OREGON ADMINISTRATIVE RULES
WATER RESOURCES DEPARTMENT
CHAPTER 690
DIVISION 20
DAM SAFETY

690-020-0000
Purpose and Applicability

~~(1) These rules describe the standards and requirements under which the department will administer and enforce the design, construction, maintenance, inspection, and fees regarding dams in Oregon. The purpose is to provide the guidance necessary for dams to be constructed and operated in a manner that will ensure the protection of life and property and to provide the department with the resources necessary to manage and support the construction and safe operation of dams in accordance with these rules.~~

(1) The purpose of these rules is to implement ORS 537.400(4) and ORS 540.350 through ORS 540.390 with actions that are intended to ensure the safety of the dams insofar as dams may affect possible damage to life or property. The department is authorized to review design and specifications for dam construction and modification, to conduct routine inspections, and to take enforcement actions on dams that do not ensure the safety of life and property.

~~(2) These rules apply to:~~

~~(a) Dams that are not subject to ORS 540.350–540.390 as described in 540.400.~~

~~(b) Dams that are subject to ORS 540.350–540.390 and which exceed the statutory limits as described in ORS 540.400(1) & (2).~~

(2) These rules apply to dams that are subject to ORS 540.350 through 540.390 and which exceed the statutory limits described in ORS 540.400.

(3) These rules do not apply to:

- **(a) Dams that are less than ten feet high or that store less than 3 million gallons (9.2 acre feet);**
- **(b)** ~~Metal or reinforced concrete~~ **W**ater storage tanks or various types of tanks that are part of water treatment facilities.

(4) The dam safety fee authorized by ORS 536.050(2) shall be used to support the dam safety program as described in OAR 690-020-0200.

(5) The State Engineer may delegate dam safety duties to a dam safety engineer working for the department for the purposes of ORS 540.350 to 540.390.

690-020-0022
Definitions

Unless the context requires otherwise, the following definitions apply in OAR 690, Division 20:

(1) “Abutment” means a natural valley or canyon side against which the dam is built;

(2) “Acre-foot” means the equivalent volume of one acre covered with one foot of water (325,900 gallons);

(3) “Annual Exceedance Probability Flood” means the likelihood of specific flood flow being equaled to or exceeded by in any given year at that specific location, expressed as a percent;

(4)“As-built drawing” means an engineering drawing of a dam as it was actually constructed, noting all differences between original design and actual constructed condition;

(~~3~~**5**) “Conduit” means a closed conveyance used to release water through a dam;

(6) "Core" means a soil of low permeability within an embankment dam;
(~~4~~**7**) "Cutoff Trench" means a trench excavated beneath the dam foundation and backfilled with low permeability material to retard water seepage;
(~~5~~**8**) "Dam" means a hydraulic structure built above the natural ground grade line that is used to impound water. Dams include wastewater lagoons and other hydraulic structures that store water, attenuate floods, and divert water into canals;
(~~6~~**9**) "Dam Crest" means the top of the dam;
(10) "Dam Height" means the maximum height of the dam as measured at the maximum section along the dam's longitudinal axis;
(~~7~~**11**) "Department" means the Oregon Water Resources Department;
(~~8~~**12**) "Director" means the Director of the Oregon Water Resources Department;
(~~9~~**13**) "Embankment" means an engineered earth fill;
(14) "Emergency Action Plan" (EAP) means a plan that assists the dam owner or operator and local emergency manager perform actions that ensure the safety of people in the event of a potential or actual dam failure or in the event of a sudden release of water;
(15) "Engineer of Record" means the professional engineer registered in Oregon working for the dam owner to design the dam to current safety standards and in responsible charge to oversee safe construction of the dam;
(~~11~~**16**) "Foundation" means the ground surface upon which a dam is constructed;
(~~12~~**17**) "Freeboard" means the vertical distance between the designed high-water level in the reservoir and the dam crest;
(~~13~~**18**) "Gate" or "Valve" means a permanent device for regulating water flow through the dam;
(~~14~~**19**) "Hazard Rating" means the rating established by the department f~~or a large dam that pertains to~~ **of** the potential ~~level and degree of~~ damage to life and property downstream of a dam in the event **of a** dam failure ~~results in a catastrophic release of water~~;
(20) "High Hazard Rating" means that if a dam were to fail, loss of human life would be expected;
~~(15) "Large Dam" for dam safety purposes, means a dam with a height of 10 feet or more and impounding 3,000,000 gallons (9.2 acre-feet) or more of water;~~
(21) "Inflow Design Flood" (IDF) means a volume and peak flood flow that the engineer of record will design to safely pass over or through the spillway;
(22) "Low Hazard Rating" means that if a dam were to fail, loss of life would be unlikely and damage to property other than that owned by the dam owner would not be extensive;
(23) "Pressurized Conduit" means any pipe that penetrates into a dam that may have a gate, valve, or irrigation pipe placed in the dam or at the outlet so that all or a portion of the pipe within the dam is under hydrostatic pressure when the valve is closed;
(24) "Probable Maximum Flood" (PMF) is the largest flood that could reasonably occur at a specific location, determined by the most severe set of atmospheric, soil moisture and snowpack conditions that might ever exist at that location;
(25) "Significant Hazard Rating" means that if a dam were to fail, loss of life would be unlikely but damage to property other than that owned by the dam owner would be extensive;
~~(16) "Significant dam work" means an activity to repair, rehabilitate, enlarge or otherwise alter a dam in which: 1) at least 30% of the fill material is impacted by the activity, 2) a spillway is being enlarged or repaired that affects the height or hydraulics of the spillway, 3) dam height and/or reservoir size is being increased, 4) a low level outlet conduit or inlet gate is being reworked with excavation or 5) any other activity that could affect the integrity of the dam or its auxiliary works;~~

~~(17) "Small dam" for dam safety purposes, means a dam with a height of less than 10 feet or impounding less than 3,000,000 gallons (9.2 acre-feet) of water; and~~

(26) "Soil Filter" means soil with a gradation designed to inhibit movement of adjacent, finer grained soils;

(~~10~~**27**) "~~Emergency~~ Spillway" means a~~n overflow~~ structure constructed to bypass flood water and prevent **water** overtopping the dam crest. ~~Often, d~~ **D**ams **may** have two **or more** spillways. ~~The lower elevation spillway that spills first is referred to as the principle spillway. The higher elevation spillway is referred to as the emergency spillway~~;

(28) "State Engineer" means a registered professional engineer working for the department, and may be either the director or a principal assistant working for the director as described in ORS 536.032.

(29) "Statutory Dam" means a dam that is ten feet in height or taller, and that stores at least 9.2 acre feet of water;

(~~18~~**30**) "Tank" means a fully-enclosed (bottom and sides) hydraulic structure made from metal, reinforced concrete, rigid fiberglass, or plastic that provides its own water-sealing and structural stability.

(31) "Toe Drain" is a drainage structure designed to collect and remove seepage water from the toe of the dam and to discharge this water in a manner where it can be measured;

(32) "Zoned Embankment" means an embankment dam with a core of low permeability materials, soil filter materials, drainage and other materials placed to improve performance and safety of the dam;

690-020-0023

Process for Construction of Dams

(1) Dam safety requirements shall be based on the hazard rating of the dam, in order to efficiently protect life and property.

(2) Any person, corporation, association, firm, partnership, limited liability company, joint stock company, unit of local government as defined in ORS 190.003, or State agency must, before beginning any construction on a dam, secure the services of a qualified engineer to design the dam and also to provide information on the dam as it was actually constructed. This engineer shall be deemed the engineer of record for the purposes of these rules.

(3) The engineer of record shall design the dam and develop plans and specifications consistent with these rules.

(4) Prior to beginning construction on any dam subject to these rules written approval of dam designs, drawings and specifications must be obtained from the State Engineer as described in OAR 690-020-0080.

(5) The engineer of record must oversee construction of the dam consistent with rules governing administration of dam construction in OAR 690-020-0065 to evaluate whether the dam is constructed consistently with approved plans and specifications.

(a) Any essential design changes must be described and justified in a letter sent to the State Engineer with the "as-built" drawings.

(6) Persons constructing or designing dams under ten feet high or storing less than 9.2 acre feet may be subject to requirements for use of registered engineers as specified in ORS 672.002 through 091.

690-020-0025
General Requirements
(1) The director may require ~~any~~ **additional** information or data to that ~~*outlined herein*~~ **specified in these rules** ~~which~~ **that** the director finds necessary for determining the safety of ~~the~~ a proposed ~~structure~~ **dam**.
~~(2) Whenever possible, precipitation and runoff records shall be submitted as part of the design for new or significant dam work on existing dams. If records are not available for the basin in which the dam is located, the hydrological/hydraulic criteria used in the design shall be submitted.~~
(**2**~~3~~) The director may include**,** as part of any permit to construct a dam**,** limitations and conditions that pertain to construction, operation, maintenance, and the protection of lives and property. These limitations and conditions become, by reference, part of the certificate and remain in effect throughout the life of the water right.
(**3**~~4~~) Approved plans and specifications for construction are, by reference, considered limitations and conditions placed on the water right permit and water right certificate. The director retains the authority to place additional limitations and conditions on the water right relative to operation and maintenance.
(**4**~~5~~) Dams constructed or operated in violation of limitations and conditions included in the permit or certificate are subject to restricted use and permit cancellation procedures. The certificate affirms the applicant's right to store water subject to the limitations and conditions therein.
(**5**~~6~~) **For new dams on stream channels, a**n outlet conduit ~~with a minimum diameter of 8"~~ must be installed ~~in any in-stream reservoir~~ to permit drainage of **all or most of** the reservoir and for passage of flow to downstream ~~prior~~ **senior water** rights **unless the engineer of record provides another alternative and demonstrates the safety of this alternative to the State Engineer**. ~~The director may waive this requirement if the director determines that the conduit is not needed for dam safety and will not be needed to pass flow for the benefit of other water rights, minimum perennial streamflows, or if the director determines an adequate alternative for passing flow is provided. Adequate alternatives must be capable of passing flow in sufficient quantity to satisfy downstream needs, and can include pumps, by-pass channels and siphons. Conduit material should be chosen based on design and site condition requirements. Acceptable conduit materials include reinforced concrete cylinder pipe; cast-in-place, reinforced concrete; appropriate PVC; concrete-encased corrugated metal pipe or plastic pipe; ductile iron; and cast iron. All joints should be water tight. The conduit valve should be installed at the upstream end and should be industry-manufactured with specifications consistent to the applied usage. Special provisions should be made for pressure conduits gated on the downstream end.~~
~~(7) The department shall determine the height of a dam by calculating the vertical distance (measured in feet) between the center point of the dam crest relative to and above the stream channel and the lower of either the natural soil surface that was in place prior to the construction of the dam or where a channel incision exists, the bottom of the channel incision. This measurement is to be taken at the maximum section along the dam's longitudinal axis.~~
(**6**~~8~~) The department shall determine water impoundment volumes ~~(~~in acre-feet ~~or millions of gallons)~~ as follows:

(a) For dams impounding water for an authorized beneficial use, the impoundment volume indicated in the area-capacity curve **as measured** from the bottom of the reservoir to the spillway crest. For dams with multiple spillways, 'spillway crest' is referring to the crest of the ~~principle or~~ lower elevation spillway.
(b) For wastewater treatment lagoons, the impoundment volume **is that** indicated in the wastewater lagoon plans and specifications~~, and~~.

(c) For diversion or flood control dams, the impoundment volume **is that** calculated at full reservoir at the dam ~~emergency (~~highest elevation~~)~~ spillway crest level.

(7) **The State Engineer may approve final designs, drawings and specifications for water storage reservoirs after a water storage application and a draft final order for that application have been issued by the Department.**

(8) Any person, firm or private or municipal corporation must provide to the state engineer an evaluation of whether the dam includes measures that make it readily adaptable to power generation for any new dam over 25 feet high on a stream with average annual flow over 2 cubic feet per second, unless exempted from this requirement as provided in ORS 540.350 (3).

(9) For any dam rated high hazard, the Department must review and approve an Emergency Action Plan prior to filling the reservoir.

(10) For any dam rated high or significant hazard, the Department must review and approve an operations and maintenance manual prior to construction on the dam.

~~690-020-0029~~

~~Small Dams, Recommended Minimum Standards~~

~~The following information is presented for the applicant's assistance in constructing small earthfill dams:~~

~~(1) It is recommended that the crest width of the dam be not less than 8 feet.~~

~~(2) It is recommended that the upstream slope of the dam be no steeper than 3:1.~~

~~(3) It is recommended that the downstream slope of the dam be no steeper than 2:1.~~

~~(4) It is recommended that the spillway channel be constructed around the dam, not over the top of the fill. The spillway is commonly excavated in natural material and, if necessary, lined to prevent erosion. The spillway should be large enough to pass the 50-year flood flow without overtopping the dam. Assistance is available from the department in sizing the spillway. Flow passing through the spillway should be returned to the creek channel at a sufficient distance downstream to prevent erosion of the dam's embankment.~~

~~(5) It is recommended that all brush, stumps, roots, and organic matter should be cleared from the area to be occupied by the dam. All such material should also be removed from the borrow area.~~

~~(6) It is recommended that the outlet pipe be encased with concrete or other method to allow for proper compaction and the prevention of uncontrolled seepage.~~

~~(7) Embankment material should be spread parallel with the dam axis in layers not exceeding eight inches in thickness and adequately compacted with sheepfoot roller or other similar equipment.~~

~~(8) It is recommended that prior to construction the dam owner have the dam's potential hazard to downstream properties studied using methods listed in 690-020-0100. It is recommended that any dam with a potential significant or high hazard rating be designed by a registered engineer familiar with dam engineering. It is advisable for any dam nearing or surpassing the dam height or storage thresholds for a "large dam" to be designed by a registered engineer.~~

690-020-0035

~~Large Dams; Minimum~~ Engineering Design Requirements

~~(1) All maps, plans, and specifications for the construction of new large dams or significant dam work for existing large dams, must be prepared by a professional engineer licensed to practice in the State of Oregon.~~

~~(2) Before initiating design, the engineer shall obtain design criteria from the department.~~

~~(3) No newly constructed large dam shall be permitted to store water until written approval is received from the department. Approval will be given after construction has been completed and is certified by~~

~~the supervising engineer to have been constructed in accordance with the approved plans and specifications.~~
~~(4) Design documents shall include the following:~~
~~(a) Plans:~~
~~(A) Plans for dams submitted for approval must accurately portray the work to be accomplished and be of sufficient detail to adequately define all features of the project. Plans must be submitted on good-quality mylar or vellum and must be neatly and accurately drawn to a scale sufficiently large, with an adequate number of views, for the drawing to be readily interpreted. To meet the requirements of this subsection, the director may allow plans for dams to be submitted electronically. The format of the plans in terms of file type, projection and other details must be approved by the department.~~
~~(B) Several sheets may be used to eliminate the necessity of large bulky drawings. No map or plan should be larger than 24 x 36 inches. The following information will be required:~~
~~(i) A contour map of the reservoir site which will show the location of the dam by quarter-quarter section, township, range and tax lot; and the name and location of the stream flowing through the reservoir. Government survey lines must be indicated on this~~
~~map, along with a survey tie to the dam axis from a government land corner. Area and capacity curves and/or tables of the proposed reservoir must be shown;~~
~~(ii) A map of the drainage basin showing the location of the dam and reservoir and the streams within the drainage area. This map may be prepared from existing reliable topographical maps and it must include: the number of square miles of drainage area; a brief description of the area; the percentage of bare and timbered lands; and general characteristics of the watershed, whether precipitous, rolling, or comparatively flat. The estimated discharge as well as the spillway capacity at different reservoir water levels should also be provided in the plans or specifications. Extraneous information can also be included in specifications or a separate hydrology report as to not clutter up the map;~~
~~(iii) A topographic map of the dam site with contour intervals not to exceed 5 feet. A plan of the dam should be superimposed on this map showing the location of spillways, outlet conduits, and other relevant auxiliary structures;~~
~~(iv) A profile of the dam site taken on the axis of the dam and a profile of the spillway along its axis. The profile should also show the location of the outlet conduit and spillway. A log showing the classification of materials encountered below the surface as shown by test pits or borings;~~
~~(v) A cross section of the dam at maximum section showing complete details and dimensions;~~
~~(vi) Plans showing sections of the outlet conduit, control works, and spillways. These sections should be in sufficient number and detail to make definite all features of the structure.~~
~~(b) Specifications. All plans for dams must be accompanied by construction and material specifications:~~
~~(A) The specifications shall describe in detail the methods and/or performance criteria to be followed in performing each class of work and shall set forth the requirements for the various types of material to be used in permanent construction;~~
~~(B) The specifications must contain a provision for supervision by the engineer during construction and for inspection by the director or director's authorized representative at any time during the construction period;~~
~~(C) The specifications must also contain a provision to the effect that plans or specifications shall not be altered or changed without the written approval of the director or the director's authorized representative.~~
~~(5) Construction: Construction should be supervised by an engineer licensed to practice in Oregon. As a minimum the following notices and construction reports shall be submitted to the Department:~~
~~(a) Notice of beginning of construction;~~

~~(b) Notice of intent to begin placement of fill materials;~~
~~(c) Completion report including test results, "as-built" drawings, and certificate of completion in accordance with approved plans and specifications.~~
~~(6) During the design process for any newly constructed dams or for significant dam work to existing dams that involves potentially changing the volume or rate of water released during failure, the dam owner or owner's representative must submit to the department an inundation analysis using methods described in 690-020-100. The department shall use this analysis to determine the hazard rating of the dam in accordance with 690-020-100.~~
~~(a) If a dam is rated as high hazard, an emergency action plan is required and the plan must be reviewed and approved by the department.~~
~~(b) The inundation/evacuation map for the dam must be developed using methods described in 690-020-100(2) and must be reviewed and approved by the department.~~

(1) A design report or multiple design reports must be submitted with the drawings and specifications by the engineer of record for all new dam construction. Design reports may be completed by other engineers registered to practice in Oregon.
(2) The design report(s) for new dam construction must include the following elements:

(a) Site suitability evaluation as provided in OAR 690-020-0036;
(b) Hydrology and inflow design flood as provided in OAR 690-020-0037;
(c) Dam structure design (embankment, concrete or other) as applicable and as provided in OAR 690-020-0038 – 0041;
(d) Spillway design as provided in OAR 690-020-0042;
(e) Design for penetrating conduit(s) as provided in OAR 690-020-0043;
(f)Methods for determining whether a dam is operating properly based on the hazard rating of the dam as provided in OAR 690-020-0044 (monitoring and instrumentation).

(3) If multiple reports are submitted, each must be stamped by the engineer who prepared the report; and the engineer of record must compile and understand reports for preparation of drawings and specifications.

690-020-0036
Site Suitability and/or Geotechnical Evaluation
The design for new dam construction shall characterize the soil and rock at and around the dam site and shall include the following elements:
(1) A description of the general and local geology and geomorphology at and around the dam and reservoir. Field investigation by a geotechnical engineer and/or engineering geologist is required for all high hazard dams and also for significant hazard dams where landslides, faults, dispersive soils or liquefiable soils could reasonably be expected near the dam site. All such features shall be shown on a map of the dam site, and described as necessary for design of the dam. For dams on rock, mapping of discontinuities relevant to safety of the dam and evaluation of the need for grouting is required.
(2) Subsurface investigation to determine distribution of relevant earth materials. This investigation shall include borings or test pits; identification of springs, seeps and groundwater encountered at the dam site; and evaluation of the potential for landslides into the dam or reservoir.

(a) All materials shall be logged by the Unified Soil Classification System; blow counts (for borings only); and description of samples taken for testing.
(b) Subsurface investigations for High Hazard dams shall include drilling to a minimum depth 1.5 times the height of the dam or at least 10 feet into bedrock, whichever is less.

(3) Soil and or rock evaluation and testing of relevant materials. This evaluation may include: proctor compaction testing from all borrow areas; estimation or testing the permeability of soils to be used in dam construction; and an assessment for the presence of dispersive soils.

(a) An analysis of materials in the foundation and proposed embankment shall be completed if materials are prone to liquefaction.

(b) Where suitable materials can be collected, strength tests shall be required for all high hazard dams, and may be required by the State Engineer for significant hazard dams.

(c) Simple cyclic shear testing may be required for high hazard dams in areas with large ground acceleration potential from earthquake loading.

(4) Borrow area locations. Areas proposed for borrow shall be identified and shown on the drawings.

(5) Earthquake considerations. Seismic site characterization is required for high hazard dams, and may be required for significant hazard dams. A seismic site characterization shall include earthquake sources, ground motion hazard, peak ground acceleration, and recommended ground motions (time histories).

(6) Site preparation criteria. The site evaluation shall recommend a depth of stripping unsuitable materials, and also a minimum depth for the cutoff trench.

690-020-0037

Hydrology and Inflow Design Flood

The design shall characterize flow into and through the reservoir and dam and shall include the following elements:

(1) A topographic map delineating the drainage area contributing to the dam, with the drainage area size labeled in square miles and showing the specific location of the proposed dam.

(2) For dams on stream channels, the name of the stream where the dam is located, the name of the principal watershed, and a determination of average annual inflow into reservoir and potential to fill the reservoir.

(3) Dam failure inundation analysis is required for any dam that might be high or significant hazard. The inundation analysis shall comply with OAR 690-020-0120.

(4) The inflow design flood that is the basis of hydraulic design for the dam shall be determined based on the hazard rating of the dam.

(a) The inflow design flood for a high hazard dam is the Probable Maximum Flood (PMF).

(b) The minimum inflow design flood for a significant hazard dam is the 0.2 percent annual exceedance probability flow.

(c) The minimum inflow design flood for a low hazard dam is a 1.0 percent annual exceedance probability flow.

(d) The inflow design flood for a lagoon or off channel reservoir is the maximum capacity of inflow pumps, ditches plus the maximum local storm precipitation over the lagoon.

(e) For watersheds under 30 square miles, the engineer may consider the 24-hour storm for determination of a general storm PMF, while larger basins the engineer shall utilize at least a 72 hour storms for calculating the general storm PMF.

(5) For a high hazard dam, the engineer of record may also propose to determine an inflow design flood based on a quantitative analysis of risk to people and property.

(6) Designs shall include a description of all hydrologic parameters and the method used to determine the inflow design flood hydrograph and the volume of the inflow design flood, which is to be determined considering basin size and other factors as appropriate to the watershed above the dam.

(7) The design report must include the information used to develop the stage and storage capacity curve for the reservoir, including the capacity with and without excavation for construction.

690-020-0038
Embankment Dam Structures
Designs for Embankment (soil and or rock) dams shall include the following elements:
(1) A determination of embankment stability and stable embankment slope angles.
- **(a) Embankment dams shall be designed to have stable slopes during construction, and under all conditions of reservoir operation.**
- **(b) Standard slopes of 3:1 upstream and 2:1 downstream may be used at the discretion of the engineer of record for low and significant hazard dams as long as low strength materials are not used in the embankment and conditions leading to elevated pore water pressures are not present.**
- **(c) Dams that are rated high hazard must be designed as zoned embankment dams and/or include a chimney drain designed also as a filter.**
- **(d) High hazard dams shall be analyzed for static and seismic slope stability, and also for deformation analysis. The department may require static and or seismic slope stability analysis for significant hazard dams. At a minimum, seismic analysis shall be based on full reservoir under steady state seepage conditions. Factors of safety shall be evaluated by slope stability analyses using appropriate strength parameters based on laboratory or insitu testing as appropriate. For materials that can be reasonably tested either on site or in a laboratory, soil strength values may not be based on assumptions and must be made on strength testing of the appropriate soil or rock units. Potential loss of crest height loss from seismic events shall also be evaluated for high hazard dams.**
- **(e) High Hazard dams shall be designed for the maximum credible earthquake. If the State Engineer requires seismic analysis of a significant hazard dams, deformation analysis shall be designed for the 0.2 annual exceedance probability earthquake.**
- **(f) Changes in depth of compressible foundation or embankment material shall be identified and a design to prevent significant differential settlement shall be developed.**

(2) Analysis of seepage and leakage expected through the dam and design of measures to prevent internal erosion and excess leakage.
- **(a) Steady state seepage and internal drainage conditions beneath, around and through the dam shall be quantified for all high hazard dams, and may be required by the State Engineer for some significant hazard dams.**
- **(b) A core of low permeability material protected by a soil filter is required for all high hazard dams. A core and soil filter is required for any significant hazard dams where the engineer of record or State Engineer determines piping could potentially occur. All core and filter zones must be of a configuration with dimensions that can be readily constructed.**
- **(c) Internal drains and/or soil filters shall be used as needed to drain water and prevent internal erosion of the dam.**
- **(d) Internal drain pipes to collect and distribute seepage flows from internal filters and drains shall be comprised of material that is non-corrodible, designed to carry the overburden load, and be no smaller than 6 inches in diameter.**

(3) A safe and accessible dam crest.
- **(a) The dam crest shall be of sufficient width to be accessible by equipment and vehicles for emergency operations and maintenance, and shall have a road to allow crest access.**

(b) The crest shall have a camber sufficient to maintain the design freeboard, based on the anticipated crest settlement and in no case shall the camber be less than 0.5 feet.
(c) Roads located on the dam crest shall have appropriate surfacing to provide a stable base that resists rutting and provides adequate traction for access and safety in wet conditions.
(d) The crest shall have adequate cross slopes to prevent ponding.
(4) Measures to control wave and surface erosion as needed.
(a) For reservoirs large enough to generate significant waves, the design shall include a determination of minimum freeboard based on expected waves. The design shall also include slope protection for wave action if significant waves are likely.
(b) The downstream slope shall be provided with a well maintained cover of non-woody vegetative cover, or a gravel or rock surface, to prevent surface erosion. No woody vegetation shall be planted on the dam during the life of the structure unless specifically designed by the engineer of record, by demonstrating that cover plants will not affect critical dam functions.

690-020-0041
Concrete Dam Structures
Designs for concrete mass dams must be prepared by a structural engineer and a geotechnical engineer and/or engineering geologist. This rule does not apply to concrete flashboard dams. Designs for all other concrete dams shall include the following elements:
(1) Concrete dams shall be specified as gravity, arch, arch-gravity, or buttress. Gravity dams can be of conventional mass concrete or roller compacted concrete.
(2) Dams shall be designed to be stable during construction and under all conditions of reservoir operation.
(a) Headwater and tailwater elevations pertinent to the design shall be described with respect to both static and dynamic loading.
(b) Uplift pressure distributions assumed for design shall be provided.
(c) When foundation drains are used to reduce uplift, the assumed drain efficiency shall be indicated and permanent access shall be provided at the project to inspect and maintain the drains.
(3) Sliding stability shall be evaluated at lift joint surfaces, at the dam foundation interface, and at discontinuities in the foundation materials beneath the dam and abutments.
(a) Factors of safety shall be based on limiting equilibrium methods.
(b) For earthquake loadings the critical acceleration (acceleration required to initiate sliding) may be less than the peak ground acceleration of the design earthquake. In such cases a permanent sliding displacement shall be determined in lieu of a sliding factor of safety.
(c) Overturning of the dam on its foundation shall be evaluated for static and seismic loading.
(4) Seismic stability analysis is required for certain concrete dams and shall demonstrate the dam can withstand the design earthquake without loss of life or damage to property.
(a)High hazard dams shall be designed for the maximum credible earthquake based on current information from the US Geological Survey or a site specific seismic evaluation. A dynamic stress analysis that considers the dynamic characteristics of the dam and the ground motions of the design earthquake shall be provided for high hazard dams.
(b) Where the State Engineer requires seismic analysis on significant hazard dams, they shall be designed for the 0.20 percent annual probability of exceedance earthquake. The department may require a dynamic stress analysis for significant hazard dams.
(5) When foundation grouting is needed, the design for the grout curtain and/or consolidation grouting of the foundation shall be required.

(6) Specific properties of mass concrete that can be important to design and construction include the compressive strength (at 28 days and one-year), modulus of elasticity, Poison's ratio, shear strength, tensile strength, volume change during drying, thermal coefficient of expansion, specific heat, thermal conductivity, permeability and durability.

(a) As a minimum for static loadings, the assumed compressive and shear strengths for the parent concrete, lift joint surfaces, and the dam-foundation contact shall be provided.

(b) In addition, tensile strength assumptions for the aforementioned regions for dynamic loadings (seismic) shall also be provided.

(c) Air entraining agents shall be provided in the concrete mix to provide freeze-thaw protection and to improve the workability of lean mass concrete mixes. The quantity of air entrained in mass concrete shall be in the order of 5-percent.

(7) Mix design and construction methods used to minimize cracking due to temperature gradients between interior regions subject to heat of hydration effects and surfaces exposed to ambient temperatures shall be specified. Treatment of lift joint surfaces to achieve desired shear and tensile strengths shall be indicated. Treatment of contraction joints to prevent leakage and/or to transfer load between adjacent monoliths shall be described.

(8) When reinforcing steel is used, the strength properties of the reinforcement shall be provided and contract drawings shall clearly indicate the size, location, spacing, and cover requirements.

(9) The minimum crest width must be 15 feet unless otherwise approved. The dam crest and appurtenant structures shall be accessible by equipment and vehicles for emergency operations and maintenance.

690-020-0042

Spillways

All dams must have a spillway. Spillway(s) design shall include the following minimum elements:

(1) Utilization of inflow design flood. Determination of inflow design flood as described in OAR 690-020-0037 is required to determine the required spillway capacity.

(2) Hydraulic evaluation of flow through control section. Flood flow through the control section must be calculated and the minimum freeboard at the inflow design flood must be 1 foot for high hazard dams and 2 feet for significant and low hazard dams.

(3) Low elevation spillway. An interior spillway connected to the low level conduit may be used for low and significant hazard dams, and for high hazard dams only with specific approval by the State Engineer. The capacity of the low elevation spillway may be considered in design of the main overflow spillway.

(4) Stable spillway control section. The spillway control section must be hydraulically and structurally stable for the inflow design flood and have permanent features so that the control section is identifiable for re-measurement of cross section during routine inspections.

(5) Spillway channel stability. Spillways shall be designed to be structurally adequate and stable under all conditions of reservoir operation. Spillway structures of high hazard dams shall be designed for earthquake ground motions per OAR 690-020-0036.

(6) Reinforced concrete specifications. Structural elements of reinforced concrete shall be designed for both strength and serviceability. The 28 day strength of structural concrete shall be provided. The strength properties of the reinforcing materials shall also be provided and contract drawings shall clearly indicate the size, location, spacing, and cover requirements shall be specified. Treatment of construction joints and contraction/expansion joints shall be described and special provisions for

strength transfer and leakage prevention identified. Air entrainment shall be provided in cast-in-place concrete if needed for freeze-thaw protection, durability, and workability.
(7) Debris booms. For high and significant hazard dams, debris or log booms may be required. Where required, they shall be designed for the spillway approach where logs and other debris may block or damage the spillway structure. The design shall specify the necessary anchor capacity, and the design of the anchors.
(8) Gates and Flashboards. Detailed drawings and specifications are required for spillway gate structures or flashboards, if present on the proposed dam. Operations and maintenance manuals are required for any dam with a gated spillway, or where flashboards or stop-logs are used in the spillway.
(9) Energy dissipation. The design of stilling basins for high hazard dams, and where required by the State Engineer for significant hazard dams, shall be based on calculated hydraulic forces and designed to dissipate energy from the inflow design flood.

690-020-0043
Penetrating Conduit (s) and Control of Flow Through Conduits
All new dams on stream channels must have a low level conduit. All other dams must have a low level conduit or other means to safely drain the reservoir. The conduit and related control structures must be designed meet the following criteria:
(1) Ability to lower the reservoir. The diameter of the conduit should be determined through analysis of the time required to drain the dam at average inflow.
(a) The conduits for high hazard dams shall be capable of releasing the top five feet of the reservoir in five days.
(b)The conduits for significant and low hazard dams must be able to release the top five feet of the reservoir in ten days.
(c) All conduits must be of sufficient size to allow passage of inflows as needed to senior water right holders.
(d) In no case shall conduits be smaller than 8 inches in diameter.
(2) Durable and water-tight conduits. Conduits must be made of medium to heavy gage durable materials. Pipe joints must be designed to seal and prevent leakage. Corrugated metal culverts are only acceptable for low hazard dams, and only when the conduits are encased in concrete. Encasement of conduits in concrete may be used to assist in the design a durable conduit and to reduce the potential for seepage and erosion adjacent to the conduit.
(a) Diaphragms using materials designed as an effective soil filter are required for any conduits not designed as encased in concrete, and are required regardless of encasement for all high hazard dams.
(b) Seepage collars may not be used in any dam.
(3) Control Mechanisms. The design for the control mechanism must be sturdy, durable, allow for air venting when needed, and allow manual operation to drain the reservoir if hydraulic or other power controls are inoperable. Hydraulic controls must have redundancy if control relies on any submerged hydraulic hoses. Intake structures for outlet works must have trash racks unless the engineer of record shows trash racks are unnecessary, or unsafe to construct due to conditions at the dam site. For high and significant hazard dams, measures to prevent unauthorized use of the control mechanism must be included in this design.
(4) Outlet structure. The outlet structure must not be submerged when the inlet control gate or valve is fully closed. The outlet structure must be designed to protect the conduit from mechanical damage

and convey water to the stream channel without channel erosion and cavitation near the gate structure.
(5) Pressurized operation. Conduits must be specified as suitable for pressurized operation if they are to be operated with controls other than at the inlet of the conduit. Conduits for dams with pressurized conduits shall have a guard gate installed at the upstream end of the conduit.

(a) Operations and maintenance manuals are required for any dam designed for pressurized operation, and the plans must include procedures for periodic inspections of the interior of any pressurized pipes.

690-020-0044
Monitoring and Instrumentation
Designs must include methods for determining if the dam is operating properly based on the hazard rating of the dam, and include:
(1) Staff gage near controls for the conduit. The staff gage shall be clearly marked in feet and tenths of feet, and extend to within one foot of the crest of the dam. Markings and numbers on the gage rod shall be of sufficient size to be easily readable from the crest of the dam.
(2) Multiple and easily accessible outlets of all toe drains. Toe drains shall be designed to discharge into locations where flows can be evaluated and monitored. Multiple discharge points are required in order to isolate seepage to various sections of the dam and foundation. Discharge points must be located where routine dam maintenance is not likely to damage the drains.

(a) For high hazard dams, drains must have a measuring weir or other device, and a basin for settling drainage water so that internal erosion can be identified.

(b) Where drainage galleries are provided for concrete dams, seepage measuring devices should be provided and accessible for making the necessary readings.
(3) Unique Identification. All instrumentation and exterior drains shall be labeled with a unique identifying marker designed for durability and to withstand maintenance activities.
(4) All high hazard and where required by the engineer of record or State Engineer, significant hazard dams shall have the following instrumentation:

- **(a) Monuments that allow measurement of the horizontal and vertical movements of the dam. Control or benchmark monuments shall be placed in areas not subject to movement;**
- **(b) Piezometers to allow monitoring of the phreatic surface within the dam or for concrete dams, to determine uplift pressures.**
- **(c) Instrumentation to measure strong ground motions for dams in locations where the peak ground acceleration is greater than 0.3 g.**

690-020-0047
Geosynthetics
Geosynthetics shall not be used as the sole element employed to perform an essential dam safety function. Redundant design features are required whenever geosynthetics are used for essential dam safety functions.

690-020-0048
Modification of Standard Design Requirements
Exceptions to design standards may only be obtained with written approval from the State Engineer. Where the engineer of record requests design exceptions, the request must be in writing, be affixed

with the engineer of record's professional stamp, and include a report describing why design standards are inapplicable to the safety of the dam.

690-020-0055
Design Drawings
The engineer of record shall submit applicable drawings when they believe the design is ready for review and approval by the State Engineer.
(1) Drawings must accurately portray the work to be accomplished and be of sufficient detail to clearly define all features of the project. After all changes required by the State Engineer are made, final design drawings must be neatly and accurately drawn to a scale sufficiently large for the drawings to be readily interpreted.
(2) Drawings must be uncluttered and easy to understand for determination of design compliance by the contractor, the engineer of record, and the State Engineer.
(3) Drawings must be no larger than 24 x 36 inches. Other acceptable sizes for drawings are 17" X 22" and 22" X 34". All drawings must have graphic scale bar so that scale can be determined after enlargement or reduction. Each sheet shall be numbered sequentially with the first sheet being sheet number one along with the total number of sheets; e.g., 1 of 6.
(4) Drawings shall include the following information:

- **(a) An official dam name, which must be not have already been used for a dam as indicated in the Oregon dam safety database of dams. This unique name must be affixed on each drawing;**
- **(b) The first drawing must include a location map with the drainage basin, the dam and reservoir, streams within the drainage area, and the location of the nearest access highway. This drawing must include legal location of the dam (Section, Township and Range), and the location of the survey reference point with latitude, longitude, elevation, and datum elevation (NAVD1988);**
- **(c) A contour map of the reservoir site showing the legal location of the dam with contour intervals not to exceed 5 feet. A plan of the dam should be superimposed on this map. If scale permits, this drawing should show the location of the spillway(s), conduit inlet and outlet, and the location, and distance and direction to a government land corner or other permanent survey marker;**
- **(d) Area and storage capacity curves and information on the hydrology of the proposed reservoir drainage area in square miles;**
- **(e) A profile of the dam site at the center of the dam;**
- **(f) A cross section of the dam at maximum section;**
- **(g) Plan view(s) of dam at maximum section, and other sections as needed;**
- **(h) Cross section(s) of dam, including the maximum section with the official dam height;**
- **(i) Spillway details, spillway approach control discharge, and energy dissipation;**
- **(j) Low level conduit details, including diameter, material, encasement, and invert elevations at both ends of the dam; and**
- **(k) Slide gate or valve details including the trash rack, control stem, pedestal and wheel, or other control details, and air vent.**

(5) Elevations that must be clearly labeled on applicable drawings and include:

- **(a) the base of dam and official height of dam;**
- **(b) the dam crest;**
- **(c) the spillway control section;**
- **(d) the base of spillway discharge;**

(e) and the invert of the conduit at both the inlet and outlet.

(6) All drawings must be dated and have sufficient space location for State Engineer's approval stamp, at least 3" x 3" near the lower right hand corner of the drawing.

(7) Drawings must be designated as final design drawing or as-built drawings.

690-020-0060

Construction Specifications

All drawings for dams must be accompanied by construction and material specifications that include the following:

(1) Construction conditions. Specifications must include the construction period based on typical weather for that location and in-stream work periods if applicable, and may include a process for the engineer of record to modify the construction period.

(2) Clearing of the dam site and reservoir. Specifications must include the area to be submerged by the new or enlarged reservoir and specify that the submerged area shall be cleared of logs and debris prior to filling the reservoir. The specifications must require that the footprint of the dam shall be cleared of all soils containing organic materials, and that this material may not be used for dam construction.

(3) Cutoff trench requirements. Specifications must include the minimum trench depth, width at base of the trench, and maximum side slope steepness. These specifications shall be based on the subsurface investigations and direct that the cutoff trench may not be filled if it contains standing water. A requirement not to begin filling the cutoff trench until approved by engineer of record, and where specified, by State Engineer or Dam Safety Engineer, must also be included in the specifications.

(4) Material specification standards. The specifications shall include material and testing specifications for dam materials, conduits, control structures, and other appurtenant structures, using an ASTM standard methodology if available.

(5) Soil Compaction. The typical compaction specification is 95 percent of standard proctor density, though the engineer of record may use a different compaction standard. Specifications shall include the types of acceptable compaction equipment, by material source if necessary. Specifications shall also include maximum lift thickness. To reduce potential for leakage around the conduit, specifications shall prohibit soil compaction dry of optimum moisture content for materials placed immediately above or adjacent to the conduit. Specifications must also include verification testing of soils, with representative samples selected for testing by the engineer of record and not the contractor.

(6) Concrete placement. Specifications shall include means to prevent separation of aggregate and cement, air entrainment requirements if needed, methods for placement and vibration of concrete, required minimum 28 day strength, slump, moisture and temperature requirements for curing. Alkali reactive aggregate shall not be used in the concrete.

(7) Conduit specifications. Specifications must include the material, diameter, and thickness of the conduit, and the length of conduit required for the project. Methods for sealing joints must be specific. Specifications must require that all materials from a manufacture are certified to meet this test, or that the engineer of record has tested the materials directly.

(8) Accepting and Rejecting Materials. Specifications must include tolerances for acceptable departure from material specifications and a process for rejection of defective materials or workmanship.

(9) Notification by the engineer of record to the State Engineer of changed conditions critical to the safety or operations of the dam. Specifications shall include State Engineer notification if previously unidentified springs, slope movement or sand lenses are identified, or if storm or other damage occurs during construction.
(10) The specifications must require supervision by the engineer of record during construction and for inspection by the director or director's authorized representative at any time during the construction period;.
(11) The specifications must also contain a provision to the effect that plans or specifications shall not be altered or changed without the written approval of the State Engineer.

690-020-0065
Dam Construction
The Engineer of record shall submit to the State Engineer for approval plans for administering the construction of the dam. Construction plans must include the following:
(1) Construction of the dam shall be observed and documented by the engineer of record and employees working for the engineer of record as applicable.
(2) The engineer of record or an inspector working for the engineer of record shall be on-site as needed for instructions to the contractor, approval of initial excavation, acceptance of materials, and general project administration.
(3) The dam owner shall cease construction activity if the engineer of record is no longer employed or for any reason cannot complete necessary construction administration activities. Construction may resume when a new engineer of record is employed, the State Engineer has been notified of the new engineer of record, and both engineers have discussed the project.
(4) The engineer of record shall observe the construction of the dam. It is the engineer of record's responsibility to make periodic inspections to evaluate whether the construction is proceeding in accordance with the approved plans and specifications. The engineer of record shall endeavor to prevent defects and deficiencies in the construction of the dam and appurtenant structures, and shall disapprove or reject work identified that fails conform to the approved plans and specifications.
(5) The engineer of record shall confirm foundation design assumptions once surface materials have been stripped and the cutoff trench excavated. Changes in actual foundation conditions from assumptions made in the initial site evaluation shall be communicated to the department.
(6) The engineer of record shall maintain a record of construction that shall include: logs of construction inspections whenever such inspections are made by the engineer or their employee; all test results pertaining to construction; photographs; as well as construction problems and remedies.
(7) The engineer of record shall complete as-built drawings and a final construction report, including statements that the observations are either consistent or inconsistent with the design drawings and specifications. If key elements of construction were not observed, the construction report shall detail those specific elements that were not observed.

690-020-0070
Submittals and Notifications by the Engineer of Record
(1) The engineer of record must include an inundation analysis that complies with OAR 690-020-0120 prior to submitting the design report, plans and specifications, so that the department can determine the hazard rating of the dam. For dams in remote locations the State Engineer may waive this requirement if it is clear to the State Engineer that the dam will be rated low hazard.

(2) All final designs, drawings and specifications submitted to the State Engineer for approval must be prepared and stamped by a professional engineer licensed to practice in the State of Oregon. The first page of the drawings, the specifications, and the construction administration plan must by stamped by the engineer of record. All submitted materials must be addressed directly to the State Engineer and labeled as a dam safety submission.
(3) Final drawings shall be submitted on full size paper. Reports and specifications must be submitted as packaged 8.5 x 11 inch bound documents, with essential maps folded within.
(4) A schedule of construction will be provided to the State Engineer prior to initiating construction of any significant or high hazard dam.
(5) Prior to completion of the cutoff trench and all stripping of foundation and embankments the engineer of record shall notify the State Engineer to allow for State Engineer inspection of the excavation. The required notice to the State Engineer is as follows: 48-hour for a low hazard dam, 120-hours for a significant hazard dam, and for high hazard dams 240-hours or the time specified in the approval, whichever is longer.
(6) Any changes made to the designed location, height or width of the dam, or to materials used in dam construction shall be reported in writing immediately to the State Engineer.
(7) If any slope instability is observed during construction in the embankment or adjacent to the dam or into reservoir, it shall immediately be reported to the State Engineer by phone.
(8) If for any reason the engineer of record ceases construction administration work, the engineer of record must immediately notify the State Engineer of the situation, by phone and in writing.
(9) For high hazard rated dams, the final emergency action plan and any additional inundation analysis required for the EAP as described in OAR 690-020-0400 must be submitted by the Engineer of Record prior to or concurrent with submission of the as built drawings and the project completion report.
(10) The engineer of record must submit as-built drawings and a project completion report. A project completion report must include the following.

- **(a) As- built drawings, if possible on the same sheet as the initial design drawings. As-built drawings shall be submitted in the form of electronic copies of all applicable drawings.**
- **(b) A completion report stating either that the dam has been built according to the drawings with changes to improve safety as documented in the as built drawings, or that essential safety functions are unknown.**
- **(c) A list of the days the engineer of record was on site, the number and location of material tests, and observations of all changed conditions.**
- **(d) Test results (compaction, strength, permeability) must be summarized in the completion report.**
- **(e) The completion report must document the observations and decisions made and communicated to the contractor or dam owner. Photographs of key stages of construction, including but not limited to photographs of the cutoff trench, borrow pit development, trenching and placement of the conduit, the spillway before and after placement of concrete.**
- **(f) The project completion report shall be stamped by the engineer of record.**

690-020-0080
Written Approval by State Engineer
(1) Prior to commencing construction activity, all design reports, drawings of the dam and critical appurtenant structures, specifications, and plans for construction administration must be approved by

the State Engineer as indicated by the State Engineer's stamp and a written letter of approval from the State Engineer.

(2) The State Engineer's approval of design plans and specifications shall be valid only for five years. Upon request, written requests for time extensions may be granted in writing by the State Engineer.

(3) The following include features involved in the construction or operation of the works that may impair the safety of an existing permitted dam and so require State Engineer approval of engineered designs:

- **(a) any changes that affect storage capacity of the dam, including all dam rises other than adding fill to restore crest height lost to settlement or erosion;**
- **(b) any changes to or near the spillway that may affect spillway capacity or ability to pass flows safely;**
- **(c) installation of any valve or gate on the downstream side of the dam;**
- **(d) excavation into or near the dam to place any new conduit or utility in the dam;**
- **(e) replacement of the conduit control structure;**
- **(f) installation of any valve on the downstream side of the low level conduit, or directly connecting irrigation pipe to the low level conduit; and**
- **(g) repair of damage which has already significantly weakened the dam.**

(4) Prior written approval will not be required for replacement or lining of toe drains, relining of conduits of low hazard dams, and for specific actions required in an emergency. As built drawings may be sent to the State Engineer after completion of such projects to show these projects have been completed in a safe manner.

(5) For existing dams without a valid storage permit, the State Engineer may approve plans and specifications so that a permit may be issued only if the engineer of record provides the following:

- **(a) Drawings of the dam as it exists during the engineer's evaluation and survey of the dam. These drawings should include all the critical features as described in OAR 690-020-0035, except for those elements that cannot be evaluated such as the cutoff trench,**
- **(b) Evaluation of any embankment distress, including erosion, seepage or leakage,**
- **(c) Condition and function of the conduit and its controls, capacity and stability of the spillway,**
- **(d) Any other safety information needed as determined by the State Engineer,**
- **(e) Designs as needed to bring the dam up to the current standards based on the hazard classification of that dam,**
- **(f) As improved drawings of the dam showing that all necessary modifications have been made with a report from the engineer describing the necessary work that was completed, and**
- **(g) The source of all information used to develop the as improved drawings must be documented in a report submitted by the engineer. This includes but is not limited to the engineer's measurements, engineer's observations, a photographic record, and testimony of individuals.**

(7) No newly constructed dam shall be permitted to store water until final written approval of necessary plans, specifications or other information is received from the department.

- **(a) Final approval may be obtained only after construction has been completed and as built drawings and a satisfactory project completion report have been submitted to and approved by the State Engineer.**
- **(b) The State Engineer shall notify the Engineer of Record and dam owner in writing when final documents have been approved.**

690-020-0100
Hazard Rating of Statutory Dams
(1) **Dams shall be assigned a h**azard rating~~s for "large dams" are classified by the department as "~~of high ~~hazard", "~~, significant ~~hazard"~~, or ~~"~~low. ~~hazard" as follows:~~
~~(a) High Hazard: This rating indicates that if the dam fails there is a strong plausibility for loss of life. The plausibility is established because of inhabited infrastructure (such as homes and business) downstream that would be inundated to such a degree see 690-020-0100(2)(d) for specific criteria that it would put the person who inhabits the structure in jeopardy. Any factor that puts a strong probability of people being downstream in an inundation area of a dam failure shall be considered. The department shall endeavor to inspect this class of dams on an annual basis.~~
~~(b) Significant Hazard: This rating indicates that if a dam fails, infrastructure (such as roads, power lines or other largely uninhabited buildings) would be damaged or destroyed due to inundation and flooding. The department shall endeavor to inspect this class of dams at least once every three years.~~
~~(c) Low Hazard: This rating indicates that if the dam fails there is little plausibility for loss of life, and human infrastructure that could be affected by inundation downstream is minor or non-existent. The department shall endeavor to inspect this class of dams at least once every six years.~~
(2) The department shall utilize **dam breach** inundation ~~of infrastructure study results~~ **analysis** as a primary factor to determine the hazard rating of dams a**s described in OAR 690-020-0120**. ~~Methods and modeling acceptable for inundation of infrastructure studies include:~~
~~(a) Hydraulic Modeling: Use of one-, two-, or three-dimensional modeling software (such as HEC-RAS, FLO-2D or MIKE) and hydrologic, topographic, and other data to estimate inundation of infrastructure downstream of dams.~~
~~(b) Hydrologic Routing Modeling: Use of modeling software such as HEC-HMS with hydrologic routing methods such as the Muskingum and Modified-Puls methods along with hydrologic and topographic data.~~
~~(c) Simplified Methods such as SMPDBK and the Washington State Method: "Dam Breach Analysis and Downstream Hazard Classification" may be used. A dam owner may request information on these methods from the department. Use of these or other simplified methods is only to be used in hazard ratings for dams, not for emergency action planning.~~
~~(d)~~**(3)** ~~Depth of inundation to trigger different hazard ratings~~: **Using the dam breach inundation analysis described in OAR 690-020-0120, the department shall make the final determination of any hazard rating using the following criteria:**

- **(a)** An **inundation** depth of at least two feet over the finished floors of **frequently occupied** buildings, ~~or~~ **paved** road **used by over 500 vehicles per day, or passenger railroad** surfaces ~~of infrastructure is required to~~ establish**es** a "high hazard" rating.
- **(b)** Any **inundation** depth of water over the floorboards of **multiple** structural buildings **on property other than the dam owners and excluding small buildings such as pump houses or storage sheds** ~~such as homes, barns, pump houses or storage sheds can~~ establish**es** a "significant hazard" rating.
- **(c)** For **other railroads and vulnerable utilities**, an inundation depth of two feet or evidence of depth and velocity capable of creating damage establishes a "significant hazard" rating.
- **(d) For water depths close to those listed in the subsections a and c, the Department may also consider water velocity in its determination of hazard rating.**

~~(4) Exceptions to Hazard rating methods:~~
~~(a) Small dams are not assigned a hazard rating.~~

(e) ~~(b)Situations in which there are~~ Wherever **h**eavy recreational **or** other frequent use occurs ~~uses~~ **downstream**~~, a dam may be rated as~~ a **"**high hazard" **rating shall be established to prevent** probable loss of life**. Such designation shall not depend** on the presence of downstream infrastructure.

~~(c) Specific data, methods and results for all methods must be reviewed and approved by the department prior to revising a hazard rating.~~

(~~3~~ **4)** The hazard rating of a dam shall remain in effect until the rating is revised by the department using ~~one of the methods described in section 2~~ the procedures described in OAR 690-020-0120. A dam owner may request that the department revise a hazard rating. The owner must provide information in support of the request~~. If the supporting information includes results and/or analysis using the methods described in subsections 2(a) or (b), the information must be~~ **and** prepared by an engineer licensed in Oregon and ~~familiar with hydraulic and hydrologic modeling; if the information includes results and/or analysis using the methods described in subsection 2(c), the information must be prepared by a licensed engineer or a practicing hydrologist~~ familiar with hydraulic and hydrologic calculations **using the procedures described in OAR 690-020-0120.**

~~(4) Exceptions to Hazard rating methods:~~

~~(a) Small dams are not assigned a hazard rating.~~

~~(b) Situations in which there are heavy recreational or other uses downstream, a dam may be rated as "high hazard" because of probable loss of life regardless of downstream infrastructure presence.~~

690-020-0120

Dam Breach Inundation Analysis

(1) A dam breach inundation analysis must be submitted with the design for any new dam, except only for dams in a remote location far enough from buildings, high use recreation sites or high use public roads so that damage or fatalities from a dam breach would be very unlikely as determined by the State Engineer.

(2) A dam breach inundation analysis is required to change the hazard rating of an existing dam.

(3) The dam breach inundation analysis must use a breach time based on dam materials and thickness and other factors that would influence the time it would take for the dam to breach from internal erosion, overtopping, or displacement.

(4) Any simplified and conservative hydraulic model may be used to show that a dam should be rated low hazard. The State Engineer may determine if the model was used appropriately and conservatively.

(4) Accepted and hydraulically consistent models must be used to conduct the inundation analysis for significant and high hazard dams, as these will be used in the event of an emergency at the dam. Models developed by the US Army Corps of Engineers including HEC-RAS are the preferred methods of analysis. Other models that use hydrodynamic equations checked for minimum tolerances such as FLO 2D are also acceptable for conducting dam breach inundation analysis.

(a) Information on the specific model used for analysis, dam breach parameters and justification, and all assumptions made for the analysis must be included in the documentation for the inundation analysis.

(5) Inundation analysis for hazard rating of high and significant hazard dams must be conducted with the reservoir at inflows from and at level associated with a 0.2 percent annual exceedance probability flood. The analysis must show on a map areas inundated, areas inundated by greater than 2 feet, and all frequently occupied structures.

(6) In following additional information shall also be required for newly constructed or modified high hazard rated dams.

(a) A sunny day and a PMF inflow analysis as part of the emergency action plan.

(b) The inundation mapping must include cross sections with depth and times to flood wave arrival, and must be extended downstream to a location where no significant property damage exists.

690-020-0150

Routine Inspection of Dams

1) The Department may conduct routine safety inspections of dams with an inspection frequency based on the hazard rating of the dam and may specify modifications necessary to insure the safety of the works to prevent possible damage to life or property.

(2) The frequency of inspections may be based on the hazard classification of the dam. Inspections may occur as follows.

(a) Inspections for high hazard dams may be scheduled on an annual basis.

(b) Inspections for significant hazard dams may be scheduled every three years.

(c) Inspections for low hazard dams may be scheduled every six years.

(3) Expedited inspections may be conducted if an urgent dam safety issue is identified or if there is a potential change in hazard classification.

(4) Following an inspection, the department shall provide to dam owners a letter with the inspection observations and recommendations that ensure the safety of the works.

690-020-0200

Fees for Dams

(1) **Dam** owners **subject to dam safety regulations** ~~of a large dam~~ shall submit to the department an annual fee in the amount **of** and on the basis established under ORS 536.050**(2)**.

(2) Dam owners who fail to pay an annual fee on or before six months after the billing date may be required to pay a late fee of $100.

(3) If a dam owner fails to pay the annual fee or late fee charged by the department, the department may, after giving the dam owner notice by certified mail, place a lien on the real property where the dam is located for the fees owed by the dam owner.

~~(4) Dams that are subject to the annual fee include dams partially or wholly in the State of Oregon that meet the definition of "dam" under OAR 690-020-0020.~~

(~~5~~4) Multiple large dams connected together and separated only by embankments or other manmade materials (common with sewage lagoons) will count as one dam for fee purposes.

~~(6) Owners Exempt from Fee Requirements include:~~

~~(a) Owners of a "small dam",~~

~~(b) Owners whose dams that are directly controlled or regulated for safety by an agency of the U.S. Federal Government and the agency that controls or regulates the dam has its own safety program that meets the following criteria:~~

~~(A) The program must allow for control of the design and construction process for dams under their control with licensed engineers designing and reviewing any major design or repair. Copies of all design drawings and construction records should be forwarded to the department for tracking and archival purposes.~~

~~(B) The program must have a regular dam inspection program that is either conducted by or directly supervised by a licensed engineer with expertise in dam safety. Formal documented dam inspections for~~

~~high hazard dams should occur at least once per year. For significant hazard dams, inspections shall occur at least once every 3 years and for low hazard dams, once every 6 years. Other more frequent inspections and reports on dam conditions may be necessary depending on the condition of individual dams. Copies of mutually agreed upon inspections and reports should be forwarded to the department for archival and tracking purposes.~~

~~(C) The federal agency in charge of the dam via regulation or control must also have a regular maintenance program or be able to require maintenance activity from the regulated party that will address problems discovered in the inspection program.~~

~~(D) The federal agency must have a memorandum of understanding or agreement with the department that outlines how the federal agency meets the criteria in paragraphs (b)(A)–(C), and must agree to meet at least annually with the department to review the state of the federal program for continued exemption purposes.~~

(5) The department may use the dam safety fee to support periodic dam safety inspections; conduct dam breach inundation analysis, help dam owners complete emergency action plans for existing dams; conduct or support the technical analysis of the safety of specific dams; and other actions as needed to support the dam safety program.

690-020-0250

Maintenance of dams

(1) When inspecting dams to insure the safety of the works, the Department may consider whether the dam owner has conducted routine maintenance on dams as follows:

- **(a) Whether brush and trees have been removed and whether vegetation on the embankment or spillway has been mowed;**
- **(b) Whether burrowing animals are controlled and animal burrows are filled;**
- **(c) Whether surface erosion is effectively controlled;**
- **(d) Whether freeboard, grading, or crest elevations have been reduced by minor settlement or cattle trampling and action to reduce freeboard have been taken;**
- **(e) Whether the spillway is functioning correctly and its capacity has been reduced;**
- **(f) Whether mechanical equipment has been properly cycled and lubricated;**
- **(g) Whether cracked concrete structures have been properly patched, sealed, caulked or replaced to prevent deterioration;**
- **(h) Whether debris, rock, or earth have been removed from outlet conduits, outlet channels or spillway channels;**
- **(i) Whether worn or damaged parts of outlet valves or controls to restore to functional condition are in need of replacement;**
- **(j) Any other condition or activity that might affect safety of the dam.**

(2) The Department may find that a dam will not insure the safety of the works if large trees or large wood vegetation exist on the dam.

(3) Maintenance deficiencies observed during periodic dam safety inspections, shall be contained in an inspection report provided to the dam owner.

690-020-0300

Modification of Dams Requiring Notification and or Approval:

(1) The following activities are considered such significant modification of the dam so as to constitute new construction requiring approval of engineered designs prior to initiating these activities.

(a) Any activity on the dam or an appurtenant structure that will change storage capacity in the reservoir;
(b) Repairing a dam after breach or overtopping of any dam;
(c) Stabilization of any landslide in or adjacent to the embankment (temporary emergency actions are allowed without approval);
(d) Alterations to the spillway that affect the spillway capacity or ability to pass the inflow design flood, or otherwise change the spillway's resistance to erosion from flood flows;
(e) Installing a penetrating conduit through a dam;
(f) Installing a valve at the outlet side of a low level conduit;
(g) Excavation into the dam and replacement of a low level conduit; and
(h) Ceasing use and sealing of low level conduit;

(2) Any activity that will increase the volume or rate of water released during failure requires a new inundation analysis using methods described in 690-020-0120 unless the dam is in a remote area with no downstream development that might be affected by a dam breach flood.

(3) The following repairs if done incorrectly may affect the safety of the dam. Repairs made after notification to the State Engineer, and submission of an as built drawing describing the repair indicating the repairs have maintained correctly may be deemed as evidence of the safety of the dam:

(a) Slip lining of existing conduits that does not involve excavation into the dam and does not result in a significant reduction in the time required for the conduit to empty the reservoir; and
(b) Replacement of toe drains.

690-020-0350
Operations and Maintenance Plans

(1) The Department may make inspection of the operation of works to insure the safety of the works and shall require a dam owner to provide to the Department operations and maintenance plans for new significant and high hazard dams, and for any dam with a gate or flashboard as part of the spillway. The dam owner shall be responsible for implementation of operations and maintenance plans.

(2) Operations and maintenance plans shall include:

(a) Procedures for operation of all gates and valves;
(b) Annual cycling of the slide gate and/or valves;
(c) The time of year flashboards are allowed in dams;
(d) Removal of trees and shrubs, and mowing other vegetation as needed;
(e) Routine inspections, including evaluation of seepage flow, and visual identification of any turbid seepage;
(f) Water release plan in the event of a flood forecast when reservoir is above a certain level; and
(g) Timing of Instrumentation readings, and maintenance requirements (at least annual) for all instrumentation.

690-020-0400
Emergency Action Plans (EAP) and Emergencies

(1) Emergency Action Plans are required prior to completion of new dam construction or modification as described in OAR 690-020-0300(1). This emergency action plan must be reviewed and approved by the State Engineer.

(2) Dam owners are encouraged to complete emergency action plans for their existing high hazard dams.

(3) An EAP shall contain, as a minimum, the following key elements:

- **(a) Emergency condition detection;**
- **(b) Emergency level determination;**
- **(c) Notification and communication lists and flowcharts applicable to each of the emergency levels;**
- **(d) Expected actions to prevent a dam failure incident or to help reduce the effects of a dam failure and facilitate response to an emergency:**
- **(e) Inundation mapping that normally includes both a sunny day and a probable maximum flood failure; and**
- **(f) Procedures for termination of the emergency.**

(4) Dam owners of High or Significant Hazard dams shall immediately notify the State Engineer of potential or actual dam failure situations.

(5) Dam owners shall notify the State Engineer of any breach of any dam subject to these regulations.

(6) If the department observes evidence of a dam at risk of imminent failure and a risk to life or property, local public safety officials shall be notified of the situation.

690-020-0500

Enforcement

(1) When any ~~structure~~ **dam** is found to be in violation of the terms and conditions of the permit or certificate or directly threatens life or property, or when any structure is found where lack of maintenance or unauthorized alterations could lead to a direct threat to life or property, the department shall notify the owner in writing of the violation and the action necessary and specified time allowed to bring the structure up to design, operation, or maintenance standards.

(2) Failure by the owner to perform the required action may result in proceedings for one or more of the following:

- (a) Notice and opportunity for a contested case hearing as provided for in ORS 540.350(5).
- (b) Cancellation of the permit.
- (c) Posting of the structure to prevent storage or to limit operation until the owner has complied with the requested action required to fulfill conditions of the permit or certificate.
- (d) Instituting legal action by the District Attorney or Attorney General to have the facility declared a public nuisance.
- (e) Issuance of an order to prevent storage or to breach the embankment as provided for in ORS 540.370.
- (f) Any other enforcement action permitted by law.

(3) Engineering work that is inconsistent with any rules in this Division may be referred to the Oregon Board of Examiners for Engineering and Land Surveying, for appropriate actions.