment. Utilities lines covered under this section shall be installed parallel to the axis of the crest and above normal pool elevation only and shall be approved by the cabinet in writing.

Section 4. Principal Spillway Requirements (see also: Sections 1 & 5)

- (a) The inflow design flood shall determine the spillway capacity.
- (b) A dam designed with only an open channel spillway, or with an auxiliary spillway and a principal spillway together, must be capable of discharging eighty (80) percent of the maximum volume of the retarding storage within ten (10) days or less.
- (c) A dam designed with only a conduit principal spillway must be capable of:
1. Storing the volume equivalent to at least the freeboard design storm plus required freeboard; and
 2. Discharging eighty (80) percent of the maximum volume of the retarding storage within ten (10) days or less.
- (d) An open channel shall be designed so that water will not flow at critical depth outside of the control section. In channels of varying slope or cross-section where non-uniform flow occurs, the transition through critical flow shall be as rapid as possible.

(e) An open channel spillway must be analyzed for flow depth, velocity, non-uniform flow conditions, super-elevation, and hydraulic jumps. A stage discharge rating must be developed based on the open channel spillway analysis.

(f) All component parts of a principal spillway shall be equally durable except for gates, trash racks, and other easily replaceable parts.

(g) Trash racks shall be installed to protect a spillway from becoming clogged under any conditions.

(h) Anti-seep collars shall not be used in embankment dams.

(i) Conduits.

1. A conduit must adhere to manufacturer specifications for manufactured products.
2. A conduit beneath an earth embankment must:
 - a. Support external loads required by the manufactured specifications to meet safety standards;
 - b. Withstand internal hydraulic pressure without leakage under full external load and settlement; and
 - c. Convey water at the design velocity without damage to the interior surface of the conduit.
3. A spillway conduit beneath an embankment must be made of:
 - a. Reinforced concrete pressure pipe;
 - b. Cast-in-place reinforced concrete; or
 - c. Ductile iron pipe with full concrete encasement with either cathodic protection or a coating system to prevent corrosion.
4. Principal spillway conduits proposed to be newly constructed or modified must have a

minimum diameter of thirty (30) inches.

5. All conduit principal spillways must be provided with concrete cradles or full concrete encasement to ensure proper fill compaction.

6. A conduit shall be in straight alignment. All changes in flow direction shall be provided with thrust restraint to eliminate movement. Variation from straight alignment when required by the site specific design must be made by:

- a. Watertight angle changes at joints; or
- b. Elbows that have a radius greater than or equal to the diameter or width of the

conduit.

7. A drop inlet conduit shall be installed with enough slope to ensure free drainage to the outlet of all parts of the conduit at the time of construction and under the maximum settlement.

(j) Diaphragms.

1. A filter and drainage diaphragm must be:

- a. Installed around a structure that extends through the embankment to the downstream slope; and
- b. shall be designed in accordance with the guidelines of FEMA publication 484 "Conduits Through Embankment Dams", September 2005.

2. The diaphragm must be:

- a. Aligned parallel to the centerline of the dam or perpendicular to the direction of seepage flow; and
- b. Extended horizontally and vertically into the adjacent embankment and foundation to intercept potential cracks, poorly compacted soil zones, or other discontinuities associated with the structure or its installation; and
- c. Extended in all directions for a minimum of twice the outside diameter from the surface of a flexible conduit.

3. A diaphragm must extend from the surface of a rigid conduit to a minimum distance:
 - a. Horizontally and vertically upward three (3) times the outside of a circular conduit; or
 - b. The vertical dimension of a rectangular box conduit.
4. A diaphragm is not required to extend:
 - a. Beyond the limits established in this section;
 - b. Beyond a bedrock surface beneath the conduit;
 - c. Vertically more than the crest of the auxiliary spillway or more than two (2) feet below the embankment surface; or
 - d. Horizontally more than five (5) feet beyond the sides and slope of excavation to install the conduit.

(k) Conduit joints and articulation.

1. A conduit on a yielding foundation must have a joint extension safety margin of one and one half (1.5) inches.
2. A conduit joint must be designed and constructed to remain watertight under maximum hydrostatic head and maximum probable joint opening conditions in accordance with manufacturer specifications.
3. A joint incorporating a round rubber gasket set in a positive groove which prevents displacement from internal or external pressure under the required joint extensibility must be used on precast concrete pipe conduits.
4. Concrete pipes must have steel joint rings that provide rubber to steel contact in the joint.
5. Articulation of a conduit must be provided at:
 - a. Each joint in a conduit;
 - b. A junction of a conduit with a riser; and
 - c. Each outlet structure.
6. Cradles shall be articulated if placed on a yielding foundation.

(l) Foundation consolidation.

1. For dams classified as High or Significant Hazard, must be estimated from foundation borings and samples, soil mechanics laboratory tests, and engineering analyses.
2. For dams classified as Low Hazard and for which undisturbed foundation samples were not taken for other purposes, may be estimated from approximate procedures based on soil classification and experience.

Section 5. Auxiliary Spillway Requirements (See also: Sections 1 & 4)

(a) All dams must be provided with an auxiliary spillway capable of passing excess flood flows to prevent overtopping.

(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.

(c) An open channel spillway must be analyzed for flow depth, velocity, non-uniform flow conditions, super-elevation, and hydraulic jumps. A stage discharge rating must be developed based on the open channel spillway analysis.

(d) An open channel must be designed so that water will not flow at critical depth outside of the control section. In channels of varying slope or cross-section where non-uniform flow occurs, the transition through critical flow must be as rapid as possible.

(e) Auxiliary Spillway Operation Frequency. An auxiliary spillway that incorporates a vegetated earth, an unlined earth, or rip rap lined channel must be designed so that, based on a 6-hour rainfall event, the average frequency of operation is no greater than:

1. Once in one hundred (100) years for a dam classified as High Hazard or Significant Hazard;
and
2. Once in fifty (50) years for a dam classified as Low Hazard.

(f) An auxiliary spillway that incorporates a rock channel shall be designed so that, based on a 6-hour rainfall event, the average frequency of operation is no greater than once in fifty (50) years for all dams.

(5) Auxiliary Spillway channels in erodible rock shall be considered as if in earth.

Section 6. Dam Hazard Classification Report:

The hazard classification report of a new or existing dam shall be developed by a professional engineer and include a breach analysis and risk assessment:

- (a) The breach Analysis shall be performed by a professional engineer, and which shall include a hydrological assessment including:
 1. Historical and meteorological conditions.
 2. At a minimum, represent failure of the dam when the pool elevation is equal to the crest elevation unless the cabinet or the engineer performing the analysis determines that a more conservative condition is necessary due to the risks posed by the dam.
 3. A hydraulic analysis that estimates flow rates and inundation areas.
- (b) A risk assessment including potential loss of life, property damage, and environmental impacts;
 1. Supporting technical data, calculations, assumptions, and model files used to determine the hazard classification.
 2. A breach flood routing analysis using best available technology.
 3. Elevations for the lowest floor and lowest adjacent grade for all structures in the inundation area.

4. Photographs and a description of the type of structures downstream of the dam.
5. An inundation map demonstrating the results of the breach analysis.

Section 7. Emergency Action Plan:

(a) At a minimum, the Emergency Action Plan (EAP) shall include:

1. The name, address, email address, and emergency contact number of every person who owns an interest in the dam, including anyone having an easement that touches the dam;
2. Emergency levels classified as:
 - a. Emergency Level 1 - an unusual situation that may be a precursor to dam failure is slowly developing.
 - b. Emergency Level 2 - dam failure is possible and rapidly developing.
 - c. Emergency Level 3 - dam failure is imminent or in progress.
3. The conditions under which each emergency level shall be activated and terminated;
4. Standard operating procedures for each emergency level, including procedures to:
 - a. Lower the reservoir level;
 - b. Reinforce areas of erosion; and
 - c. Plug leakage entrances;
5. An inundation map;
6. For each emergency level, the roles, responsibilities, and contact information for each dam owner, local, state, and federal agencies, contractors, and consultants during emergency procedures;
7. The procedure to notify the potentially affected public of the emergency; and
8. Identification and location of available equipment, workforce, and materials to implement the EAP during any emergency level.
 - a. A description of any other actions necessary to reduce the effects of a dam failure and facilitate response to an emergency.
 - b. Pertinent design and operational information that may provide guidance during an

emergency including as-built plans or the most recent engineering stability analysis.

- (b) Distribute the EAP to all local, state, and federal entities and individuals listed in the EAP once cabinet approval has been received. The dam owner shall certify to the cabinet that the distribution has been made within 30 days after distribution.

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