E.29. New Jersey
Hydrologic Research Needs for Dam Safety Analyses

by

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Somerset County Dam Safety Program

The following describes both the current scope and research needs of the dam safety program of Somerset County, New Jersey. The County encompasses 305 square miles in the central portion of the state and has a population of approximately 300,000, yielding a population density of approximately 1000 people per square mile. The County has experienced significant land development pressure since the 1970’s with no significant abatement expected in the foreseeable future.

Somerset County’s dam safety program includes the analysis, operation, inspection, and maintenance of nine Significant Hazard dams ranging in height from 13 to 40 feet with drainage areas ranging from approximately 50 acres to 10 square miles. Eight of these dams serve as regional stormwater detention facilities that help offset the adverse hydrologic impacts of land developments within their watersheds. The remaining dam is a former water intake dam located on property acquired from a private water purveyor and converted into a County park. Since their original design, engineering activities at the dams include the determination and periodic reassessment of their hazard classifications and Spillway Design Floods (SDFs) as well as any subsequent revisions to their Emergency Action Plans (EAPs). These activities are performed in accordance with the Dam Safety Standards (N.J.A.C. 7:20) of the Dam Safety Section of the N.J. Department of Environmental Protection (NJDEP).

In addition to the dam safety activities described above, the County Planning Board also regulates that stormwater management aspects of all new land developments in the County that front on a County road and/or drain to a County bridge or culvert. These regulations typically result in the design and construction of one or more onsite stormwater detention basins that can range up to approximately 15 feet in height and up to 100 acres in drainage area. While the design of such basins do not normally require a dam break and downstream inundation analysis, the design does include the determination of emergency spillway size and top of dam elevation. This is done using County-based emergency spillway criteria at all dams not subject to the NJDEP Dam Safety Standards noted above. An unofficial survey indicates that there are presently more than 500 such basins in County, most close to residential, commercial, and/or industrial structures.

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Current State and County Practices

As noted above, all County-owned dams are regulated by the Dam Safety Standards of the NJDEP’s Dam Safety Section. Similar to the FERC’s Engineering Guidelines for the Evaluation of Hydropower Projects, these state standards classify dams by Hazard Class based upon the threat posed by a dam failure to downstream structures and roadways. A summary of the various NJDEP Hazard Classes is presented in Table 1 below.

Table 1

Summary of Dam Hazard Classes and Spillway Requirements
NJDEP Dam Safety Standards

<table>
<thead>
<tr>
<th>Hazard Class</th>
<th>Downstream Failure Threat</th>
<th>Spillway Design Storm</th>
</tr>
</thead>
<tbody>
<tr>
<td>I – High</td>
<td>Loss of Life or Extensive Property Damage</td>
<td>PMP</td>
</tr>
<tr>
<td>II- Significant</td>
<td>Significant Property Damage</td>
<td>One-Half PMP</td>
</tr>
<tr>
<td>III – Low</td>
<td>Minor Property Damage</td>
<td>100-Year NRCS Type III</td>
</tr>
<tr>
<td>IV – Small Dams</td>
<td>Height &lt; 15 Feet, Storage &lt; 15 Acre-Feet, Drainage Area &lt; 150 Acres*</td>
<td>100-Year + 50 Percent NRCS Type III</td>
</tr>
</tbody>
</table>

* Class IV Dam criteria only applicable if Class I or II threats do not exist.

According to discussions with NJDEP Dam Safety personnel, PMP rainfall amounts are typically obtained from HMR No. 51. For the majority of projects, spatial distribution of the rainfall is not necessary and the rainfalls are temporally distributed in accordance with a variety of storm distributions, including the NRCS Type III distribution and the U.S. Army Corps of Engineers PMP distribution as contained in HEC-1 Flood Hydrograph Package. One foot of freeboard is required above the routed SDS water surface. The NRCS Runoff Equation and Dimensionless Unit Hydrograph are typically used to compute losses and convert the rainfall to runoff. Antecedent Moisture Conditions are typically assumed to be either average (AMC II) or high (AMC III). Sources of dam failure parameters vary, with those published in the FERC Engineering Guidelines or derived from the Froelich equations utilized most frequently.

Downstream discharges and water surface profiles are typically computed using steady flow assumptions with HEC-1 used for discharge and failure computations and either HEC-2 Water Surface Profiles or HEC-RAS River Analysis System used for profile computations. Unsteady flow computations using either DAMBRK or FLDWAV are used on approximately 10 percent of the projects, which typically involve large dams and drainage areas. Downstream failure impacts are typically assessed based upon the difference in water surface with and without a dam failure, with a difference greater than two feet considered excessive. A minority of projects utilizes the Downstream Hazard Classification Guidelines published by the Bureau of Reclamation.

As noted above, the Somerset County dam safety criteria, which were originally established in 1975, apply to all structures subject to County Planning Board approval unless superceded by the NJDEP regulations described above. Hazard classification for
all dams is assumed to be Class B as defined by the NRCS unless a reconnaissance of downstream conditions warrants a higher classification. Safe spillway capacity and freeboard requirements are based upon routing Emergency Spillway (ESH) and Freeboard (FBH) Hydrographs through the facility based upon 24-hour rainfalls of 10 and 17 inches, respectively. These rainfalls were derived from the same equations used by the NRCS to develop the Service’s 6-hour ESH and FBH rainfalls. It should also be noted that the County’s 17 inch FBH rainfall is equivalent to one-half of the 24-hour PMP for the County.

Problems and Research Needs

A summary of technical and operational problems and related hydrologic research needs of both the NJDEP and Somerset County dam safety programs is presented below. The NJDEP problems and needs were identified during interviews with representatives of the NJDEP’s Dam Safety Section. Resolution of these problems and needs, either through research and/or policy decisions, will help improve the effectiveness and efficiency of both programs.

1. Perhaps the most significant operational problem facing the State and County dam safety programs is the lack of hydrologic and hydraulic expertise in many of the engineers performing dam failure, inundation, and hazard classification studies and/or preparing emergency spillway designs. In the last 20 years, both the sophistication and availability of computer-based models to perform such studies and designs has increased significantly, along with the data to base them on. Unfortunately, these models and databases have exceeded, in many instances, the knowledge and expertise of the modelers and designers of small dams. This “ability gap” leads to inaccurate studies and designs and prevents many dam safety programs from realizing their full potential, thereby negating the efforts of researchers and regulators to create advanced, effective dam safety programs. Under such conditions, further technical advances can be expected to only widen this gap.

Research Request: Investigate the feasibility of establishing minimum education and/or experience requirements for engineers performing dam safety studies and designs for small dams. Alternately, develop a basic set of small dam hydrology and hydraulic courses that can be presented by state and/or local dam safety officials to engineers within their jurisdictions.

2. A technical problem that has grown more acute in recent years involves the presence of concrete corewalls within older earthen dams that have come under closer scrutiny by dam safety personnel. Similar problems also arise with older dams that have been constructed with masonry or concrete walls along their upstream face. These walls were commonly utilized to prevent seepage from the upstream impoundment and, while they theoretically have little structural strength, experience has shown that some have been able to remain intact even after the loss of large portions of the downstream fill material. Such dams, due to their age, typically have principal spillways that are inadequate under
present standards and, as such, are prone to failure due to overtopping. However, modeling this failure can be difficult, particularly in the selection of failure width and time due to the presence of the concrete wall within or upstream of the earthen fill. While conservatively large width and short time parameters can be selected, their use may result in overestimates of hazard class and Spillway Design Storm. This, in turn, may require the construction of excessive remedial measures that the owners, who are predominantly private individuals or organizations, may find cost-prohibitive.

**Research Request:** Develop typical failure parameters and/or policies for dams with corewalls and upstream face walls that can be utilized or adopted by local and state dam safety programs.

3. Standard computation methods for drainage area Time of Concentration (TC) are typically intended for use in estimating flood peaks and hydrographs for frequencies up to the 100-Year storm. However, both theory and experience suggest that shorter TCs should be used when computing peaks and hydrographs from larger, less frequent events such as the PMF, due primarily to the greater flow depths and velocities. As such, the standard computation methods may be yielding lower peak flow estimates for such events, which can lead to inaccurate hazard classification and underdesigned remedial measures.

**Research Request:** Investigate accuracy of standard TC computation methods under extreme storm conditions. If necessary, develop alternative methods or policies for estimating drainage area TCs for such extreme events.

4. Since the majority of dams subject to local or state dam safety regulations have drainage areas less than 10 square miles, questions arise over the most appropriate temporal rainfall distribution to utilize in a hazard classification and/or Spillway Design Storm analysis. These questions include concerns whether the NRCS design storm distributions are appropriate for extreme rainfall amounts and whether other popular storm distributions such as the Corps of Engineers’ Standard Project Storm is appropriate for small drainage areas.

**Research Request:** Investigate suitability of popular design storm distributions for extreme rainfall amounts falling over small drainage areas. Develop appropriate distribution for such rainfalls and areas through research and/or policy.

5. As noted above, the majority of water surface profile computations downstream of a dam failure are based upon steady rather than unsteady flow assumptions. In most instances, however, the selection of steady over unsteady flow is not based upon theoretical grounds but rather on the difficulty in performing the unsteady flow computations with the DAMBRK and FLDWAV computer programs (see 1 above). The recent inclusion of unsteady flow in HEC-RAS offers an opportunity to address this problem. However, limited training has been available to date to small dam designers and analysts and local and state dam safety personnel.
Research Request: Develop guidelines and limitations for use of steady flow models in
dam safety studies. Also develop effective HEC-RAS unsteady flow and FLDWAV
training courses for small dam analysts and designers and local and state dam safety
personnel.

6. The most significant and, at times, prohibitive cost of an accurate hazard classification
or Spillway Design Storm study for a small dam is incurred during the development of
the hydraulic model of the downstream waterway. Costs associated with field surveys,
topographic mapping, and model data development often exceed the remaining study
costs.

Research Request: Develop inexpensive techniques to develop waterway and
floodplain topography and cross sections in a digital format that can readily be input into
available hydraulic computer models.

7. According to the FERC’s Engineering Guidelines, dam failures should not be assumed
to begin on the rising limb of the inflow hydrograph. Instead, the presumably more
conservative assumption of failure starting at the maximum water surface should be
made. However, instances have arisen where greater discharges are computed when the
failure is assumed to occur somewhat before the maximum water surface is achieved.
This is particularly true at certain small dams with very short (10 to 15 minute) failure
times. In these instances, the rapid enlargement of the dam breach begins while the water
surface is still rising, leading to ultimately greater heads and resultant peak outflows due
to the failure. While these greater peak outflows can be identified through sensitivity
analyses of failure starting times, such analyses can increase costs for small dam projects.

Research Request: Determine the sensitivity of starting water surface elevation to peak
outflows from small dam failures and establish parameters to identify the most
conservative starting water surface assumptions.

Acknowledgements

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of New Jersey practices, problems, and research needs.
SAFE DAM ACT

58:4-1 Reservoir, dam restrictions.

58:4-1. a. No municipality, corporation or person shall, without the consent of the Commissioner of Environmental Protection, hereafter in this chapter designated as the commissioner, build any reservoir or construct any dam, or repair, alter or improve existing dams on any river or stream in this State or between this State and any other state which will raise the waters of the river or stream more than five feet above its usual mean low-water height.

No municipality, corporation or person shall, without the consent of the commissioner, build any reservoir or construct any dam, or repair, alter or improve existing dams in the pinelands area, as designated by subsection a. of section 10 of P.L.1979, c.111 (C.13:18A-11), which will raise the waters of any river or stream more than eight feet above the surface of the ground where the drainage area above the dam or reservoir is more than one square mile in extent and where the water surface created by the dam or reservoir is more than 100 acres in extent.

The commissioner may investigate and take appropriate action regarding any dam or reservoir about which the commissioner has a security or safety concern.

With respect to dams and reservoirs located on lands utilized for agricultural or horticultural purposes within the pinelands area, the commissioner's actions shall be undertaken after consultation with the Secretary of Agriculture.

b. The commissioner shall not require a permit for the repair of any dam used for agricultural purposes within a special agricultural production area designated pursuant to N.J.A.C.7:50-5.14 in the pinelands area.

Amended 1981, c.249, s.3; 1985, c.33; 1995, c.402, s.1; 2001, c.82, s.1.

58:4-2. Approval of plans of reservoirs and dams

Every municipality, corporation or person, before constructing any reservoir or dam subject to the provisions of this chapter shall apply to the commissioner for the approval of the plans of such reservoir or dam, which approval the commissioner may grant with such modifications, limitations or changes as in his judgment may be necessary for the protection of life and property.

Amended by L.1981, c. 249, s. 4, eff. Aug. 6, 1981.

58:4-3. Descriptions, surveys and plans of existing reservoirs and dams

Every municipality, corporation or person owning and maintaining or having control of any reservoir or dam shall, upon written request therefor, furnish to the commissioner as full, true and particular description of the reservoir or dam as may be practicable, and shall, when so requested by the commissioner cause to be made such surveys, plans and drawings of the reservoir or dam as may be necessary to give sufficient information for the determination of its safety as may be required by the commissioner.

Amended by L.1981, c. 249, s. 5, eff. Aug. 6, 1981.
58:4-4. Inspection of reservoirs and dams
Upon written application by any person owning or representing property liable to be injured or destroyed by the breaking of any reservoir or dam, or upon application by the mayor or governing body of any municipality on account of possible danger of loss of life or of injury to any property within the municipality from the breaking of any reservoir or dam, or without such complaint whenever the commissioner shall choose, he shall forthwith thoroughly inspect such reservoir or dam.

Amended by L.1981, c. 249, s. 6, eff. Aug. 6, 1981.

58:4-5 Alterations, additions and repairs of unsafe reservoirs or dams; duties of owner.

58:4-5. a. An owner or person having control of a reservoir or dam shall:

(1) Implement all measures required pursuant to this chapter or the provisions of P.L.1981, c.249 (C.58:4-8.1 et seq.), or any rule, regulation, code, permit or order issued pursuant thereto, including but not limited to, performance of periodic inspections required pursuant to section 2 of P.L.1981, c.249 (C.58:4-8.2) or development, updating and implementation of emergency action plans;

(2) Provide to the Department of Environmental Protection, upon request, any reports or information required pursuant to this chapter or the provisions of P.L.1981, c.249, or any rule or regulation adopted, or permit or order issued pursuant thereto; and

(3) Implement any action ordered by the Commissioner of Environmental Protection to correct conditions that render the reservoir or dam to be considered, as determined by the commissioner, unsafe or improperly maintained or to bring the reservoir or dam into compliance with standards established pursuant to this chapter, or any rule or regulation adopted, or permit or order issued pursuant thereto.

b. If, in the judgment of the commissioner, any reservoir or dam is not sufficiently strong to resist the pressure of water that is or may be upon it or there is reasonable cause to believe that danger to life or property may be anticipated from the reservoir or dam, or if for any other cause the commissioner shall determine the reservoir or dam to be unsafe or improperly maintained, the commissioner shall take any action authorized pursuant to this section to compel compliance with the provisions of this chapter, or any rule or regulation adopted, or permit or order issued pursuant thereto, and shall determine whether the water in the reservoir or above the dam shall be drawn off in whole or in part, and what alterations, additions and repairs are necessary to be made to the reservoir or dam to make it safe and properly maintained or whether the dam or appurtenant structures located therein should be removed. The commissioner also may take action as authorized pursuant to R.S.58:4-6 against the owner or person having control of the reservoir or dam for such relief as the commissioner may determine. The commissioner shall forthwith in writing order the owner or person having control of the reservoir or dam to cause the alterations, additions and repairs to be made within the time to be limited in the order. A copy of any order issued by the commissioner pursuant to this section shall be sent to the clerk of the municipality and the clerk of the county in which the reservoir or dam is located. The commissioner also may order the water in the reservoir or above the dam to be drawn off in whole or in part as the commissioner may determine. The commissioner shall not approve the decommissioning of a reservoir or dam until the commissioner has provided 30 days' prior notice
and the commissioner has complied with the provisions of R.S.58:4-10 as applicable. The notice of the proposed decommissioning shall be published at least 30 days prior to the decommissioning of the reservoir or dam in at least one newspaper of general circulation in the municipality in which the reservoir or dam is located. The commissioner shall have the right to enter upon any and all properties for the purpose of obtaining information about the safety and proper maintenance of any reservoir, dam or appurtenant structures located therein.

c. Any owner or person having control of a reservoir or dam who fails to comply with an order issued pursuant to this section or R.S.58:4-6 may be liable to the department in an amount equal to the cost of removal of the dam or appurtenant structures located therein undertaken by the department, including attorney's fees and court costs, pursuant to subsection d. of this section.

Whenever two or more owners or persons having control of a reservoir or dam are liable for the cost of removal, including attorney's fees and court costs, the department may allocate the cost of removal among the liable parties using such factors as the department determines are appropriate. Nothing in this subsection shall affect the right of any party to seek contribution from any other person responsible for the cost of removal of the dam pursuant to any other statute or under common law.

d. (1) Whenever the commissioner determines that a dam is in imminent danger of failure and has reasonable cause to believe that danger to life or property may be anticipated from the reservoir, dam or appurtenant structures located therein, and the owner of the dam or person having control of the reservoir or dam has failed to comply with an order to repair the dam issued pursuant to subsection a. of this section or R.S.58:4-6, or to take such interim measures as the department determines are appropriate, including reducing the amount of water impounded by the dam or breaching the dam, the department may, in addition to actions authorized pursuant to R.S.58:4-6, enter upon any and all properties whereon the reservoir, dam or appurtenant structures are located and, using resources and personnel available to the department, remove or cause to be removed the dam or appurtenant structures located therein, allowing the water to flow freely.

Prior to any action by the department pursuant to this subsection, the owner or person having control of the reservoir or dam, shall, no later than 60 days after receipt of a notice from the department of a pending removal action, submit to the department, in writing, an acceptable implementation plan addressing the proposed actions to be taken regarding the failed or failing reservoir or dam.

(2) Any expenditures made by the department pursuant to this section shall constitute, in each instance, a debt to the State. The debt shall constitute a lien on all property owned by the owner or person having control of the reservoir or dam when a certificate of debt, incorporating a description of the property of the owner or person having control of the reservoir or dam subject to the repair, and related costs, is duly filed with the clerk of the Superior Court. The clerk shall promptly enter upon the civil judgment and order docket the name and address of the owner or person having control of the reservoir or dam and the amount of the lien as set forth in the certificate of debt. Upon entry by the clerk, the lien, to the amount committed by the department for dam repair, shall attach to the revenues and all real and personal property of the owner or person having control of the reservoir or dam, whether or not the owner or person having control of the reservoir or dam is insolvent.
The certificate of debt filed pursuant to this paragraph which affects the property of an owner or person having control of a reservoir or dam subject to the dam repairs shall create a lien with priority over all other claims or liens which are or have been filed against the property, except if the property comprises six dwelling units or less and is used exclusively for residential purposes, this certificate of debt shall not affect any valid lien, right or interest in the property filed in accordance with established procedure prior to the filing of this certificate of debt.

The certificate of debt filed pursuant to this subsection which affects any property of an owner or person having control of a reservoir or dam, other than the property subject to the repairs, shall have priority from the day of the filing of the certificate of debt over all other claims and liens filed against the property, but shall not affect any valid lien, right, or interest in the property filed in accordance with established procedure prior to the filing of a certificate of debt pursuant to this subsection.

Whenever the owner or person having control of the reservoir or dam is a private lake association or other body representing owners of property adjacent to the reservoir or lake created by the dam or impoundment, liens may be imposed upon the individual owners of the property represented by the association. An owner whose property has such a lien imposed may release the property from a lien claimed under this subsection by filing with the clerk of the Superior Court a cash or surety bond, payable to the department in the amount of the sums expended by the department pursuant to this section, including attorney's fees and court costs, or the value of the property after the abatement action is complete, whichever is less.

e. The provisions of this section shall not limit the use of other remedies available to the department pursuant to law.

f. The commissioner may adopt, pursuant to the "Administrative Procedure Act," P.L.1968, c.410 (C.52:14B-1 et seq.), any rules or regulations necessary to implement the provisions of this section.

Amended 1981, c.249, s.7; 1994, c.84, s.1; 2005, c.228, s.1.

58:4-6 Enforcement powers of department, civil, criminal; violations; penalties.

58:4-6. a. Whenever the Commissioner of Environmental Protection finds that a person has violated any provision of the "Safe Dam Act," P.L.1981, c.249 (C.58:4-8.1 et seq.), or any rule, regulation or order issued pursuant thereto, the commissioner may:

(1)Issue an order requiring any such person to comply in accordance with subsection b. of this section; or

(2)Bring a civil action in accordance with subsection c. of this section; or

(3)Levy a civil administrative penalty in accordance with subsection d. of this section; or

(4)Bring an action for a civil penalty in accordance with subsection e. of this section; or

(5)Petition the Attorney General to bring a criminal action in accordance with subsection f. of this section.
Recourse to any of the remedies available under this section shall not preclude recourse to any of the other remedies prescribed in this section or by any other applicable law.

b. Whenever, on the basis of available information, the commissioner finds a person in violation of any provision of P.L.1981, c.249, or any rule, regulation or order issued pursuant thereto, the commissioner may issue an administrative order: (1) specifying the provision or provisions of the law, rule, regulation, or order, of which the person is in violation; (2) citing the action which constituted the violation; (3) requiring compliance with the provision or provisions violated; (4) requiring the restoration of the area which is the site of the violation; and (5) providing notice to the person of the right to a hearing on the matters contained in the order.

c. The commissioner is authorized to institute a civil action in Superior Court for appropriate relief from any violation of P.L.1981, c.249, or any rule, regulation or order issued pursuant thereto. Such relief may include, singly or in combination:

(1) A temporary or permanent injunction, including an order or judgment as will effectually secure the persons interested from danger of loss from the breaking of a dam. The court may proceed in the action in a summary manner or otherwise;

(2) Assessment of the violator for the costs of any investigation, inspection, or monitoring survey which led to the establishment of the violation, and for the reasonable costs of preparing and bringing legal action under this subsection;

(3) Assessment of the violator for any costs incurred by the State in removing, correcting, or terminating the adverse effects resulting from any violation for which legal action under this subsection may have been brought;

(4) Assessment against the violator for compensatory damages for any loss or destruction of wildlife, fish or aquatic life, and for any other actual damages caused by a violation;

(5) A requirement that the violator restore the site of the violation to the maximum extent practicable and feasible.

d. The commissioner is authorized to assess a civil administrative penalty of up to $25,000 for each violation of any provision of P.L.1981, c.249, or any rule, regulation or order issued pursuant thereto, and each day during which each violation continues shall constitute an additional, separate, and distinct offense. Any amount assessed under this subsection shall fall within a range established by regulation by the commissioner for violations of similar type, seriousness, and duration. In adopting rules and regulations establishing the amount of any penalty to be assessed, the commissioner may take into account the economic benefits from the violation gained by the violator. No assessment shall be levied pursuant to this section until after the party has been notified by certified mail or personal service. The notice shall: (1) identify the section of the law, rule, regulation or order violated; (2) recite the facts alleged to constitute a violation; (3) state the amount of the civil penalties to be imposed; and (4) affirm the rights of the alleged violator to a hearing. The ordered party shall have 20 days from receipt of the notice within which to deliver to the commissioner a written request for a hearing. After the hearing and upon finding that a violation has occurred, the commissioner may issue a final order specifying the amount of the fine imposed. If no hearing is requested, the notice shall become final after the expiration of the 20-day period. Payment of the assessment is due when a final order is issued or
the notice becomes a final order. The authority to levy an administrative penalty is in addition to all other enforcement provisions in this act and in any other applicable law, rule, or regulation, and the payment of any assessment shall not be deemed to affect the availability of any other enforcement provisions in connection with the violation for which the assessment is levied. Any civil administrative penalty assessed under this section may be compromised by the commissioner upon the posting of a performance bond by the violator, or upon such terms and conditions as the commissioner may establish by regulation.

e. A person who violates any provision of P.L.1981, c.249 or any rule, regulation or order issued pursuant thereto, an administrative order issued pursuant to subsection b. of this section, or a court order issued pursuant to subsection c. of this section, or who fails to pay a civil administrative penalty in full pursuant to subsection d. of this section, shall be subject, upon order of a court, to a civil penalty not to exceed $10,000 per day of such violation, and each day during which the violation continues shall constitute an additional, separate, and distinct offense. Any civil penalty imposed pursuant to this subsection may be collected with costs in a summary proceeding pursuant to the "Penalty Enforcement Law of 1999," P.L.1999, c.274 (C.2A:58-10 et seq.). In addition to any penalties, costs or interest charges, the court may assess against the violator the amount of actual economic benefit accruing to the violator from the violation. The Superior Court and the municipal court shall have jurisdiction to enforce the provisions of the "Penalty Enforcement Law of 1999" in connection with this section.

f. A person who purposely, knowingly or recklessly violates any provision of P.L.1981, c.249, or any rule, regulation or order issued pursuant thereto, shall be guilty, upon conviction, of a crime of the fourth degree and, notwithstanding any provision of N.J.S.2C:43-3 to the contrary, shall be subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, in addition to any other applicable penalties and provisions under Title 2C of the New Jersey Statutes. A second or subsequent offense under this subsection shall subject the violator to a fine, notwithstanding any provision of N.J.S.2C:43-3 to the contrary, of not less than $5,000 nor more than $50,000 per day of violation, in addition to any other applicable penalties and provisions under Title 2C of the New Jersey Statutes. A person who knowingly makes a false statement, representation, or certification in any application, record, or other document filed or required to be maintained under the provisions of P.L.1981, c.249 shall be guilty, upon conviction, of a crime of the fourth degree and, notwithstanding any provision of N.J.S.2C:43-3 to the contrary, shall be subject to a fine of not more than $10,000, in addition to any other applicable penalties and provisions under Title 2C of the New Jersey Statutes.

g. In addition to the penalties prescribed in this section, a notice of violation of any provision of P.L.1981, c.249, or any rule, regulation or order issued pursuant thereto, shall be recorded on the deed of the property wherein the violation occurred, on order of the commissioner, by the clerk or register of deeds and mortgages of the county wherein the affected property is located and with the clerk of the Superior Court and shall remain attached thereto until such time as the violation has been remedied and the commissioner orders the notice of violation removed.

h. The department may require an owner or person having control of a reservoir or dam to provide any information the department requires to determine compliance with any provision of P.L.1981, c.249, or any rule, regulation or order issued pursuant thereto.

i. Any person who knowingly, recklessly, or negligently makes a false statement, representation or certification in any application, record, or other document filed or required to be maintained
under the provisions of P.L.1981, c.249, shall be in violation of the act and shall be subject to the penalties assessed pursuant to subsections d. and e. of this section.

j. All penalties collected pursuant to this section or sums collected pursuant to R.S.58:4-5 shall be deposited in the "Environmental Services Fund," established pursuant to section 5 of P.L.1975, c.232 (C.13:1D-33), and kept separate from other receipts deposited therein, and appropriated to the department for the removal of dams in the State.

k. The department shall have the authority to enter any property, facility, premises, or site for the purpose of conducting inspections to determine the condition of any dam, or to conduct inspections of ordered repairs or to otherwise determine compliance with the provisions of P.L.1981, c.249.

Amended 1953, c.54, s.5; 1981, c.249, s.8; 2005, c.228, s.2.

58:4-8. Personnel to conduct inspections
The commissioner may, when provided with sufficient funds, employ personnel for the inspection of existing reservoirs and dams and the supervision of the erection of new reservoirs and dams in this State or between this and any other state so that said structures may be built with due regard for the safety of property and life which might be endangered by improper construction thereof.

Amended by L.1981, c. 249, s. 9, eff. Aug. 6, 1981.

58:4-8.1. Short title
This act shall be known and may be cited as the "Safe Dam Act."

L.1981, c. 249, s. 1, eff. Aug. 6, 1981.

58:4-8.2. Periodic dam safety inspection and reporting procedure
The Commissioner of Environmental Protection shall, by rule, establish a periodic dam safety inspection and reporting procedure, on an annual or longer term basis, for the owner of any dam meeting the criteria contained in R.S. 58:4-1. The owner shall have a professional engineer inspect the dam and prepare and submit a report containing such information as the commissioner may require, concerning the safety of said dam and appurtenant structures. Every dam which raises the waters of any stream more than 70 feet above its usual mean low-water height or which impounds more than 10,000 acre-feet of water shall be inspected on an annual basis by a professional engineer retained by the owner, in the company of a professional engineer assigned from the Department of Environmental Protection.

L.1981, c. 249, s. 2, eff. Aug. 6, 1981.

58:4-9. Maintenance of existing reservoirs and dams; petition against abandonment
58:4-9. Where a reservoir or dam has been in existence 20 years and the owners of land along the shores above the dam or on the reservoir have made or shall have made permanent improvements on the land or where the shores have become a populated community, depending upon the permanency of the condition created, or where the reservoir or dam has become a valuable resource for the quality of life in the municipality in which the reservoir or dam is located, and a petition signed by a majority of the landowners along the shore of any pond formed by the reservoir or dam, or by any number of residents of the municipality in which the
reservoir or dam is located, or by the governing body of the municipality, protesting against the removal of the reservoir, water or dam or the decommissioning of the reservoir or dam has been filed with the commissioner, the owner or owners of the reservoir or dam shall not, without the consent of the commissioner, tear down, destroy or abandon the reservoir or dam, or, except for the purpose of making necessary repairs, withdraw the water below the usual low-water mark, or maintain the water at the reduced level.

Amended 1981,c.249,s.10; 1994,c.84,s.2.

58:4-10. Hearing on petition; fixing low-water mark; maintenance expenses
58:4-10. When a petition has been filed protesting against the removal of any reservoir, water or dam or against the decommissioning of any reservoir or dam as provided in R.S.58:4-9, the commissioner shall hold a public hearing, upon 30 days' notice to all parties interested, and following prior notice published 30 days before the hearing in at least one newspaper of general circulation in the municipality in which the reservoir or dam is located. Following this public hearing, the commissioner may make a determination concerning the removal of the reservoir, water or dam or decommissioning of the reservoir or dam and may then establish and fix a permanent low-water mark. Should it appear that the maintenance of the reservoir or dam would be an undue burden upon the owner thereof, the commissioner shall enter into negotiations with the landowners interested around the reservoir or above the dam, the governing body of the municipality in which the reservoir or dam is located, and any other parties to the petition filed with the commissioner protesting against the removal of the reservoir, water or dam or the decommissioning of the reservoir or dam, for the purpose of determining how and by whom the expenses of maintenance shall be paid.

Amended 1981,c.249,s.11; 1994,c.84,s.3.
N.J.A.C. 7:20

Dam Safety Standards

Statutory authority: Safe Dam Act, N.J.S.A. 58:4-1

Date last amended: June 16, 2008

For regulatory history and effective dates see the New Jersey Administrative Code Table of Contents
DAM SAFETY STANDARDS
N.J.A.C. 7:20
EFFECTIVE DATE: SEPTEMBER 8, 2005,
AMENDMENT JUNE 16, 2008
EXPIRATION DATE: SEPTEMBER 8, 2010

SUBCHAPTER 1. APPLICATION PROCEDURE; DESIGN CRITERIA
FOR DAM CONSTRUCTION; DAM INSPECTION
PROCEDURE

N.J.A.C. 7:20-1.1 Scope and applicability
The rules in this subchapter were adopted pursuant to the authority of N.J.S.A. 58:4-1 et seq., as amended by the Safe Dam Act of 1981, and N.J.S.A. 13:1D-1 et seq.

1. These rules set forth procedures for application to construct, repair or modify a dam, as defined in N.J.A.C. 7:20-1.2 and set standards for design and maintenance of dams. These rules also establish a dam inspection procedure.

2. Any dam which raises the waters of a stream five feet or less above its usual, mean, low water height falls under the jurisdiction of the Flood Hazard Area Control Act, N.J.S.A. 58:16A-50 et seq.

3. The requirements in this subchapter shall not affect or relate to a dam or reservoir in the pinelands area, as designated by subsection a. of section 10 of P.L. 1979, c.111 (C. 13:18A-ll), which will raise the waters of any river or stream less than eight feet above the surface of the ground where the drainage area above the same is less than one square mile in extent and where the water surface created by the dam or reservoir is less than 100 acres in extent except that the commissioner may investigate and take appropriate action regarding any dam or reservoir about which he has a security or safety concern. With respect to dams and reservoirs located on lands utilized for agricultural or horticultural purposes within the pinelands area, the commissioner's actions shall be undertaken after consultation with the Secretary of Agriculture. See N.J.S.A. 58:4-1, P.L. 1985, c.33, SI and 2.

N.J.A.C. 7:20-1.2 Definitions
The following words and terms, as used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

"Applicant" means any person making application for a dam permit.

"Auxiliary spillway" means the second used spillway during flood flows which is not the emergency spillway.
"Dam" means any artificial dike, levee or other barrier, together with appurtenant works, which is constructed for the purpose of impounding water on a permanent or temporary basis, that raises the water level five feet or more above the usual, mean, low water height when measured from the downstream toe-of-dam to the emergency spillway crest or, in the absence of an emergency spillway, the top-of dam.

"Department" means the New Jersey Department of Environmental Protection.

"Design freeboard" means the minimum freeboard which would exist during passage of the design flood.

"Division" means the Division of Engineering and Construction in the Department of Environmental Protection.

"Emergency spillway" means the spillway capable of passing the spillway design storm with the principal and/or auxiliary spillway blocked.

"Environmental impact statement" means a report which describes the real and potential impacts which will or may result from the construction and operation of a proposed dam project, the adverse environmental impacts which cannot be avoided, the steps to be taken to minimize adverse impacts and the alternatives to the project with reasons for the acceptability or unacceptability; and

1. The report shall address real or potential impacts upon ecology, natural resources, historical and archeological resource, recreational resources, aesthetic resources, endangered and non-game species, fisheries and any other identifiable impacts;

2. The report shall include a listing of qualifications of those preparing the report and a reference list of pertinent published information relating to the project, the project site and the surrounding region.

"Formal inspection" means the inspection by a New Jersey licensed professional engineer to reevaluate the safety and integrity of the dam and appurtenant structures to determine if the structure meets current design criteria, including a field inspection and a review of the records on project design, construction and performance.

"Freeboard" means the vertical dimension between the crest of the embankment of a dam (without camber) and the reservoir water surface at the spillway design flood stage.

"Height-of-dam" means the vertical dimension from the lowest point in the stream bed or ground surface at the downstream toe of the dam to the elevation of the top of dam (without camber).

"Independent Review Board" means one or more independent professional engineers who are qualified in the design, construction and rehabilitation of dams to perform a review of
the project design and construction.

"Informal inspection" means the visual inspection of the dam by the dam owner or operator to detect apparent signs of deterioration or other deficiencies of the dam structure or function.

"Levee" or "dike" means any artificial barrier together with appurtenant works that will divert or restrain the flow of a stream or river.

"One-hundred-year storm" means the storm which is estimated to have a one percent chance, or one chance in 100, of being equaled or exceeded in one year.

"Outlet" means an opening through which water can be freely discharged from a reservoir for a particular purpose.

"Owner and/or operator" means any person who owns, controls, operates, maintains, manages or proposes to construct a dam.

"Permit" or "dam permit" means all approvals required under N.J.S.A. 58:4-1 et seq. for the construction and operation of a dam.

"Person" means any individual, proprietorship, partnership, association, corporation, municipality, county or public agency.

"Pipe conduit" means any hollow tube which conveys water through a dam from a reservoir, either as a spillway or as a drain.

"Principal spillway" means the primary or first used spillway during normal inflow and flood flows.

"Probable maximum precipitation" or "(PMP)" means the theoretically greatest depth of precipitation for a given duration that is physically possible, over a given size storm area, at a particular geographic location, at a certain time of year.

"Regular inspection" means the visual inspection of a dam by a New Jersey licensed professional engineer to detect any signs of deterioration in material, developing weaknesses or unsafe hydraulic or structural behavior.

"Reservoir" means any impoundment or any potential impoundment that will be created by a dam, dike or levee.

"Spillway" means a structure other than low flow outlets, over or through which flood flows are discharged.

"Spillway design storm" means the storm upon which the hydraulic capacity of the spillway structure is designed.
"Toe-of-dam" means the junction of the downstream face of a dam with the ground surface or the invert of the outlet pipe whichever is the lowest point.

**N.J.A.C. 7:20-1.3 Permit-by-rule**

(a) All dams must be designed, constructed, operated, maintained or removed in compliance with the rules in this subchapter except as set forth below:

1. Owners and operators of Class IV dams (see N.J.A.C. 7:20-1.8, Dam classification) are not required to file documents with nor obtain a permit from the Department, but must meet the following requirements, in addition to those set forth elsewhere in this subchapter:
   
i. Design must be based upon a spillway design storm that results in rainfall of 50 percent greater than a 24-hour, 100-year, Type III storm (Later technology adopted by the United States Department of Agriculture, Natural Resources Conservation Service may be substituted for the use of the Type III storm.); and
   
ii. All necessary local approvals must be obtained;
   
iii. A New Jersey licensed professional engineer must design the Class IV Dam to meet all technical requirements of this subchapter; and
   
iv. If the Class IV dam is designed or constructed for stormwater management purposes, the dam shall comply with the Stormwater Management Rules at N.J.A.C. 7:8.

2. Owners and operators of Class III agricultural impoundments, meaning any impoundment used for fish and wildlife, fire control or livestock or crop production and maintenance, where the drainage area is less than one-half square mile in extent, must meet only the following requirements.
   
i. All necessary local approvals must be obtained;
   
ii. Design and construction must be supervised by the United States Department of Agriculture, Natural Resources Conservation Service.

(b) The Department may, in its discretion, require the owner or operator of any dam subject to (a) above to obtain a permit and/or to submit any information relating to dam design, construction, operation or maintenance.
The Department may, in its discretion, require the owner or operator of any dam to make modification of the design, construction or operation of the dam in order to comply with the intent of this chapter and the Safe Dam Act, N.J.S.A. 58:4-1 et seq.

N.J.A.C. 7:20-1.4 General requirements and prohibitions

(a) No person may construct or operate a new dam or modify or repair an existing dam without first having obtained a permit from the Department, unless subject to the permit-by-rule provision in N.J.A.C. 7:20-1.3. Where emergency circumstances justify, repairs of a dam may be undertaken prior to obtaining a permit, in accordance with (i) below.

(b) No dam may be approved by the Department where, in the opinion of the Department, there is an unacceptable potential for harm to human health or to human safety.

(c) Backwater created by a dam during a 100-year storm shall be the minimum which is contained within the applicant's property unless written consent is obtained from all potentially affected property owners. Effects on both surface and ground water shall be considered, during normal pool conditions.

(d) No person may construct a dam in any waterway of this state which is a runway for migratory fish, without installing a fish ladder or other approved structure to permit the fish to pass the dam in either direction (see N.J.S.A. 23:5-29.1).

1. This provision is applicable to dams of any size.

2. The Department will determine whether a stream is currently a runway for migratory fish, during the review of the dam permit application. Applicants should consult the Division of Fish and Wildlife in this matter prior to finalizing the application.

(e) Unless otherwise approved by the Department, dam construction shall commence within one year from the date of the permit and be completed within two years from the said date or the permit will become null and void. For good cause shown, the Department may extend the two year construction deadline for a total of no more than five years, one year at a time. Applicants must make written request for an extension, prior to the expiration date of the permit or prior extension.

(f) No action shall be brought against the State or the Department or its agents or employees for the recovery of damages caused by the partial or total failure of any dam or reservoir or through the operation of any dam or reservoir upon the ground that the Department is liable by virtue of any of the following:
1. The approval of the dam or reservoir, or approval of flood handling plans during construction.

2. The issuance or enforcement of orders relative to maintenance or operation of the dam or reservoir.

3. Control, regulation and inspection of the dam or reservoir.

4. Measures taken to protect against failure during an emergency.

(g) The Department may deny any application for a dam permit, based upon its conclusion that the construction or operation of dam will cause an unacceptable threat to or impact on natural or cultural resources or the environment.

(h) The Department shall be notified immediately by the owner or operator upon the detection of any condition which may jeopardize the safety of the structure.

(i) Situations which threaten the public health, safety, and welfare and require emergency dam repair will be considered by the Department under the following procedure:

1. The owner or operator shall inform the Department by telephone as to the extent of work to be performed, the reason for the emergency and the location of the project.

2. The owner or operator shall perform the emergency work upon verbal approval of the Department, which approval shall be verified by the Department in writing within three working days. The Department shall offer guidance and instructions in performing the work.

3. After the work has been completed in accordance with the Department's instructions, the owner or operator shall submit a dam Permit Application and "as built" drawings to the Department for review. A letter shall be issued by Department in lieu of a dam permit.

(j) The Department shall be notified in writing on or before the transfer of dam ownership.

(k) Unless otherwise approved by the Department in writing, no person shall dredge within 200 feet of a dam.

(l) Utilities crossing within dam embankments are prohibited unless demonstrated to the satisfaction of the Department that such utilities will not jeopardize the safety of the dam.
(m) No person shall remove or breach an existing dam without first having obtained a permit from the Department unless subject to the permit-by-rule provisions in N.J.A.C. 7:20-1.3.

(n) Unless otherwise approved by the Department, no trees shall be permitted to grow on the dam embankment.

N.J.A.C. 7:20-1.5 General application procedures

(a) The procedures for applying for a dam construction, modification or repair permit and for submitting the supporting engineering documents include the preapplication stage and the application stage, as described below. For Class III dams (see N.J.A.C. 7:20-1.8) all required information may be submitted at one time, with such detail as is appropriate to the safe design of the type of structure proposed.

(b) The applicant for a dam permit must use a New Jersey licensed professional engineer to prepare the plans and specifications and to supervise the inspection of the construction.

(c) The Department may require any owner or operator of an existing dam to obtain a permit for repair or modification of the dam and appurtenances where:

1. Repair or modification is necessary to insure protection of human health or safety; or

2. Modification is required to comply with the provisions of this chapter, unless the following circumstances exist:

   i. Compliance is impracticable; and,

   ii. Noncompliance poses no unacceptable threat to human health or safety.

(d) Appeal procedures; permit denials

1. 1. An applicant for a dam permit may request in writing an administrative hearing from the Department within 15 days of receipt of the decision by the Department to deny the application. The request for a hearing shall be sent to the Office of Legal Affairs, ATTENTION: Adjudicatory Hearing Requests, Department of Environmental Protection, CN 402, Trenton, New Jersey 08625-0402.
2. The request for a hearing shall specify in detail the basis for the request, including all issues of fact or law. The Department may attempt to settle the dispute by conducting such proceedings, meetings and conferences as deemed appropriate. Should the efforts to settle the dispute fail and if the Department determines that the matter is a contested case, the Department shall forward the request for a hearing to the Office of Administrative Law, pursuant to the provisions of the Administrative Procedure Act (N.J.S.A. 52:14B-l et seq.)

(e) Applicants for a dam permit for a Class III dam, as defined pursuant to N.J.A.C. 7:20-1.8, may submit a preliminary application, which should include that information needed to establish a Class III hazard classification. Thereafter, in its discretion, the Department may waive certain documentation and inspection requirements set forth in these rules.

N.J.A.C. 7:20-1.6 Preapplication Stage

(a) The applicant must submit a written Preliminary Report which must include the following:

1. A general description of the dam and all appurtenances thereto, and the proposed dam classification, pursuant to N.J.A.C. 7:20-1.8. The description shall include the following:
   
i. A statement of the purpose for which the dam and appurtenances are to be used; and
   
   ii. A description of the potential effects of project construction and operation upon the environment.

2. Maps of the area within one-half mile of the dam and impoundment boundary, showing the following:
   
i. The location of the proposed dam and all appurtenances, thereto;
   
   ii. The location of all structures;
   
   iii. The county and township;

   iv. The boundary of the reservoir;
v. The location of all streets and roads;

vi. The location of all major utilities, i.e. pipe lines and transmission, telegraph, and telephone lines; all minor utilities shall be identified in the immediate vicinity of the dam and impoundment area.

vii. The topography and scale; and

viii. All other structures or facilities affected by the proposed dam, including the area downstream from the dam (State, county, and U.S.G.S. maps and aerial photographs may be used for this purpose).

3. A written report of the surficial conditions (i.e. geology, topography, and culture), based upon a field reconnaissance by the applicant's engineer;

4. Typical cross-sections of the dam, and any dike(s) and levee(s), showing proposed elevations, pool levels and top and bottom widths;

5. Preliminary design data, tentative conclusions and references. The design data shall address hydrologic features such as drainage area and rainfall data, the basis for proposed dam location, the basis for the type of structure and spillway proposed, the soils and geologic engineering criteria and the basis for design and construction;

6. The hydrologic design procedure and the storm durations which are used in the design;

7. All documentation and information related to determining hazard classification; and

8. Other information required by the Department.

(b) Upon review of the pre-application, the Department will notify the applicant of what design criteria will apply.

(c) Applicants for a permit to repair an existing dam are not required to submit a preliminary report unless the Department determines it to be necessary.

N.J.A.C. 7:20-1.7 Application Stage

(a) The application shall be on forms specified and supplied by the Department and
must be accompanied by two copies of the final design report, construction specifications and all plans, drawings, and designs. Upon the written request of the applicant, the Department may waive certain requirements for documentation in the application stage set forth at (b) to (g) below for a permit to modify, repair or remove an existing dam.

(b) The application shall include a Final Design Report, which must contain the following:

1. A report of the field and laboratory investigation(s) of the foundation soils and/or bedrock, a location map to identify borings and the materials that will comprise the dam and any dikes or levees. Stability and settlement analyses and seepage and underseepage studies are required, unless the applicant can demonstrate to the satisfaction of the Department that these analyses are not necessary.

2. The bases, references, calculations and conclusions relative to hydrologic studies and design of spillway.

3. Structural and hydraulic design studies and calculations. Structural, hydraulic and hydrologic design procedures should be used, as established by one of the following: the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, the U.S. Natural Resources Conservation Service and other procedures universally accepted as sound engineering practice.

(c) The application must include all drawings necessary to fully describe the proposal. Drawings must be prepared in accordance with the following:

1. All drawings must be prepared by a New Jersey licensed professional engineer or land surveyor, as appropriate. Each drawing shall have a title block which meets the requirements of the State Board of Professional Engineers and Land Surveyors.

2. Drawings must clearly show the datum to which elevations shown are referred. The National Geodetic Vertical Datum of 1929 (N.G.V.D.), formerly known as the U.S. Coast & Geodetic Survey datum, should be used wherever possible. If the N.G.V.D. datum is not used, an appropriate conversion equation must be indicated on the drawings.

3. The applicant must submit drawings showing the following information:

i. A general plan of the dam, drawn to an appropriate scale, which must show accurately the position of all essential details, such as the spillway and its point of discharge into the stream, pipes through the dam, inlets, outlets, screen chambers, gate or valve houses, head-races, the canal mill or power plant, tailraces and downstream
bridges which might cause backwater on the dam;

ii. A longitudinal section of the dam and cross-section of the valley at the site of the dam, showing the elevation of the crest of the dam, the elevation of the normal and design storm flow line of the lake or reservoir, the original surface of the ground, the nature and depth of the underlying strata, the probable depth of the excavation for the foundation of the dam and for the cutoff, foundation treatment, elevation of the restored surface of the ground, the location and elevation of all pipes or conduits passing through the dam, the core wall, if any, and the spillway structure;

iii. Typical cross sections, including a maximum section of the dam and of a spillway section which shall meet the following requirements;

(1) Cross sections must show the original surface of the ground, subsurface conditions as disclosed by test pits or borings, the probable depth of excavations for the foundation and for cutoff, the elevations of the top of the dam, the crest of the spillway and the normal flow line or water surface in the reservoir;

(2) For earth dams, the depth of stripping must be shown, as well as the position, material and dimensions of the cutoff or core wall, the width of the crest, the slopes and the nature and dimensions of the slope protection, the position and dimensions of the outlet pipes or conduits and the cutoff to prevent seepage along such structures, the disposition of different classes of embankment material if of varying composition, toe drains and clay blankets;

(3) For concrete or other composite dams, the cross sections shall show all dimensions and shall indicate the position and kinds of material to be included in the structure.

iv. If not clearly indicated on one or more of the drawings listed above, the following details shall be shown on additional detail sheets:

(1) Detail of spillway or overflow, showing the length and depth of opening, together with the width and shape of the crest, grade and shape of the approach and discharge channels, if any, methods of protecting the toe of the dam or end of the discharge channel from erosion and the dimensions of all
walls, floors and paving;

(2) Details of the intake and outlet works, showing the location and dimensions of all valves or sluice gates, intakes, screen chambers, racks, outlet towers and gate houses and appurtenances;

(3) For reinforced concrete dams, detailed drawings must also be submitted, showing the size, spacing and arrangement of all reinforcing steel and expansion joints; and

(4) Special drawings shall be submitted showing any special construction features not otherwise shown, such as piling, fishways, aprons, materials used in the core wall, movable dams, tainter gates and mechanical devices, drains and instrumentation.

(d) The application must include specifications, containing the following:

1. General provisions, specifying the rights, duties and responsibilities of the owner, applicant, applicant's engineer and the builder;

2. The estimated project schedule and sequence of work; and

3. Technical provisions, describing carefully and in detail the approved work methods and procedures, standards for equipment and testing, materials to be used and the results to be obtained.

(e) The applicant shall complete all investigations, including the following, prior to submission of the final design report which shall meet the following requirements:

1. The scope and the degree of precision of investigations required for a specific project shall be based on the complexities of the site, the importance of the proposed structure and the hazard created by the proposed structure.

2. The foundation investigation shall consist of borings, test pits, seismic investigations or other subsurface explorations and must be performed so as to accurately define the soil and rock stratigraphy and the ground water conditions to the satisfaction of the Department.

3. Laboratory testing of undisturbed and remolded soil specimens and rock samples may be required by the Department.
4. The applicant must determine the nature and extent of materials which are proposed for use in the structure, (e.g., borrow material, concrete aggregate, riprap stone, filter materials) and their structural properties when incorporated into the proposed structure.

5. Stability analysis and calculations for the proposed structure to ensure safety against failure due to overturning, sliding or overstressing must be submitted and approved by the Department.

6. Topographic surveys must be performed with sufficient accuracy to locate the proposed construction and to define the volume of the storage in the reservoir and the flowage limits. The upstream and downstream area must be investigated in order to delineate the area of potential damage in case of failure or flooding. Locations of baselines, centerlines and other horizontal and vertical control points must be shown on the topographic map of the site.

7. The drainage area must be accurately determined. Both present and projected future land use must be considered in determining the runoff characteristics of the drainage area. The most severe of these two conditions must be used in the design. The hydrologic assumptions and design calculations used in spillway designs shall be specified and shall include:
   
   i. Drainage area size;
   
   ii. Rainfall and runoff data;
   
   iii. Reservoir inflow hydrographs;
   
   iv. Reservoir area-capacity-elevation data;
   
   v. Spillway elevation-discharge data; and
   
   vi. Reservoir flood routings, except as otherwise provided in this subchapter.

(f) All applicants must submit an Operation and Maintenance Manual in accordance with N.J.A.C. 7:20-1.1 and applicants for Class I and II dams (see N.J.A.C. 7:20-1.8) shall prepare and submit an Emergency Action Plan which shall at least include a Dam Breach Analysis, Inundation Maps and Emergency Notification and Evacuation Plans.

(g) The Department may require the submission of an Environmental Impact
Statement, as defined in N.J.A.C. 7:20-1.2, by any applicant for a dam permit.

(h) The application to remove or breach a dam shall include the following:

1. Design report, and plans and computations to effect the breach including size of breach, shape of breach, disposal of spoil material;

2. Plans and computations for stabilization of the lake bed including the channel upstream of the breach, and for the control of sediment within the lake and downstream of the breach during and after the breach has been effected;

3. Computations for design of the method and timing for dewatering the lake;

4. Computations detailing the effects of the breach on the downstream channel and demonstrating that the project will not adversely affect flooding conditions downstream during the 10, 50 and 100 year storms;

5. Specifications containing the technical provision which describe in detail the proposed work methods and equipment and, in addition, a work schedule for the entire project;

6. A plan of the existing dam and lake along with surrounding property lines;

7. Evidence that all adjoining property owners of the impoundment and the municipality where the reservoir or dam is located have received notification that an application has been submitted to the Department to remove or breach a dam and proof of publication of notice of the proposed removal application in at least one newspaper of general circulation in the municipality where the reservoir or dam is located;

8. A description of the potential effects of the dam removal or breach upon the environment; and

9. A description of the potential effects of the dam removal or breach upon life and property downstream of the dam.

(i) When a petition has been filed in accordance with the Safe Dam Act, N.J.S.A. 58:4-9, protesting against the removal of any reservoir, water or dam or against the decommissioning of any reservoir or dam, the Commissioner shall, pursuant to the requirements of N.J.S.A. 58:4-10, hold a public hearing, upon 30 days notice to all parties interested, and following prior notice published 30 days before the hearing in at least one newspaper of general circulation in the municipality in which the reservoir or dam is located.
N.J.A.C. 7:20-1.8 Dam Classification

(a) The Department will use the following guidelines to classify dams according to hazard. Probable future development of the area downstream from the dam which might be affected by its failure will be considered in determining the hazard classification. The Department may, in its discretion, change the hazard class of any proposed or existing dam.

1. Class I - High Hazard Potential: This classification includes those dams, the failure of which may cause the probable loss of life or extensive property damage.
   i. The existence of normally occupied homes in the area that are susceptible to significant damage in the event of a dam failure will be assumed to mean "probable loss of life".
   ii. Extensive property damage means the destructive loss of industrial or commercial facilities, essential public utilities, main highways, railroads or bridges. A dam may be classified as having a high hazard potential based solely on high projected economic loss.
   iii. Recreational facilities below a dam, such as a campground or recreation area, may be sufficient reason to classify a dam as having a high hazard potential.

2. Class II - Significant Hazard Potential: This classification includes those dams, the failure of which may cause significant damage to property and project operation, but loss of human life is not envisioned. This classification applies to predominantly rural, agricultural areas, where dam failure may damage isolated homes, major highways or railroads or cause interruption of service of relatively important public utilities.

3. Class III - Low Hazard Potential: This classification includes those dams, the failure of which would cause loss of the dam itself but little or no additional damage to other property. This classification applies to rural or agricultural areas where failure may damage farm buildings other than residences, agricultural lands or non-major roads.

4. Class IV - Small Dams: This classification includes any project which impounds less than 15 acre-feet of water to the top of dam, has less than 15 feet height-of-dam and which has a drainage area above the dam of 150 acres or less in extent. No dam may be included in Class IV if it meets the criteria for Class I or II. Any applicant may request consideration as a Class III dam upon submission of a positive report and demonstration proving low hazard.
N.J.A.C. 7:20-1.9   Design criteria

(a) The minimum design storm used to calculate required spillway capacity must be determined according to the following table:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Spillway Design Storm (SDS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I</td>
<td>PMP</td>
</tr>
<tr>
<td>Class II</td>
<td>One-half PMP</td>
</tr>
<tr>
<td>Class III</td>
<td>24 hour 100 year frequency, Type III storm*</td>
</tr>
<tr>
<td>Class IV</td>
<td>24 hour 100 year frequency, Type III storm plus 50%*</td>
</tr>
</tbody>
</table>

*Any later technology adopted by the U.S. Department of Agriculture, Natural Resources Conservation Service may be substituted for the use of the Type III storm.

(b) For existing dams, it is recognized that the relationships between valley slope and width, total reservoir storage, drainage area, and other hydrologic factors have a critical bearing on determining the safe spillway design flood. When appropriate, based on the design of a dam, rational selection of a reduced spillway design for specific site conditions based on quantitative and relative impact analysis is acceptable. The spillway should be sized so that the increased downstream damage resulting from overtopping failure of the dam would not be significant as compared with the damage caused by the flood in the absence of a dam overtopping failure. The minimum design storm for the dam shall be the 100 year storm.

(c) All Class II and III dams shall, where practicable incorporate in the proposed design, the ability to make modifications necessary to increase the spillway capacity of the facility or other alternative measures if the downstream hazard potential increases.

(d) All dams shall have an adequate storage for the design storm or have a spillway system which will safely pass the design storm without endangering the safety of the dam.

(e) Each spillway shall include a satisfactory means of dissipating the energy of flow at its outlet without endangering the safety of the dam.

(f) The capacity of the spillway system shall be equal to the peak inflow of the design flood unless the applicant demonstrates by flood routing procedures that the spillway system has the capacity to safely pass the resulting water flow.
(g) Pipe conduits may be used for the primary (principal) spillway. When so used, the following requirements shall be met:

1. Pipe conduits shall be of such design as to safely support the total external loads in addition to the total internal hydraulic pressure without leakage. The type of construction material used shall be consistent with the anticipated life of the structure. Corrugated metal pipe shall not be used in the construction of new dams.
   
i. For Class I and II dams, the minimum allowable inside dimension of the pipe conduit is 30 inches.
   
ii. For Class III dams, the minimum allowable inside diameter of the pipe conduit is 18 inches.
   
iii. For Class IV dams, the minimum allowable inside diameter of the pipe conduit is 12 inches.

2. All pipe conduits shall convey water at the maximum design velocity without damage to the interior surface;

3. The pipe conduit must be designed so that negative pressures will not occur at any point along the primary (principal) spillway system;

4. Drainage filters or other methods approved by the Department must be installed to control seepage along the conduit;

5. Adequate allowances shall be incorporated in the design to compensate for differential settlement and possible elongation of the pipe conduit;

6. An anti-vortex device must be included in the design, unless the applicant can demonstrate that one is not necessary.

7. A trash rack, approved by the Department, shall be installed at the intake to prevent clogging of the pipe conduit; and

8. An emergency spillway shall be provided; and

9. Cathodic protection is required for all metal pipes.

(h) Should a vegetated or unlined auxiliary spillway, approved by the Department, be installed, it must be able to pass the design storm without jeopardizing the safety of
the structure and that has a predicted average frequency of use less than:

1. Once in 100 years for Class I dams:

2. Once in 50 years for Class II dams; or

3. Once in 25 years for Class III and IV dams.

(i) Drawdown requirements are as follows:

1. Except for excavated impoundments, all dams shall include a device to permit draining the reservoir, as approved in writing by the Department. Computations for the minimum time required to drain the reservoir shall be required for new and existing dams.

2. Unless the applicant demonstrates to the satisfaction of the Department that there is a need to locate a valve downstream from the dam and that the areas downstream of the dam will remain protected, all valves or sluice gates in pipe conduit drains must be installed upstream of the dam.

3. All pipe conduits used as drawdown drains for all dam classifications shall meet requirements of (g) above, except that the minimum allowable inside dimension may be less than 30 inches.

4. Dams which impound water on a permanent basis shall include a means to allow the reduction of the reservoir water surface elevation five feet in 10 days at a rate not to exceed one foot per day. This requirement shall not apply to dams whose intended purpose requires and whose design allows faster drawdown times. For existing dams which satisfactorily meet Department safety and operating criteria, the applicant may, with prior approval of the Department, present alternative reservoir drawdown plans.

(j) Design references used shall be cited in the information submitted to the Department.

(k) Monitoring devices to permit inspection and assessment of the dam's condition may be required by the Department for use in the inspections during and after completion of construction.

(l) The applicant shall demonstrate to the Department that the riparian rights of downstream property owners will be protected during construction, during the period when the reservoir is being filled and during the life of the dam and reservoir.

(m) Unless the applicant can demonstrate that an alternative slope is acceptable, upstream slopes of an earth dam may be no steeper than three horizontal to one
vertical ratio, and downstream slopes may be no steeper than two horizontal to one vertical ratio. Measures are required for protection of upstream slopes against wave action or rapid draw-down and for protection of the downstream slope against scour or erosion due to high tailwater.

(n) Freeboard requirements are as follows:

1. Sufficient freeboard shall be provided to prevent overtopping of the dam or any dike or levee due to passage of the design flood or due to frost damage, ice damage or wave action.

2. For all dams the minimum elevation of the top of the dam must be that necessary to pass the design storm with at least one foot of freeboard to the top of dam.

3. Where special conditions of severe frost damage, ice damage or wave action may occur, higher elevations than required in (n)2 above may be required and should be considered by the applicant.

(o) The Department may require the design and installation of any additional or modified measures by any applicant for a dam permit where appropriate to insure the protection of human health or safety.

N.J.A.C. 7:20-1.10 Construction

(a) Requirements relating to supervision of dam construction are as follows:

1. All applicants shall submit a written description and schedule of the proposed construction, including:
   i. The estimated time to complete the construction activities, see N.J.A.C. 7:20-1.4(e);
   ii. Where applicable, a description of the means by which stream flow will be diverted around or through the dam site, or otherwise kept from interfering with the work;
   iii. The number of inspectors designated for inspection for construction quality control; and
   iv. Steps to be taken to minimize erosion and sediment production during construction.

2. The extent and method of inspection for construction quality control must be described and approved by the Department, including an inspection schedule.
3. The diversion facility, as outlined in 1.i above, must remain open and no water may be permanently stored in the reservoir until the permittee demonstrates to the Department that storage of water will neither interfere with construction activities nor create a hazard to life, health or property.

4. The professional engineer responsible for inspecting the construction must submit progress reports to the Department at least once each month, during the construction period.

5. The permittee shall promptly advise the Department of all proposed changes in the approved design, plans or specifications. There may be no change in the approved design, plans or specifications without prior approval of the Department. All approved changes must be recorded on the complete set of as-built plans, required in (a) 6, below. The Department may require the submission of revised designs at any time. Written prior approval from the Department is required for major modifications, which shall include significant changes in scale, use, design, impact, etc. of the project, as initially approved. The Department may require written, prior approval of any proposed modification.

6. A complete set of as-built designs, plans and specifications must be submitted to the Department upon completion of the project.

7. The professional engineer who has inspected the construction shall submit written certification that the structure has been built in conformance with the designs, plans and specifications, and with any changes approved by the Department.

(b) The Department may, in its discretion, require the owner to obtain the services of an Independent Review Board to oversee the design and construction of any proposed or existing dam.

(c) Construction inspection program requirements are as follows:

1. The Department may inspect the dam during construction to insure that it is being built in compliance with the designs, plans and specifications submitted to the Department. Departmental inspections in no way relieve either the permittee or the professional engineer in charge from the responsibility of providing adequate inspection of the work.

2. If, at any time during the progress of the work, the Department finds that the work is not being performed in accordance with the approved designs, plans and specifications and any approved changes, the Department will serve a written notice to that effect on the permittee or his representative. Such notice will state the particulars with which the work has not complied.
Additionally, the Department may order the immediate compliance with such designs, plans, specifications, and changes and suspension of all other work until compliance has been effected. If the owner or his representative fails to comply with this order, the permit under which construction is authorized may be revoked or suspended by the Department.

3. Upon receipt of the as-built plans required in subsection (a) 6 above and the engineer's certification required in subsection (a) 7 above the Department will inspect the completed construction within 45 days. If the Department finds that construction was completed in accordance with the approved designs, plans, specifications and approved changes, the construction will be approved in writing within 30 days. The approval date shall be the date such approval is sent by the Department.

4. In the 12th month following approval of construction by the Department pursuant to (b) 3 above, the Department will make a final inspection of the construction. If the Department makes a final inspection of the construction, a final approval may be given by the Department, if the final inspection shows that the terms of the permit, designs, plans, specifications and approved changes thereof have been met.

N.J.A.C. 7:20-1.11 Dam operating requirements and inspections: new and existing dams

(a) The owners and operators of all dams shall develop and use an Operation and Maintenance Manual which provides guidance and instruction to project personnel for the proper operation and maintenance of the reservoir and dam, and meets the following requirements:

1. The manual shall be composed of two parts:
   
i. Part One shall include an introduction, project description, project authorizations, project history and list of project contracts.

   ii. Part Two shall contain the operation and maintenance instructions for major project facilities and equipment and a schedule for maintenance.

(b) The owners or operators of all dams which raise the waters of any stream more than 70 feet above its usual mean low-water height or which impound more than 10,000 acre-feet of water shall have a regular inspection performed annually and formal inspections performed every three years by a New Jersey licensed professional engineer. These inspections must be attended by a professional engineer assigned from the Department. In the year of the formal inspection, regular or informal
inspections need not be performed.

(c) Owners or operators of Class I dams not meeting the size characteristics described in (b) above shall have a regular inspection performed once every two years and a formal inspection performed every six years.

(d) Owners or operators of Class II dams shall have a regular inspection performed once every two years and a formal inspection performed every 10 years.

(e) Owners or operators of Class III and IV dams shall have a regular inspection performed every four years. The Department may at its discretion require the owner or operators to perform a formal inspection of a Class III or IV dam.

(f) All dam inspections shall be performed from March through December.

(g) All inspections shall be performed in compliance with the following requirements:

1. A written guide provided by the Department for the preparation of a Report on Condition of the dam shall be used for all inspections.

2. Formal and regular dam inspections shall be performed by a licensed New Jersey professional engineer. Except for Class IV dams, the required report shall be submitted to the Department by the engineer within 30 days of completion of the inspection. The report shall indicate the results of the inspection, documenting the conclusions and recommendations. Reports for Class IV dams shall be submitted to the county and/or municipal engineer having jurisdiction over the dam structure.

3. Informal inspections may be performed by the dam owner or operator and the Report on Condition shall be part of the owner's or operator's permanent file and, unless requested by the Department, Reports shall not be submitted to the Department.

4. The Department may extend the time for submission of the required material for up to 30 days, if the owner or operator justifies the need for such extension.

5. Failure by the permittee to inspect within the required time periods or failure to submit the Report on Condition may result in an order to drain the impoundment under the provisions of the Safe Dam Act (N.J.S.A. 58:4-1 et seq.), and/or any other remedy allowed by law.

(h) For good cause, the Department may require the owner or operator of any dam to perform an inspection of any type at any time.
(i) The owner or operator of all Class I and II dams shall prepare and use an Emergency Action Plan, as described in N.J.A.C. 7:20-1.7(f).

N.J.A.C. 7:20-1.12 Duty to Provide Information

The Department may require an owner or person having control of a reservoir or dam to provide any information the Department requires to determine compliance with any provision of the Safe Dam Act, or any rule, regulation or order issued pursuant to the Safe Dam Act.

N.J.A.C. 7:20-1.13 Inspection Authority

The Department shall have the authority to enter any property, facility, premises, or site for the purpose of conducting inspections to determine the condition of any dam, or to conduct inspections of ordered repairs or to otherwise determine compliance with the provisions of the Safe Dam Act.

Subchapter 2. CIVIL ADMINISTRATIVE PENALTIES; REQUESTS FOR ADJUDICATORY HEARINGS; ACTIONS BY THE DEPARTMENT TO REPAIR OR MITIGATE

N.J.A.C. 7:20-2.1 Authority and purpose

(a) This subchapter governs the assessment of uniform civil administrative penalties pursuant to the Safe Dam Act, N.J.S.A. 58:4-1 et seq. and the issuance of orders for the violation of any provision of the Safe Dam Act or any regulation, rule, permit or order adopted or issued by the Department pursuant thereto. This subchapter also establishes the procedure for requesting an adjudicatory hearing or appeal from a notice of civil administrative penalty assessment or administrative order.

(b) Neither the issuance of an administrative order nor the assessment of a civil administrative penalty shall affect the availability to the Department of any other enforcement provision in N.J.S.A. 58:4-5 and 4-6 or any other action or remedy available by law.

N.J.A.C. 7:20-2.2 Procedures for Issuing an Administrative Order Pursuant to the Safe Dam Act

(a) Whenever the Department finds that a person has violated any provision of the Safe Dam Act, or any regulation, rule or order adopted or issued by the Department pursuant thereto, the Department may issue an administrative order specifying the provision or provisions of the law, rule, regulation, or order, of which the person is in
violation citing the action which constituted the violation requiring compliance with the provision or provisions violated; requiring specific actions by the violator to achieve compliance with provisions violated; and providing notice to the person of the right to an adjudicatory hearing on the matters contained in the order. The ordered party shall have 20 days from receipt of the order within which to deliver to the Department a written request for a hearing in accordance with N.J.A.C. 7:20-2.4.

N.J.A.C. 7:20-2.3 Procedures for assessment, settlement and payment of civil administrative penalties for violations

(a) To assess a civil administrative penalty, the Department shall notify the violator by certified mail (return receipt requested) or personal service. This notice of civil administrative penalty assessment shall:

1. Identify the section of the Safe Dam Act, or the rule, regulation and/or administrative order violated;
2. State the facts which constitute the violation;
3. State the amount of the civil administrative penalty to be imposed and the amount of any other costs and economic benefit to be imposed; and
4. Advise the violator of the right to request an adjudicatory hearing under N.J.A.C. 7:20-2.4.

(b) The violator shall pay a civil administrative penalty immediately upon receipt of the Department’s final order in a contested case, or as soon as a notice of civil administrative penalty assessment becomes a final order as follows:

1. If no hearing is requested pursuant to N.J.A.C. 7:20-2.4, a notice of civil administrative penalty assessment becomes a final order on the 21st day after the violator receives the notice;
2. If the Department denies a hearing request under N.J.A.C. 7:20-2.4, a notice of civil administrative penalty assessment becomes a final order upon the violator’s receipt of the denial; or
3. If the Department grants the hearing request, a notice of civil administrative penalty assessment becomes a final order upon issuance of a final order by the Department.

N.J.A.C. 7:20-2.4 Procedures to Request an Adjudicatory Hearing to Contest an Administrative Order and/or a Notice of Civil Administrative Penalty Assessment; Procedures for Conducting Adjudicatory Hearings
(a) To request an adjudicatory hearing to contest an administrative order and/or a notice of civil administrative penalty assessment issued pursuant to the Safe Dam Act, the person to whom the administrative order and/or notice of civil administrative penalty assessment was issued, shall within 20 days of receipt of the order and/or notice submit an original written request for an adjudicatory hearing to:

New Jersey Department of Environmental Protection  
Office of Legal Affairs  
Attention: Adjudicatory Hearing Requests  
401 East State Street  
P.O. Box 402  
Trenton, New Jersey 08625-0402

(b) A complete copy of the request shall be submitted to the Bureau of Dam Safety and Flood Control at:

New Jersey Department of Environmental Protection  
Bureau of Dam Safety and Flood Control  
501 E. State Street  
P.O. Box 419  
Trenton, New Jersey 08625-0419

(c) The written request shall include all information required by the “Adjudicatory Hearing Request Checklist and Tracking Form” available from the Bureau of Dam Safety and Flood Control, 501 E. State Street, P.O. Box 419, Trenton, NJ 08625-0419 and on the Department’s website at www.state.nj.us/dep/damsafety, including the following:

1. The name, address, and telephone number of the violator and its authorized representative;

2. The date the violator received the enforcement document being contested;

3. A copy of the administrative order and/or notice of civil administrative penalty assessment and a list of all issues being appealed;

4. The violator’s defenses to each of the findings of fact stated in short and plain terms;

5. An admission or denial of each of the findings of fact. If the violator is without knowledge or information sufficient to form a belief as to the truth of a finding, the violator shall so state and this shall have the effect of a denial. A denial shall fairly meet the substance of the findings denied. When the violator intends in good faith to deny only a part or a qualification of a finding, the violator shall specify so much as is true
and material and deny only the remainder. The violator may not generally deny all of the findings but shall make all denials as specific denials of designated findings. For each finding the violator denies, the violator shall allege the fact or facts as the violator believes it or them to be;

6. Information supporting the request and specific reference to or copies of other written documents relied upon to support the request;

7. An estimate of the time required for the hearing (in days/and or hours); and

8. A request, if necessary, for a barrier-free hearing location for physically disabled persons.

(d) If the Department does not receive the written request for a hearing within 20 days after receipt by the person of the administrative order and/or notice of civil administrative penalty assessment being contested, the Department shall deny the hearing request.

(e) The Department shall notify the requester if the request for a hearing is granted and, if denied, the reason why. If a hearing request is granted, the Department shall refer the matter to the Office of Administrative Law for an adjudicatory hearing in accordance with the Administrative Procedure Act, N.J.S.A. 52:14B-1 et seq., and the Uniform Administrative Procedure Rules, N.J.A.C. 1:1.

(f) If the person fails to include all the information required by (a) above, the Department may deny the hearing request.

N.J.A.C.7:20-2.5 Civil Administrative Penalty Assessment for Violation of the Safe Dam Act

(a) The Department may assess a civil administrative penalty of up to $25,000 for each violation of any provision of the Safe Dam Act, N.J.S.A. 58:4-1 et seq., or for any failure to comply with any rule or regulation adopted pursuant to the Act, or for any failure to comply with any permit, order or directive issued pursuant to the Act, or for failure to comply with a request for information or request to enter upon the property.

(b) Each violation of any provision of the Safe Dam Act, or any rule or regulation adopted pursuant to the Act, or for any failure to comply with any permit, order or directive issued pursuant to the Act, or for failure to comply with a request for information or request to enter upon the property shall constitute a separate and distinct offense.

(c) Each day during which a violation continues shall constitute an additional, separate and distinct offense.
(d) When the Department determines that the violator has gained economic benefit from a violation, the Department may, in addition to any other civil administrative penalty assessed, include as a part of a civil administrative penalty the economic benefit that the violator has realized as a result of not complying or delaying compliance. Economic benefit shall include the amount of savings realized from avoided costs; the return earned or that may be earned on the amount of the avoided costs; and any other benefits resulting from the violation.

N.J.A.C.7:20-2.6 Civil Administrative Penalty Amount for Violation of the Safe Dam Act

(a) The Department may assess the following civil administrative penalty for each day that the respective identified violations continue:

1. Failure to draw off (drain or lower) an impoundment:
   i. Class I Dams $10,000-$25,000;
   ii. Class II Dams $5,000-$10,000;
   iii. Class III and IV Dams $1,000-$5,000;

2. Failure to submit a permit application, compliance schedule, inspection report, Emergency Action Plan or Operation and Maintenance plan or other document required by the Safe Dam Act or these rules, or failure to respond to a request for information:
   i. Class I Dams $5,000;
   ii. Class II Dams $2,500;
   iii. Class III and IV Dams $1,000;

3. Failure to conduct or complete dam repairs, maintenance, modification or removal:
   i. Class I Dams $10,000-$25,000;
   ii. Class II Dams $5,000-$10,000;
   iii. Class III and IV Dams $1,000-$5,000;

4. Failure to obtain Department approval prior to the construction or modification of a dam or appurtenant structure:
   i. Class I Dams $10,000-$25,000;
ii. Class II Dams $5,000-$10,000;

iii. Class III and IV Dams $1,000-$5,000;

5. Failure to allow access to a dam site, including appurtenant structures, to representatives of the Department presenting proper credentials:
   i. All dams $1,000-$5,000;

6. Failure to implement a security plan:
   i. Class I Dams $10,000-$25,000;
   ii. Class II Dams $5,000-$10,000;
   iii. Class III and IV Dams $1,000-$5,000;

7. Failure to comply with any permit requirement:
   i. Class I Dams $10,000-$25,000;
   ii. Class II Dams $5,000-$10,000;
   iii. Class III and IV Dams $1,000-$5,000;

8. Knowingly, recklessly, or negligently making a false statement, representation, or certification in any application, record or other document filed or required to be maintained by the Safe Dam Act:
   i. All Dams $1,000-$5,000.

(b) The civil administrative penalty shall be established at the mid-point of the ranges set forth at (a) above unless adjusted by the Department in its discretion within the range on the basis of the following factors:

1. The compliance history of the violator;

2. The number, frequency and severity of the violations;

3. The measures taken by the violator to mitigate the effect of the current violation or to prevent future violations;

4. The cooperation of the violator in correcting the violation, remedying the damage caused by the violation and ensuring the violation does not reoccur;

5. The deterrent effect of the penalty;
6. Any costs or impacts directly or indirectly imposed on the public or the environment as a result of the violation; and

7. Other specific circumstances of the violator or violation.

(c) In settling a civil administrative penalty, the Department may in its discretion consider the following:

1. Mitigating and extenuating circumstances;

2. Measures taken to mitigate impact of the violation; and

3. Other terms and conditions acceptable to the Department.

N.J.A.C. 7:20-2.7 Notice of Violation Recorded on Property Deed

In addition to penalties prescribed in this subchapter, a notice of violation issued pursuant to the Safe Dam Act, or any rule, regulation or order issued pursuant thereto, shall, on order of the Commissioner, be recorded on the deed of the property wherein the violation occurred, by the clerk or register of deeds and mortgages of the county wherein the affected property is located and with the clerk of the Superior Court and shall remain attached thereto until such time as the violation is remedied and the Commissioner orders the notice of violation removed.

N.J.A.C. 7:20-2.8 Penalty Collection

All penalties collected pursuant to this subchapter or sums collected pursuant to N.J.S.A. 58:4-5 shall be deposited in the “Environmental Services Fund,” established pursuant to N.J.S.A. 13:1D-33, and kept separate from other receipts deposited therein, and appropriated to the Department for the removal of dams in the State.

N.J.A.C. 7:20-2.9 Action by the Department to Repair and Mitigate

(a) Whenever the Commissioner determines that a dam is in imminent danger of failure and has reasonable cause to believe that danger to life or property may be anticipated from the reservoir, dam or appurtenant structures located therein, and the owner of the dam or person having control of the reservoir or dam has failed to comply with an order to repair the dam or to take such interim measures as the Department determines are appropriate, including reducing the amount of water impounded by the dam or breaching the dam, the Department may, in addition to other actions authorized by the Safe Dam Act, these regulations and other law, enter upon any and all properties wherein the reservoir, dam or appurtenant structures are located, and using resources and personnel available to the Department, remove or cause to be removed the dam and/or appurtenant structures located therein, allowing the water to flow freely.
(b) The Department shall provide notice to the owner or person having control of the reservoir or dam prior to the removal action provided for in (a) above. The owner shall, no later than 60 days after receipt of notice, submit to the Department in writing, an implementation plan addressing the proposed actions the owner or person having control of the reservoir or dam intends to take to repair or remove the failed or failing reservoir or dam, along with a schedule for implementation of the proposed actions. Any permits required for the proposed actions shall be applied for within the 60-day time period.

(c) If the proposed actions, schedule and permit applications are timely submitted and the Department in its discretion determines that the proposed actions and schedule will satisfactorily address the danger specified in (a) above, and that the permits applied for can properly be issued, the Department shall allow the owner or person having control of the reservoir or dam to take the actions identified. If the owner or person having control of the reservoir or dam fails to comply with the proposed schedule, the Department may take removal action in (a) above.

(d) Any expenditures made by the Department pursuant to (a) shall constitute a debt to the State and a lien on all property owned by the owner or person having control of the reservoir or dam. When a certificate of debt incorporating a description of the property subject to the removal action and the costs is filed with the clerk of the Superior Court, the lien shall attach to all revenues and all real and personal property of the owner or person having control of the reservoir or dam.

(e) The lien described in (d) above shall have priority over all other liens, interests or claims on the dam or reservoir property subject to the Department’s removal action. However, if that property is six dwelling units or less and used exclusively for residential purposes, the certificate of debt shall not affect any valid lien, claim or interest which was filed prior to the certificate of debt. When the lien described in (d) above affects property other than the property subject to the removal action, it shall have priority from the date of filing but shall not affect any valid lien, interest or claim filed prior to filing of the certificate of debt.

(f) Whenever the owner or person having control of the reservoir or dam is a private lake association or other body representing owners or property adjacent to the reservoir or lake created by the dam or impoundment, liens may be imposed upon the individual owners of the property represented by the association. An owner whose property has such a lien imposed may release the property from a lien claimed under this subsection by filing with the clerk of the Superior Court a cash or surety bond, payable to the Department in the amount of the sums expended by the Department pursuant to this section, including attorney’s fees and court costs, or the value of the property after the abatement action is complete, whichever is less.

(g) The provisions of this section shall not limit the use of other remedies available to the Department pursuant to law.
THIS IS A COURTESY COPY OF THIS RULE. ALL OF THE DEPARTMENT’S RULES ARE COMPILED IN TITLE 7 OF THE NEW JERSEY ADMINISTRATIVE CODE.
E.30. New Mexico
RULES AND REGULATIONS
GOVERNING DAM DESIGN, CONSTRUCTION
AND DAM SAFETY

JOHN R. D’ANTONIO, JR., P.E.
STATE ENGINEER
March 31, 2005
The New Mexico Office of the State Engineer Dam Safety Bureau is located in Santa Fe. Copies of forms referred to herein and a copy of these rules and regulations can be obtained from the Dam Safety Bureau or from the Office of the State Engineer website. All documents filed for dams shall be delivered to the Dam Safety Bureau.

Phone Number: 505-827-6122
Fax Number: 505-827-6068
Web-Site: www.ose.state.nm.us

**Mailing Address:**
Office of the State Engineer
Dam Safety Bureau
P.O. Box 25102
Santa Fe, New Mexico 87504

**Street Address:**
Office of the State Engineer
Dam Safety Bureau
Lew Wallace Building, Room 210
495 Old Santa Fe Trail
Santa Fe, New Mexico 87501
19.25.12.1 ISSUING AGENCY: New Mexico Office of the State Engineer
[19.25.12.1 NMAC - N, 3/31/2005]

19.25.12.2 SCOPE: These regulations apply to the design and construction of all jurisdictional dams in New Mexico and are intended to facilitate the continued safe operation and maintenance of all non-federal jurisdictional dams. These regulations govern the review and acceptance of plans for construction, alteration, modification, repair, enlargement and removal of a jurisdictional dam. These regulations ensure the continued safe operation, maintenance, site security and emergency preparedness for existing non-federal jurisdictional dams. These regulations do not authorize the appropriation or use of water pursuant to 19.26 NMAC and 19.27 NMAC.

19.25.12.3 STATUTORY AUTHORITY: Section 72-5-32 NMSA requires any person, association or corporation, public or private, the state or the United States that is intending to construct a jurisdictional dam to submit detailed plans to the state engineer. Sections 72-5-9 and 72-5-10 NMSA establish the state engineer’s authority over the construction of works and issuing certificates of construction. Sections 72-5-8 and 72-5-14 NMSA require construction to be completed in a time limit set by the state engineer and procedures for requesting an extension of time. Sections 72-5-11, 72-5-12 and 72-5-13 NMSA gives the state engineer jurisdiction over unsafe works, penalties for failure to comply with state engineer orders and priority of liens. Section 72-2-6 NMSA gives the state engineer authority to assess fees. Section 72-2-8 NMSA gives the state engineer authority to adopt regulations and codes to implement and enforce any provision of any law administered by him. Section 72-8-1 NMSA gives the state engineer authority to enter upon private property for the performance of his duties. Nothing in these rules shall be construed so as to limit the state engineer's authority to take lawful alternative or additional actions relating to the design, construction and safety of dams.
[19.25.12.3 NMAC - N, 3/31/2005]

19.25.12.4 DURATION: Permanent.

19.25.12.5 EFFECTIVE DATE: March 31, 2005 unless a later date is cited at the end of a section.
[19.25.12.5 NMAC - N, 3/31/2005]

19.25.12.6 OBJECTIVE: To establish minimum design requirements, minimum submittal requirements and dam site owner responsibilities that shall be addressed to the state engineer’s satisfaction in order to ensure a dam is designed, constructed, operated, maintained and secured in a safe manner.
[19.25.12.6 NMAC - N, 3/31/2005]

19.25.12.7 DEFINITIONS: Unless defined below or in a specific section of these regulations, all other words used herein shall be given their customary and accepted meaning.

A. Abutment: That part of the valley side against which the dam is constructed. The left and right abutments of dams are defined with the observer viewing the dam looking in the downstream direction.

B. Alteration, modification, repair, rehabilitation or enlargement of an existing dam: To change from the state engineer accepted construction drawings and specifications or current condition.

C. Appurtenant structure: Auxiliary features of a dam such as outlets, spillways, access structures, tunnels and related housing at a dam.

D. American society for testing and materials (ASTM): An accepted standard for testing the properties of materials. Methods cited in these regulations include laboratory compaction characteristics of soils.

E. Breach: An opening through a dam or spillway that is capable of draining a portion of the reservoir or the entire reservoir. A controlled breach is a constructed opening. An uncontrolled breach is an unintentional discharge from the reservoir.
F. **Consequences of failure:** Potential loss of life or property damage downstream of a dam caused by waters released at the dam or by waters released by partial or complete failure of dam; includes effects of landslides upstream of the dam or property located around the reservoir.

G. **Crest width:** The thickness or width of a dam at the crest level (excluding corbels or parapets). In general, the term thickness is used for gravity and arch dams and width is used for other dams.

H. **Dam:** A man-made barrier constructed across a watercourse or off-channel for the purpose of storage, control or diversion of water.

(1) **Jurisdictional dam:** A dam that is more than 10 feet in height measured from the lowest point on the downstream toe to the dam crest or impounds more than 10 acre-feet of water as measured from the lowest point on the downstream toe to the spillway crest. Dams constructed under the supervision of the U.S. army corps of engineers before May 19, 2004, become jurisdictional when such supervision by the U.S. army corps of engineers is terminated. For purposes of these regulations, reference to a dam means a jurisdictional dam unless otherwise noted.

(2) **Non-jurisdictional dam:** Any dam less than or equal to 10 feet in height and having storage less than or equal to 10 acre-feet of water. The state engineer does not regulate the design, construction and operation of a non-jurisdictional dam unless the dam is unsafe and there is a threat to life or property, as determined by the state engineer. Waters impounded by a non-jurisdictional dam may not be exempt from water right permit requirements; therefore a separate state engineer water right permit for the water impounded in the reservoir created by a non-jurisdictional dam may be required. Non-jurisdictional dams shall meet the requirements of 19.26.2.15 NMAC unless otherwise exempt. The structures listed below are considered non-jurisdictional dams:

(a) **Stock dam:** A stock dam constructed prior to May 19, 2004 with a storage capacity of 10 acre-feet or less regardless of the height of the dam.

(b) **Erosion control dam:** A dam for the sole purpose of erosion control constructed on a naturally dry watercourse as determined by the state engineer, with a storage capacity of 10 acre-feet or less as measured from the lowest point on the downstream toe to the spillway crest and the reservoir drains in 96 hours unless a quicker drain time is required by court decree.

(c) **Levee or diversion dike:** A structure where water flows parallel to the length of the levee or diversion dike as determined by the state engineer.

(d) **Roadway embankment:** A structure across a watercourse designed for the sole purpose of supporting a roadbed or other means of conveyance for transportation as determined by the state engineer; where the area upstream has not been enlarged to increase flood storage; and where the embankment is provided with an uncontrolled conduit of sufficient capacity to satisfy requirements of the appropriate state or local transportation authority. If no transportation authority has jurisdiction over the structure, the current drainage design criteria of the New Mexico department of transportation shall apply.

I. **Dam crest:** The lowest elevation of the uppermost surface of a dam, usually a road or walkway excluding any parapet wall, railing, etc.

J. **Dam failure:** The breakdown of a dam, characterized by the uncontrolled release of impounded water. There are varying degrees of failure.

K. **Dam height:** The vertical distance from the lowest point on the downstream toe to the dam crest.

L. **Dam incident:** An event at a dam that interrupts normal procedures and performance, affects the safety of the dam or results in a potential loss of life or damage to property.

M. **Fetch:** The straight-line distance across a body of water subject to wind forces. The fetch is one of the factors used to calculate wave heights in a reservoir.

N. **Freeboard:** The vertical distance between the spillway crest and the lowest point of the dam crest not including camber.

O. **Functional exercise:** A meeting in a conference room environment involving the dam owner and state and local emergency personnel with responsibilities in the emergency action plan. The exercise takes place in a stress-induced environment with time constraints and involves simulation of a dam failure and other specific events. The exercise is designed to evaluate both the internal capabilities and responses of the dam owner and the workability of the information in the emergency action plan used by emergency management officials.

P. **High water line:** The highest water level elevation in the reservoir as determined from routing the spillway design flood or inflow design flood.

Q. **Inflow design flood:** The flood flow above which the incremental increase in downstream water surface elevation due to failure of a dam is no longer considered to present an unacceptable additional downstream threat. The upper limit of the inflow design flood is the flood resulting from the probable maximum precipitation and the lower limit is the flood resulting from the 100-year precipitation.
R. **Inundation map**: A map delineating the area that would be flooded by a particular flood event.

S. **Length of dam**: The length measured along the dam axis at the dam crest. This also includes the spillway, powerplant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam these structures should not be included.

T. **Loss of life**: The likely number of human fatalities that would result from a dam failure flood event. No allowances for evacuation or other emergency actions by the population should be considered.

U. **Naturally dry watercourse**: A watercourse or portion thereof, which under normal conditions is dry, which flows only in direct response to precipitation and whose channel is at all times above the groundwater table.

V. **Normal operating level**: The water level elevation corresponding to the maximum storage level that excludes any flood control or surcharge storage.

W. **North American vertical datum 1988 (NAVD88)**: The current vertical control datum in use in North America established from nine space geodetic stations. This basis of establishing elevation provides a precise surface, whereas the North American vertical datum 1927 (NAVD27) is elevation established from mean sea level.

X. **One-hundred year flood**: A flood that has 1 chance in 100 of being equaled or exceeded during any year.

Y. **Owner**: The individual, association or corporation, public or private, the state or the United States, owning the land upon which a dam is constructed; having a contractual right to construct, operate or maintain a dam; or the beneficiary of an easement to construct, operate or maintain a dam.

Z. **Probable maximum precipitation**: Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular location during a certain time of year.

AA. **Spillway**: A structure over or through which excess flow is discharged from a reservoir. If the rate of flow is controlled by mechanical means such as gates, it is considered a controlled spillway. If the geometry of the spillway is the only control, it is considered an uncontrolled spillway. For purposes of these regulations, an uncontrolled outlet conduit that is used to drain the reservoir is not considered a spillway.

BB. **Spillway crest**: The lowest level at which water can flow over or through the spillway.

CC. **Spillway design flood**: The required flood that a spillway must pass without failure of the dam.

DD. **Storage**: For purposes of determining whether a dam is jurisdictional, the storage is the volume of water impounded by the dam above the lowest elevation of the downstream toe to the elevation of the spillway crest. For dams with no spillway, storage is measured to the dam crest. Definitions of specific types of storage in reservoirs are:

1. Dead storage is the storage volume of a reservoir that lies below the invert of the lowest outlet and therefore, cannot readily be withdrawn from the reservoir.
2. Flood surcharge storage is the storage volume between the maximum operating level and the maximum water level during the spillway design flood.
3. Live storage is the storage volume of a reservoir that is available for use and lies above the invert of the lowest outlet.
4. Reservoir storage capacity is the sum of the dead and live storage of the reservoir.
5. Maximum storage is the sum of the reservoir storage capacity and flood surcharge storage.

EE. **Tabletop exercise**: A meeting in a conference room environment involving the dam owner and state and local emergency personnel with responsibilities in the emergency action plan. The format is a discussion of an emergency event, response procedures to resolve concerns regarding coordination and responsibilities.

FF. **Toe**: The contact line between the outer shell of the dam and the natural ground surface.

GG. **Wave runup**: Vertical height above the water level to which water from a specific wave will run up the face of a structure or embankment.

[19.25.12.7 NMAC - N, 3/31/2005]

**19.25.12.8 FEE SCHEDULE**: The state engineer assesses fees for filing forms, reviewing plans and specifications for dams and appurtenant structures and construction inspections.

A. For filing an application for permit to construct and operate a dam the fees shall be $25.

B. For each review of design plans, construction drawings and specifications for a dam the fee shall be $2 per $1000 or fraction thereof of the estimated construction cost. For determination of fees, inclusion of contingencies, taxes and other permit fees is not required. Assessment of multiple review fees for the same application is at the sole discretion of the state engineer.

C. For issuing an extension of time for construction of a dam the fee shall be $50.
D. For inspecting construction of a dam the fee shall be $100/8-hour day and actual and necessary traveling expenses.
E. For filing a proof of completion of works for a dam the fee shall be $25.
F. For filing a change of ownership for a dam the fee shall be $5.
G. For copies of dam safety records up to 11 inches by 17 inches the fee shall be $0.20 per copy.
H. For copies of dam safety records greater than 11 inches by 17 inches the fee shall be $3.00 per copy.

19.25.12.8 NMAC - N, 3/31/2005

19.25.12.9 SIZE CLASSIFICATION: A dam shall be less than or equal to the maximum height and storage to qualify for the size classification.
A. Small: A small dam is greater than 10 feet but less than or equal to 40 feet in height, or greater than 10 acre-feet but less than or equal to 1000 acre-feet of storage.
B. Intermediate: An intermediate dam is greater than 40 feet but less than or equal to 100 feet in height, or greater than 1000 acre-feet but less than or equal to 50,000 acre-feet of storage.
C. Large: A large dam is greater than 100 feet in height, or greater than 50,000 acre-feet of storage.

19.25.12.10 HAZARD POTENTIAL CLASSIFICATION: The hazard potential classification is a rating for a dam based on the potential consequences of failure. The rating is based on loss of life, damage to property and environmental damage that is likely to occur in the event of dam failure. No allowances for evacuation or other emergency actions by the population should be considered. The hazard potential classification is not a reflection of the condition of the dam.
A. Low hazard potential: Dams assigned the low hazard potential classification are those dams where failure or misoperation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the dam owner’s property.
B. Significant hazard potential: Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in populated areas with significant infrastructure.
C. High hazard potential: Dams assigned the high hazard potential classification are those dams where failure or misoperation will probably cause loss of human life.

19.25.12.11 DESIGN OF A DAM: Any person, association or corporation, public or private, the state, or the United States that is intending to construct a dam shall submit an application to construct and operate a dam and supporting documentation acceptable to the state engineer. This section primarily addresses the design and construction of embankment dams. Other types of dams shall conform to sound engineering principles and current state of the practice. Because each site, design and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. Construction shall not begin until the state engineer has accepted the supporting documentation and approved the application with construction and operation conditions. The application and supporting documentation shall include:
A. Application: An application form shall be completed with original signature of the dam owner and accompanied with a filing fee in accordance with Subsection A of 19.25.12.8 NMAC. The form will be the only information available to the public before the project is approved for construction. All other supporting documentation is considered draft until accepted by the state engineer. A plan review fee in accordance with Subsection B of 19.25.12.8 NMAC shall accompany the submittal of the design report, construction drawings and specifications. A detailed estimate of the construction cost for the proposed dam and appurtenant structures shall be submitted in support of the plan review fee.
B. Water right: A water right is required for water impounded by the dam. If the dam owner has a permit for the diversion of water, documentation addressing the necessity for storage, diversion periods and release conditions for the reservoir may be required. This requirement is waived for flood control dams that do not detain
water longer than 96 hours in accordance with Subparagraph (b) of Paragraph (7) of Subsection C of 19.25.12.11 NMAC or provide documentation that a waiver by the state engineer has been granted. Flood control dams that do not drain within 96 hours require a water right for water permanently stored beyond the 96-hour drain time requirement and for associated losses due to evaporation and other potential depletions to the system unless a waiver in accordance with 19.25.12.11 NMAC is obtained.

C. Design report: A design report, which includes information to evaluate the safe design of the dam and appurtenant structures, shall be submitted in a form acceptable to the state engineer. The design report shall contain the information described below and any other additional information determined necessary by the state engineer. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare or supervise the preparation of the design report. The front cover shall show the name of the dam (identical to the application), the county in which the dam is located and type of report. The first page behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located and the signed certifications for the engineer and state engineer in accordance with Subsections B and E of 19.25.12.12 NMAC. The design report shall include:

(1) Hazard potential classification. A hazard potential classification shall be based on the dam failure condition that results in the greatest potential for loss of life and property damage. If the state engineer concurs, the classification may be based on the judgment and recommendation of the professional engineer. For all other cases, a low or significant hazard potential classification shall be supported by a dam breach analysis, which includes calculations and data that supports the predicted dam failure flood. This analysis shall also address the potential for foreseeable future development. Evaluation of the effects of flooding from dam failure shall extend at least to the location downstream where the classification can be properly identified. The dam breach analysis shall include, but not be limited to:

(a) dam failure inundation maps;
(b) map of the water surface profiles;
(c) cross-sections drawn to scale showing water surface elevation at critical sections where structures are impacted and showing discharge in cubic feet per second, average velocity in feet per second, flood wave travel times, rate of rise and structures located in the flooded sections;
(d) a tabulation and justification of assumed parameters used in the analysis;
(e) a sensitivity analysis of the assumed parameters used in the analysis;
(f) references to all computer models, data and supporting justification used in the analysis;
and
(g) appropriate data sheets and computer program output computations from computerized analysis shall be provided.

(2) Hydrologic analysis. The hydrologic analysis shall include a discussion of methodology used to calculate the spillway design flood for determining the available flood storage and spillway capacity. Consideration of how the dam will perform under these hypothetical flood conditions shall be evaluated. The hydrologic analysis shall include, but not be limited to:

(a) a topographic map of the drainage area above the dam with the drainage area and subbasins delineated and presented on a map of appropriate scale and size;
(b) a description of the topography, soils and vegetative cover of the drainage area;
(c) a discussion of the depth, duration and distribution of the spillway design storm;
(d) a tabulation, discussion and justification of all hydrologic parameters and methodology used to calculate runoff from rainfall;
(e) a discussion of the peak inflow, volume of runoff and maximum reservoir water level elevation for the inflow hydrograph;
(f) a plot of the reservoir inflow and outflow hydrographs extended until flow is negligible and plotted on the same figure of appropriate size and scale;
(g) a table showing the reservoir area (in acres) and storage capacity (in acre-feet) for each foot of elevation above the bottom of the reservoir to the dam crest; the table shall be determined from the reservoir topography map; indicate the amount of dead storage, elevation of the invert of the outlet and elevation of the crest of each spillway; all elevations shall be based on North American vertical datum 1988 or more recent adjustment; and
(h) appropriate data sheets and computer program output computations from computerized analysis shall be provided.
(3) Spillway design flood. The spillway design flood is the flood that a spillway must be capable of conveying without dam failure. For perimeter embankment dams with no spillway and no external drainage area, the dam must be capable of impounding the spillway design flood without dam failure. A spillway design flood less than these requirements is acceptable to the state engineer if an incremental damage analysis is presented to justify the inflow design flood in accordance with Paragraph (4) of Subsection C of 19.25.12.11 NMAC. The spillway design flood is based on size classification and hazard potential classification of the dam as follows:

(a) Dams classified as low hazard potential, regardless of size, shall have spillways designed to pass a flood resulting from a 100-year precipitation event expressed as a percentage of the probable maximum precipitation.

(b) Dams classified as small and intermediate, with a significant hazard potential rating shall have spillways designed to pass a flood resulting from 50 percent of the probable maximum precipitation.

(c) Dams classified as large, with a significant hazard potential rating shall have spillways designed to pass a flood resulting from 75 percent of the probable maximum precipitation.

(d) Dams classified as high hazard potential, regardless of size, shall have spillways designed to pass a flood resulting from the probable maximum precipitation.

(4) Incremental damage assessment. Where spillways are not in compliance with Paragraph (3) of Subsection C of 19.25.12.11 NMAC an incremental damage assessment shall justify the inflow design flood used to size the spillway. The assessment shall evaluate the consequences of dam failure. The assessment shall compare the impact of with-failure and without-failure conditions on downstream water levels and existing and known future development. The assessment shall include a dam breach analysis in accordance with Subparagraphs (a) through (g) of Paragraph (1) of Subsection C of 19.25.12.11 NMAC for the failure and non-failure conditions. Methods for assessing the damage between failure and non-failure conditions shall be fully documented.

(5) Spillway capacity. The spillway capacity shall be adequate to pass the spillway design flood in accordance with Paragraph (3) of Subsection C of 19.25.12.11 NMAC or accepted inflow design flood in accordance with Paragraph (4) of Subsection C of 19.25.12.11 NMAC without failure of the dam. If design calculations show that overtopping will occur, an erosion study of the embankment documenting that the dam will not breach is required. The spillway capacity shall be based on the crest of the spillway to the dam crest. A spillway rating curve and table showing elevation in one-foot increments versus maximum discharge capacity shall be prepared. Elevations shall be based on North American vertical datum 1988 or more recent adjustment.

(6) Spillway design. Spillways shall be evaluated for erosion potential during normal operation and the design flood event. Damage to a spillway during the design flood event is acceptable; however, a breach of the spillway is unacceptable. The spillway design shall address the following minimum requirements:

(a) The material required for spillway lining depends on the spillway location, frequency of discharge and velocity of discharge to adequately address erosion and breach potential. The design shall provide adequate justification for the material selected.

(b) The spillway must discharge away from the toe of the dam and abutment slopes.

(c) The material shall provide aeration of the nappe for cavitation control where control weirs are used at the spillway crest.

(d) The potential for the accumulation of debris that may block the spillway shall be addressed.

(e) Energy dissipation to control erosion of the natural channel due to spillway discharge shall be addressed.

(f) Channel lining shall be placed on a suitably prepared, stable subgrade. All edges and joints in channel lining material must be designed to prevent undermining and erosion. Concrete channel lining must be provided with adequate jointing to permit thermal expansion and contraction and adequate reinforcing to control thermal cracking. Adequate water stops are required at joints in the spillway lining. Concrete lining shall be adequately anchored against displacement and uplift and shall be provided with adequate subdrainage to relieve hydrostatic pressure and prevent frost heave.

(g) Where training dikes are used to divert the water away from the dam, the dike shall be designed with a compaction to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557, or at least 70% relative density if Proctor testing is not
appropriate. Erosion protection for the dike shall be addressed in accordance with Paragraph (16) of Subsection C of 19.25.12.11 NMAC.

(7) Outlet works capacity. Dams shall be designed with a low level outlet to drain the entire contents above the elevation of the downstream toe of the dam. If environmental consequences prevent draining of the reservoir, the state engineer will grant a waiver if written justification is provided to the satisfaction of the state engineer. The outlet shall be sized to provide adequate capacity to satisfy water rights of downstream priority users. A stage discharge curve and table showing elevation in one-foot increments versus discharge capacity shall be prepared. The rating curve and table shall be from the invert of the outlet to the dam crest. The parameters used to calculate the outlet works capacity shall be justified and appropriate data sheets and computer program output computations from computerized analysis shall be provided. Elevations shall be based on North American vertical datum 1988 or more recent adjustment. The outlet works capacity shall meet the following minimum requirements:

(a) Outlets for water storage reservoirs shall drain in 45 days with supporting calculations provided.

(b) Outlets for flood control dams shall drain the reservoir in 96 hours unless a waiver is granted by the state engineer. The 96-hour time frame begins once the reservoir storage drops to the emergency spillway crest or reaches its peak during the 100-year, 24-hour event. Documentation supporting the waiver shall include the time to drain more frequent events.

(8) Outlet works design. The outlet works design includes the intake structure, conduit and terminal structure. The outlet works design shall meet the following minimum requirements:

(a) Minimum conduit diameter is 18 inches unless a waiver is granted by the state engineer. Documentation supporting a waiver shall include identification of methods to inspect the interior of the conduit.

(b) Metal conduits used in dams that are classified as significant hazard potential where the sole purpose of the dam is flood control, or in dams classified as low hazard potential, shall have adequate strength after corrosion for a minimum of 200 years, based on corrosivity testing of onsite soils. Cathodic or other protection of metal conduits is permissible and may be considered in this analysis. Metal conduits are not acceptable for dams classified as high hazard potential or dams classified as significant hazard potential with permanent water storage except as interior forms for cast-in-place concrete conduits.

(c) Outlet conduits for storage reservoirs shall be gated at the upstream end unless a waiver is granted by the state engineer. Where gates are located other than at the upstream end of the conduit, a guard gate or bulkhead shall be provided at the upstream end to allow draining of the conduit for inspection, maintenance and repair.

(d) Outlet conduits shall be adequately vented. Where the outlet conduit ties directly to a downstream pipe, a by-pass valve shall be provided.

(e) Outlet controls and equipment shall be properly designed to be secure from damage due to vandalism, weather, ice, floating debris, wave action, embankment settlement and other reasonably foreseeable causes. The outlet control operators shall remain accessible during outlet works and spillway releases.

(f) Outlets for flood control structures shall be un gated. Where a gate is required to satisfy downstream release restrictions, a waiver from the state engineer is required. The written request for waiver shall include a plan for timely release of the floodwater.

(g) Outlet works intake structures shall be provided with trash racks or grates to prevent clogging with debris. Grate opening size or bar spacing shall be adequate to satisfy applicable public safety requirements, if appropriate. Total size of grate openings must be at least three times the cross-sectional area of the outlet conduit.

(h) The design of the outlet works terminal structure shall address energy dissipation to prevent erosion and shall include supporting calculations.

(i) Outlet conduits shall be designed for full embankment loading and for hydrostatic pressure equal to the maximum reservoir head, acting separately and in combination, with an adequate factor of safety for the conduit material. If future increases in embankment height and/or reservoir head are foreseeable, allowance shall be made in the design.

(j) The conduit together with all joints and fittings shall be watertight at the design pressure and shall be pressure tested prior to backfilling. Conduits shall be designed for all reasonably foreseeable adverse conditions including corrosion, abrasion, cavitation, embankment settlement and spreading, thermal effects and seismic loading. The ability of the conduit to withstand deflection and separation at the joints shall be addressed in the design of the outlet conduit.
Outlet works shall be supported by stable, well-consolidated foundation materials. Where the conduit is placed in embankment fill or native overburden materials, settlement analysis shall be performed.

Minimizing seepage along conduits shall be addressed including the methods for ensuring compaction of backfill around and beneath the conduit.

All supporting documentation and calculations for the outlet works design shall be provided. The outlet works design shall include all foreseeable loading conditions, including but not limited to ice loading, debris buildup, wave action and embankment settlement. Structural design calculations for the intake structure, conduit and outlet structure shall be submitted.

Geological assessment. A geological assessment of the dam and reservoir site is required for all dams classified as high or significant hazard potential. The geological assessment may be included in the geotechnical investigation or seismic study, or may be submitted as a separate document. The geological assessment shall address regional geologic setting; local and site geology; geologic suitability of the dam foundation; slide potential of the reservoir rim and abutment areas; and seismic history and potential.

Geotechnical investigation. A geotechnical investigation shall assess site conditions and support the design. A professional engineer licensed in the state of New Mexico qualified to provide geotechnical expertise in the design and construction of dams shall prepare, stamp and sign the geotechnical investigation, which may be submitted as a separate report. The scope of the geotechnical investigation is dependent on the size classification, hazard potential classification, anticipated materials and construction methods, site geology and seismicity, anticipated soil strata and other site-specific conditions. The geotechnical investigation shall include a field investigation and laboratory testing. Results of field and laboratory testing shall be presented in a report, including recommended parameters to be used in design and construction of the dam and appurtenant structures. The field investigation and laboratory testing shall include but not be limited to the following:

- Test borings in the footprint of the embankment, spillway excavations and appurtenant structures extending to bedrock or to a depth equal to at least the height of the dam; where appropriate, borings may include coring of bedrock materials to determine the quality and character of the rock;
- Standard penetration tests or other field-testing to assess soil character and consistency;
- "Undisturbed" sampling for further tests such as insitu density, shear strength and compressibility;
- Supplemental test pits, if deemed necessary, to obtain bulk and undisturbed samples, assess soil layering and measure bedrock orientation;
- Measurement of water level in drill holes;
- Field permeability testing, if feasible;
- Logs of test borings and test pits, location map and profile along dam axis with soil information shown;
- Testing to determine the relevant properties of the material to be used in construction, including but not limited to shear strength, permeability, compressibility and filter characteristics; the testing method shall conform to accepted industry standards and be appropriate for the material being tested;
- Evaluation of liquefaction potential and dynamic shear strength testing if deformation analysis is required; and
- Identification of the location of the borrow material to be used during construction.

Seepage and internal drainage. The effects of seepage and potential for internal erosion shall be evaluated. A seepage analysis shall be performed to address the performance of the embankment under steady-state conditions for dams classified as high or significant hazard potential. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the seepage analysis. A waiver may be requested in writing for flood control dams or reservoirs with synthetic liners. The seepage analysis and internal drainage design shall include but not be limited to the following:

- Flow nets of appropriate size and scale shall be prepared. The effects of anisotropy with respect to permeability shall be addressed. Ratios of horizontal to vertical permeability of less than 4 for constructed embankments and less than 9 for native deposits shall be supported by field and laboratory permeability tests. Appropriate data sheets and computer program output computations from computerized analysis shall be provided.
- The design shall address the effects of anticipated seepage beneath, around and through the dam. Seepage shall not exit on the dam face and excessive exit seepage gradients are unacceptable. All filter, transition and drainage zones within earth dams shall have a thickness adequate to address constructability and enhance seismic stability with a minimum thickness of 3 feet for each zone.
Dams shall be designed to provide the following minimum factors of safety from the stability analysis:

- Appropriate data sheets and computer program output computations from computerized analysis shall be provided.
- Where appropriate, the analysis shall consider noncircular or block and wedge type failure surfaces as well as circular failures. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the geotechnical investigation. A scale drawing, utilizing the same scale for vertical and horizontal dimensions, shall be provided for each cross-sectional model used in the analysis, with the critical failure surface(s) identified.
- The analysis model shall adequately represent the geometry and zoning, shear strength parameters, material unit weights, pore pressure and seepage conditions, external loading and other relevant factors of the critical cross section or sections. Manual computations in the analysis will be accepted if judged to be sufficiently rigorous. Where appropriate, the analysis shall consider noncircular or block and wedge type failure surfaces as well as circular failures. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the geotechnical investigation. A scale drawing, utilizing the same scale for vertical and horizontal dimensions, shall be provided for each cross-sectional model used in the analysis, with the critical failure surface(s) identified.
- Drain pipes shall be sized to provide a flow depth no more than ¼ of the pipe diameter when carrying the anticipated discharge. Drain pipes shall be at least 6 inches in diameter unless the availability of technology for inspection and maintenance can be demonstrated. Individual pipes shall discharge to a gallery, well, manhole, or to daylight such that the flow of each pipe can be monitored and measured. Manifold connections, tees and wyes are not permitted. If the anticipated flow from a drain line exceeds 10 gpm, a measuring flume or weir shall be provided for that line. If the anticipated flow from a drain line is less than 10 gpm, the outfall shall be designed to allow a 5 gallon bucket to be used to collect and measure discharge. Where pipes from internal drains are discharged to daylight, a rodent screen shall be provided.

Stability analysis. Cross-sectional design for dams shall be supported by slope stability analysis. Dams classified as low hazard potential with upstream slopes no steeper than 3 horizontal to 1 vertical, downstream slopes no steeper than 2 horizontal to 1 vertical and which are 25 feet or less in height will not require slope stability analysis. The analysis model shall adequately represent the geometry and zoning, shear strength parameters, material unit weights, pore pressure and seepage conditions, external loading and other relevant factors of the critical cross section or sections. Manual computations in the analysis will be accepted if judged to be sufficiently rigorous. Where appropriate, the analysis shall consider noncircular or block and wedge type failure surfaces as well as circular failures. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the geotechnical investigation. A scale drawing, utilizing the same scale for vertical and horizontal dimensions, shall be provided for each cross-sectional model used in the analysis, with the critical failure surface(s) identified. Appropriate data sheets and computer program output computations from computerized analysis shall be provided. Dams shall be designed to provide the following minimum factors of safety from the stability analysis:

1. For steady state long-term stability:
   - 1.5
2. For operational drawdown conditions:
   - 1.5
3. For rapid drawdown conditions:
   - 1.2
4. For end of construction:
   - 1.2

Seismic design and analysis. Dams classified as high or significant hazard potential shall be analyzed for seismic stability. Seismic analysis for water storage dams shall be based on full reservoir under steady state seepage conditions. Flood control dams with ungated outlets that satisfy Subparagraph (b) of Paragraph (7) of Subsection C of 19.25.12.11 NMAC without waiver shall be designed for earthquake loads under empty reservoir conditions and need not consider steady-state seepage. Dams sited on active faults shall obtain a waiver from the state engineer. To obtain a waiver the analysis shall show that the location of the dam is unavoidable and the dam must be designed to withstand anticipated fault movement without compromising its integrity. Appropriate data sheets and computer program output computations from computerized analysis shall be provided. The seismic analysis shall meet the following minimum requirements:

1. A seismological investigation for the dam area and reservoir area. This study may be part of the geological or geotechnical report for the structure, or may be a separate effort. The study shall determine and justify the appropriate seismic parameters to be used for design. The seismic parameters shall be based on the following design earthquake:
   - Dams classified as high hazard potential other than flood control structures shall be designed for the maximum credible earthquake or for an earthquake with a 5000-year return frequency.
   - Dams classified as significant hazard potential or high hazard potential dams whose sole purpose is for flood control shall be designed for a 2% chance of occurrence in 50 years (approximately 2500-year return frequency).

2. An analysis of materials in the foundation, reservoir area and proposed embankment shall be completed to determine the potential for liquefaction, earthquake-induced sliding, or other seismic sensitivity, which may be accomplished as part of the geotechnical investigation.

3. Pseudostatic analysis will be acceptable for the following cases:
   - The embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557 or
at least 70% relative density if Proctor testing is not appropriate; no materials prone to liquefaction are present in the foundation and peak bedrock acceleration is 0.20g or less; or

(ii) the embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557; potentially submerged portions of the embankment except for internal drain elements are constructed of clayey material; the dam is constructed on clayey soil or bedrock foundation and peak bedrock acceleration is 0.35g or less; and

(iii) all safety factor requirements in accordance with Subparagraphs (a) through (d) of Paragraph (12) of Subsection C of 19.25.12.11 NMAC are met;

(iv) minimum freeboard requirements in accordance with Subparagraphs (a) through (e) of Paragraph (15) of Subsection C of 19.25.12.11 NMAC are met; and

(v) the pseudostatic coefficient selected for analysis must be at least 50% of the predicted peak bedrock acceleration, but not less than 0.05g and the factor of safety under pseudostatic analysis shall be 1.1 or greater. In determining the factor of safety for pseudostatic analysis, a search for the critical failure surface shall be made.

(d) For dams not satisfying the requirements for pseudostatic analysis, a deformation analysis is required. The resulting embankment must be capable of withstanding the design earthquake without breaching and with at least 3 feet of freeboard remaining after deformation. The analysis shall also assess the potential for internal erosion as a result of cracking during deformation.

(e) The seismic assessment shall also address the stability of appurtenant structures to the dam during the design earthquake as appropriate, unless failure of an appurtenance due to earthquake does not represent an immediate threat to the dam, in which case the operating basis earthquake may be used.

14. Dam geometry. The dam geometry shall be supported by the stability and seismic analysis and meeting the following minimum requirements:

(a) The crest width shall be at least equal to the dam height in feet divided by 5 plus 8 feet, with the minimum permissible crest width being 10 feet and the maximum required crest width being 24 feet.

(b) Roads located on the crest shall have appropriate surfacing to provide a stable base that resists rutting and provides adequate friction for safety in wet conditions.

(c) The crest design shall provide a minimum of 2 feet of cover or the depth of frost penetration; whichever is greater, above clay cores to prevent cracking of the core due to desiccation or frost penetration.

(d) Turnarounds should be provided on dead-end service roads on dam crests, located in such a manner that backing maneuvers longer than 300 feet are eliminated.

(e) The crest shall be provided with adequate cross slope to prevent ponding.

(f) The slope or slopes to which crest drainage is directed must be provided with adequate erosion protection to accept the crest drainage.

(g) The crest longitudinal profile shall be provided with adequate camber to maintain the profile after embankment settlement. Camber should be based on settlement analysis and shall be at least 2 percent of the total embankment height, with a minimum of 1 foot at the highest point of the dam. The tops of internal core zones shall also be provided with camber in a similar manner to the crest of the dam.

(h) In the event that safety berms, street curbs, or other longitudinal features which block, control, or concentrate drainage are required on the dam crest, the design shall provide for collection and conveyance of accumulated water to discharge away from the embankment without erosion.

15. Freeboard. Dams shall be provided with adequate freeboard. Wave runup shall be determined taking into consideration wind speed, reservoir fetch, embankment slope and roughness of the slope surface. Freeboard shall satisfy the following conditions:

(a) Anticipated wave runup resulting from a 100 mph wind with reservoir level at the spillway crest will not overtop the dam.

(b) Anticipated wave runup resulting from a 50 mph wind with maximum reservoir level from routed spillway design flood will not overtop the dam.

(c) Clay core cover and capillary rise requirements in accordance with Subparagraph (c) of Paragraph (14) of Subsection C of 19.25.12.11 NMAC are satisfied.

(d) A minimum of 3 feet of freeboard remains after seismic deformation.
In any case, at least 4 feet of freeboard shall be provided. The minimum of 4 feet of freeboard may be waived for perimeter embankments with no spillway, provided a written request is made to the state engineer accompanied with supporting justification.

Erosion protection. Erosion protection shall be addressed to protect the dam and appurtenant structures from erosion that can threaten the safety of the structure. At a minimum, the following areas of erosion shall be addressed:

(a) Wave erosion. The upstream slope shall be protected from wave erosion. The material selected and area of coverage shall be appropriate for the protection required with justification provided. Flood control dams in compliance with Subparagraph (b) of Paragraph (7) of Subsection C of 19.25.12.11 NMAC without waiver are exempt from wave protection.

(b) Surface erosion. The slope, crest, abutment and groins, toe areas and any other constructed areas associated with the dam and appurtenant structures shall be protected from surface erosion and concentrated flows. The material selected and area of coverage shall be appropriate for the protection required with justification provided.

Geotextile design. Geotextiles are an acceptable material for use in dam design if the geotextile is placed so that it does not jeopardize the dam or appurtenant structures during repair or failure of the geotextile. The geotextile material shall be used in accordance with the manufacturer’s recommendations and intended use for the product. Installation shall be by certified personnel and the completed installation certified by installer or manufacturer, if required by the manufacturer.

Structural design. The structural design information for all appurtenant structures, addressing water, earth, ice and any other applicable load shall be provided. Reinforced concrete design including assumptions for loads and limiting stresses and sample calculations shall be provided. Appropriate data sheets and computer program output computations from computerized analysis shall be provided.

Utilities design. Utility placement or relocation shall be addressed as applicable. Utilities located in the vicinity of the proposed embankment footprint should be relocated and trenches backfilled and compacted with suitable material to the satisfaction of the state engineer. If utilities are allowed to remain, they will be required to satisfy applicable provisions for outlet conduits in accordance with Paragraph (8) of Subsection C of 19.25.12.11 NMAC.

Miscellaneous design. Because each design is unique, all design elements not specifically addressed in these regulations shall be documented and justified with sample calculations and appropriate data sheets and computer program output computations from computerized analysis shall be included in the design report.

D. Construction drawings: A professional engineer licensed in the state of New Mexico qualified in dam design and construction shall prepare the construction drawings. Illegible, mutilated, careless or otherwise poorly prepared drawings are not acceptable for filing with the state engineer. Plan drawings and maps prepared with the aid of a computer require the submittal of the digital data files in tagged image file format or other format acceptable to the state engineer. The preparation of construction drawings is described below and shall include the following items:

(1) Quality. Construction drawings and maps shall be made from actual field or photogrammetric surveys of an accuracy acceptable to the state engineer. Construction drawings and maps shall be prepared with permanent black ink on mylar. All original signatures, dates and acknowledgments appearing on the sheet(s) shall be in permanent ink. Plan drawings and maps shall always be rolled, never folded, for transmittal.

(2) Scale and size. Sheets shall be twenty-four (24) inches by thirty-six (36) inches with one (1) inch margins on all sides. The scale(s) used on the drawings may vary according to requirements and space available to show all necessary data in detail clearly in feet and decimals and to be clearly legible when the drawings are reduced to eleven (11) inches by seventeen (17) inches. Detailed dimensions of appurtenant structures shall be given in feet and inches. All sheets shall have bar scales in order to allow scaling of reduced drawings.

(3) Sheet numbers. Each sheet shall be numbered sequentially with the first sheet being sheet number one in conjunction with the total numbered sheets (example Sheet 1 of 5). The sheet number on the last sheet shall equal the total number of sheets.

(4) Engineer’s seal and signature. Each sheet shall have the responsible engineer’s seal and signature.

(5) Orientation and date. The direction of north and the basis of bearings shall be shown on all maps. The date that field surveys are made or the date of the aerial photography used shall be shown on the maps.

(6) Title sheet. The first sheet of a set of plans is the title sheet. The title sheet shall only contain sufficient information to summarize the scope of the project, the title of the project and signed certifications for the
dam owner, engineer and state engineer in accordance with Subsections A, B and E of 19.25.12.12 NMAC. The title sheet shall summarize the properties of the dam and shall include the following information, as appropriate:

(a) name of the dam (same as shown on the application);
(b) type of dam (material);
(c) hazard potential classification;
(d) maximum height above the downstream toe in feet;
(e) maximum length in feet;
(f) crest width in feet;
(g) slope of the upstream face (horizontal to 1 vertical);
(h) slope of the downstream face (horizontal to 1 vertical);
(i) elevation of the dam crest;
(j) elevation of spillway crest;
(k) elevation of outlet conduit flow line;
(l) freeboard in feet;
(m) maximum spillway discharge capacity in cubic feet per second;
(n) type of outlet conduit (give size and material);
(o) maximum outlet conduit discharge capacity in cubic feet per second; and
(p) location of the outlet works intake structure (using latitude and longitude or to the New Mexico state plane coordinate system).

7) Vicinity map. A vicinity map of sufficient scale and size to locate the pertinent area shall be shown on the title sheet or second sheet of the drawings.

8) Site topography. A detailed topography of the dam site including sufficient area upstream and downstream and at the abutments shall be provided. Elevations shall be based on North American vertical datum 1988 or more recent adjustment.

9) Design details. Detailed information of the various construction features including plan view, elevations, cross-sections at the maximum section and along the outlet works, profile along and section through the centerline of the dam showing construction features and cross-sections and a profile of the emergency spillway with dimensions and construction details shall be provided. Any other information necessary for the state engineer to determine the feasibility and safety of the dam shall be required.

10) Reservoir area, capacity and high water line traverse. The topography of any proposed reservoir site shall be determined to industry standards and a contour map with a contour interval of 1 foot shall be prepared. Elevations of the contours shall be tied to the North American vertical datum of 1988 or more recent adjustment. The high water line at the elevation of the dam crest will be highlighted on the contour map. A curve or table of elevation versus area and storage capacity for the reservoir shall be prepared from the contour map. The curve or table shall be from the bottom of the reservoir to the dam crest. Area shall be provided in acres and storage capacity in acre-feet.

11) Point of outlet. A location of the outlet works shall be referenced using latitude and longitude or to the New Mexico state plane coordinate system.

12) Permanent bench mark. A permanent bench mark shall be established above the high water line at a location unlikely to settle or be disturbed. The North American vertical datum of 1988 or more recent adjustment and latitude and longitude or the New Mexico state plane coordinate system for the bench mark elevation and location shall be provided. A detail of construction of the permanent bench mark shall be provided.

E. Specifications: Specifications shall be prepared for each project describing work to be done and materials to be used to supplement construction drawings. Specifications must be clear and concise and include detailed methods of construction, qualities and sizes of materials, unit amounts to be used and methods of testing and quality control, construction supervision and inspection. Specifications shall be prepared by a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams. The specifications shall meet the following requirements:

1) The front cover of the specifications shall show the name of the dam (identical to the application) and the county in which the dam is located. The first page behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located, signed certifications for the engineer and state engineer in accordance with Subsections B and E of 19.25.12.12 NMAC and a statement recognizing the authority of the state engineer. An approved model statement recognizing the authority of the state engineer is provided below. Changes to the model statement require prior approval of the state engineer.
“All construction shall be performed in strict accordance with the accepted plans and specifications. Representatives of the state engineer shall have full authority to perform inspections during construction and shall have full power to act pursuant to the law and in accordance with Title 19, Chapter 25, Part 12, Dam Design, Construction and Dam Safety of the New Mexico Administrative Code if plans and specifications are not followed.”

(2) The specifications shall be indexed.
(3) The specifications shall be bound and submitted on a good grade of white 8 1/2-inch by 11-inch paper.
(4) The general conditions shall include statements that the construction drawings and specifications cannot be significantly changed without the prior written approval of the state engineer.

F. Boundary, easement or right of way plat of survey: A professional surveyor licensed in the state of New Mexico shall prepare a plat of survey showing the dam owner’s property boundaries or easement and/or right of way granted by the land owner. The plat of survey shall be prepared in conformance with the requirements as set forth in the Minimum Standards for Surveying in New Mexico, 12.8.2 NMAC. The plat of survey shall clearly state to whom an easement is granted and what rights are conveyed with the easement. The plat of survey shall show the footprint of the dam and appurtenant structures and the high water line in the reservoir. The plat of survey shall be submitted with the construction drawings and recorded with the county clerk of the county or counties in which the survey is located. A certificate signed by the surveyor in accordance with Subsection C of 19.25.12.12 NMAC shall appear on the plat of survey. A certified copy of the recorded plat of survey bearing the recorded page and endorsement of the county clerk shall be submitted to the state engineer for filing upon completion of construction. Adequate property ownership, easement or right of way shall be required for the following conditions:

(1) to access the dam and outlet controls during normal and flood events;
(2) to prevent development encroachment into the reservoir area defined by normal operation and the spillway design flood;
(3) to prevent development in the approach, control and discharge section of the spillway that may restrict flow through the spillway;
(4) to return outlet works and spillway discharge to the natural drainage and allow the outlet works to discharge freely; and
(5) to perform maintenance on the dam, appurtenant structures and surrounding areas to ensure the safe performance of the dam.

G. Dam site security: Dams classified as high or significant hazard potential shall address security at dams to prevent unauthorized operation or access. If in the opinion of the state engineer, the failure of the dam will result in catastrophic consequences, a security and risk management program for the dam will be required. Elements of a security and risk management program are:

(1) threat, vulnerability and risk assessments;
(2) physical security plans; and
(3) integration of security operational procedures.

H. Instrumentation plan: An instrumentation plan providing the ability to monitor and evaluate the performance of a dam is required for dams classified as high or significant hazard potential. The instrumentation plan may be submitted as a separate report or part of the operation and maintenance manual. Minimum requirements of the instrumentation plan shall include:

(1) general description of instrumentation;
(2) reading schedule;
(3) identification of critical readings;
(4) specifics for each installation including:
- detailed description of installations;
- purpose of the instrumentation;
- reading and maintenance schedule instructions; and
- special instrumentation or monitoring requirements.

I. Operation and maintenance manual: An operation and maintenance manual is required for dams classified as high or significant hazard potential. The operation and maintenance manual identifies activity necessary to address the continued safe operation, maintenance and overall performance of the dam. Any restrictions imposed by the design shall be addressed in the operation and maintenance manual. The operation and maintenance manual shall conform to the requirements set forth in 19.25.12.17 NMAC.
J. Emergency action plan: An emergency action plan is required for dams classified as high or significant hazard potential. The emergency action plan identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The emergency action plan shall conform to the requirements set forth in 19.25.12.18 NMAC.


19.25.12.12 CERTIFICATIONS: Signed certifications by the dam owner, engineer, surveyor, state office of emergency management and the state engineer are required by these regulations on specific documents. Approved model certifications for the dam owner, engineer, surveyor, state office of emergency management and state engineer are provided below. Changes to the model certifications require prior approval of the state engineer.

A. DAM OWNER’S CERTIFICATE: A certificate followed by the dated signature of the dam owner and notary public acknowledgment is required on the title sheet of the construction drawings and first page behind the front cover of the operation and maintenance manual and emergency action plan. The following model certification is considered to be an example of the minimum that the dam owner shall certify. If the dam owner is a corporation, political subdivision or other governmental entity a model certificate is also provided.

state of ________________________ )

) ss.
county of ________________________ )

I, __ (dam owner’s name)_______, being first duly sworn, upon my oath, state that I have read and examined the accompanying ________________________ (construction drawings consisting of ____ sheets, operation and maintenance manual, or emergency action plan) and know the contents and representations therein for ________________________ dam and all that is shown herein is done with my free consent and in accordance with my wishes and state that the same are true and correct to the best of my knowledge and belief.

_______________________________
Dam owner signature                   Date

Subscribed and sworn to before me this _____ day of ________________, 20__.

_______________________________
Notary public

My commission expires ____________ (SEAL)

If a claimant is a corporation, political subdivision or other governmental entity the following shall be used:

state of ________________________ )

) ss.
county of ________________________ )

I, __ (representative’s name)_______, being first duly sworn, upon my oath, state than I am the _____________ (officer) of the ___________________________, a corporation duly organized under the laws of the state of ______________, that the accompanying ________________________ (construction drawings consisting of ____ sheets, operation and maintenance manual, or emergency action plan) for ________________________ dam were made under authority of the board of directors of said corporation and that, in their behalf, I have read and examined the statements and representations and all that is shown herein is done with their free consent and in accordance with their wishes and state that the same are true and correct to the best of my knowledge and belief.

_____________________________________
Representative signature, title           Date

Subscribed and sworn to before me this _____ day of ________________, 20__.

_______________________________
Notary public
My commission expires ____________ (SEAL)

B.  ENGINEER’S CERTIFICATE: A certificate followed by the dated signature, license number and seal of the engineer responsible for preparing the design report, construction drawings, specifications, operation and maintenance manual and engineering elements of the emergency action plan is required. The certificate shall be placed on the title sheet of the construction drawings and first page behind the front cover of the design report, specifications, operation and maintenance manual and emergency action plan. The following model certification is considered to be an example of the minimum that the engineer should certify to:

state of ________________________ )

) ss.

county of ________________________ )

I, __ (engineer’s name)__, hereby certify that I am a professional engineer licensed in the state of New Mexico, qualified in ____________ (civil, geotechnical, etc.) engineering; that the accompanying ______________ (design report, construction drawings consisting of ____ sheets, specifications, operation and maintenance manual, or _________________ elements of the emergency action plan) was prepared by me or under my supervision; that the accompanying ______________ (design report, construction drawings consisting of ____ sheets, specifications, operation and maintenance manual, or _________________ elements of the emergency action plan) is in compliance with the Dam Design, Construction and Dam Safety Regulations (19.25.12 NMAC) and that the same are true and correct to the best of my knowledge and belief.

(Engineer’s signature) __________, License number ____________, (SEAL)

Engineer’s name

Date submitted ______________

C.  SURVEYOR’S CERTIFICATE: The professional surveyor licensed in the state of New Mexico preparing the plat of survey showing property boundaries, acquired easements or rights-of-way shall include a certificate on the plat of survey as modeled in Paragraph (2) of Subsection J of 12.8.2.9 NMAC, the Minimum Standards for Surveying in New Mexico. The following model certificate is considered to be an example of the minimum that the surveyor should certify to:

I, __ (surveyor’s name)__, New Mexico professional surveyor no. (surveyor’s license number), do hereby certify that this ______________ (boundary, easement, or right of way) plat of survey and the actual survey on the ground upon which it is based were performed by me or under my direct supervision; that I am responsible for this survey; that this survey meets the Minimum Standards for Surveying in New Mexico; and that it is true and correct to the best of my knowledge and belief. I further certify that this survey is not a land division or subdivision as defined in the New Mexico Subdivision Act and that this instrument is a ______________ (boundary, easement, or right of way) plat of survey of ________________ dam.

(Surveyor’s signature) __________, License number ____________, (SEAL)

Surveyor’s name

Date submitted ______________

D.  STATE OFFICE OF EMERGENCY MANAGEMENT: A certificate form for the state office of emergency management acceptance shall be placed on the first page behind the front cover of the emergency action plan. This certificate is to be signed by state office of emergency management after all necessary corrections or additions, if any, have been made.

state of ________________________ ) ss.

county of ________________________ )
I hereby certify that the accompanying emergency action plan for _________________ dam has been duly examined by me and accepted for filing on the _____ day of _______________, 20__. 

State office of emergency management

E. STATE ENGINEER’S CERTIFICATE: A certificate form for the state engineer acceptance shall be placed on the title sheet of the construction drawings and first page behind the front cover of the design report, specifications, operation and maintenance manual and emergency action plan. This certificate is to be signed by the state engineer or his representative after all necessary corrections or additions, if any, have been made.

state of ______________________ )

) ss.

county of ____________________ )

I hereby certify that the accompanying ____________________ (design report, construction drawings, specifications, operation and maintenance manual or emergency action plan) for _________________ dam and appurtenant structures has been duly examined by me and accepted for filing on the _____ day of _________________, 20__. 

__________________________________

State engineer


19.25.12.13 CONSTRUCTION AND OPERATION CONDITIONS: After reviewing the required documentation, the state engineer will notify the dam owner if any deficiencies are found with the submittal to construct and operate a dam. The dam owner will be given an opportunity to correct any deficiencies noted in the review process. Once all deficiencies have been addressed the state engineer will approve the application for permit to construct and operate a dam with conditions under which construction and operation shall occur. Failure to comply with conditions of the approved permit may result in the state engineer issuing an order to redesign, reconstruct or restrict operation of the dam and reservoir until conditions are met. Construction must be completed within two years of approving the application unless an extension of time for the construction is requested and approved by the state engineer. The conditions of construction and operation shall include, but not be limited to the following:

A. Engineer supervising construction: Prior to initiation of construction, the dam owner shall designate a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams to supervise construction. If the state engineer finds the engineer acceptable, an order is issued approving the engineer and setting forth conditions under which the engineer will supervise construction. Conditions shall include, but shall not be limited to:

1. The engineer supervising construction shall submit monthly progress reports including summary of test results, problems encountered and their solutions.

2. Construction shall be in accordance with accepted drawings and specifications. State engineer approval of any modifications to the accepted drawings or specifications is required prior to undertaking the modifications. Requests for changes or modifications by the engineer supervising construction shall be submitted in writing, supported with appropriate documentation.

3. The engineer supervising construction shall provide the state engineer a minimum of 72 hours notice to perform inspections as specified in the conditions of construction.

4. Upon completion of construction, the engineer supervising construction shall submit to the state engineer the following items:

   a. a completion report, which shall include descriptions of problems and their solutions;

   b. a summary of materials test data and labeled and dated construction photographs;

   c. record mylar construction drawings including signed certifications on the title sheet; and
(d) A certificate that the dam was constructed in accordance with the accepted drawings and specifications and is in satisfactory condition. An approved model certificate for the engineer supervising construction is shown below. Changes to the language in the certification require prior approval by the state engineer.

State of ______________________

County of ______________________

I, __________________________, (engineer’s name) state that I am a qualified professional engineer licensed in the state of New Mexico, that I have inspected the ____________________ dam and appurtenant structures and find them to be completed in accordance with the record construction drawings and specifications and are now in a satisfactory condition for acceptance.

(Engineer’s signature)

License number __________, (SEAL)

Engineer’s name

Date submitted ______________

B. State engineer’s authority during construction: The state engineer may perform inspections at any time during construction of the dam and appurtenant structures. Inspections will vary with each project, based on the complexity of the design. Inspection of specific construction items are standard construction conditions in the permit and require the engineer supervising construction to provide the state engineer with a minimum of 72 hours advanced notice. If the state engineer receives a minimum of 72 hours advanced notice, a delay of construction to schedule a state engineer inspection is not required. State engineer inspection fees are charged in accordance with Subsection D of 19.25.12.8 NMAC. Fees for inspection of construction by the state engineer not paid on demand shall become a lien on any land or other property of the dam owner and may be recovered by the state engineer.

C. Completion of construction: Upon completion of construction, a proof of completion of works form for the dam shall be submitted in accordance with 19.25.12.14 NMAC. Owners of dams classified as high or significant hazard potential shall submit to the state engineer an updated operation and maintenance manual in accordance with 19.25.12.17 NMAC and an updated emergency action plan in accordance with 19.25.12.18 NMAC incorporating any modifications made during construction. Upon the satisfactory completion of all conditions in the permit, pending the issuance of a certificate of construction and license to operate a dam, use of the reservoir shall require written permission from the state engineer. Use of the dam and reservoir are restricted until the state engineer accepts the updated operation and maintenance manual and emergency action plan, if required.

D. Extension of time for construction: The state engineer will grant an extension of time for completing construction upon proper showing by the dam owner of due diligence or reasonable cause for delay and accompanied with a fee in accordance with Subsection C of 19.25.12.8 NMAC. An affidavit by a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall be filed with the state engineer providing evidence that the design of the dam meets or exceeds the design requirements in accordance with 19.25.12.11 NMAC. An extension of time may be granted for a period not to exceed five (5) years. No extension of time shall be granted which in combination extend the time allowed by the permit beyond ten (10) years from the initial date of approval of the application, unless the state engineer in his discretion expressly waives this limitation pursuant to NMSA 1978, Section 72-5-14. Failure to request an extension of time shall result in cancellation of the permit by the state engineer.


19.25.12.14 PROOF OF COMPLETION OF WORKS: Upon completion of all construction conditions a proof of completion of works for the dam shall be filed on a form provided by the state engineer with appropriate fees in accordance with Subsection E of 19.25.12.8 NMAC. The proof of completion of works for the dam shall be filed with original signature of the dam owner and engineer supervising construction.


19.25.12.15 CERTIFICATE OF CONSTRUCTION OF A DAM: Upon receipt of the proof of completion of works form, the state engineer will determine if all construction conditions of the permit were met. Upon a
determination by the state engineer that all construction conditions have been complied with, the state engineer shall issue a certificate of construction. The certificate of construction shall address the general properties of the dam and appurtenant structures. The dam owner shall record the certificate of construction with the county clerk of the county within which the works are located. [19.25.12.15 NMAC - N, 3/31/2005]

19.25.12.16 LICENSE TO OPERATE A DAM: Upon issuance of a certificate of construction the state engineer shall issue a license to operate a dam. The license to operate a dam shall address operation conditions and dams shall be operated in accordance with the operation conditions. In addition, dams classified as high and significant hazard potential shall operate in accordance with the operation and maintenance manual and emergency action plan prepared in accordance with Sections 17 and 18 of 19.25.12 NMAC. Failure to comply with the conditions of the license to operate a dam may result in a state engineer order that limits operation, requires specific action by the owner and if necessary the license to operate a dam may be revoked by the state engineer. If a license to operate a dam is revoked the state engineer may order the dam breached in accordance with Subsections B or C of 19.25.12.19 NMAC. [19.25.12.16 NMAC - N, 3/31/2005]

19.25.12.17 OPERATION AND MAINTENANCE MANUAL: Owners of dams classified as high or significant hazard potential shall prepare, maintain and adhere to an operation and maintenance manual that addresses the continued safe operation, maintenance and performance of the dam. Because each site, design and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare the operation and maintenance manual. The front cover shall show the name of the dam (identical to the application), the county in which the dam is located and type of report. The first page behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located and signed certifications for the dam owner, engineer and state engineer in accordance with Subsections A, B and E of 19.25.12.12 NMAC. Operation or maintenance of the dam in violation of the procedures presented in the accepted operation and maintenance manual that affect the safety of the dam will result in an order being issued requiring the dam owner to address the problem. Failure to comply with orders issued by the state engineer may result in the license to operate the dam being revoked and the dam being ordered breached in accordance with Subsection B or C of 19.25.12.19 NMAC. Generally, the operation and maintenance manual shall address the following, with modification depending on the specific dam application:

A. Project information: General information on the project including the purpose, location, history, responsibilities and description and properties of the dam and appurtenant structures shall be required.

B. Operation: Operation instructions for the project shall include but not be limited to the following:

   (1) Reservoir:
       (a) storage allocations;
       (b) spillway design flood water level;
       (c) emergency reservoir evacuation procedures and maximum discharge rate; and
       (d) first filling criteria and monitoring requirements.

   (2) Outlet works:
       (a) first operation;
       (b) seasonal startup;
       (c) seasonal shutdown;
       (d) installation and removal of bulkhead;
       (e) operation procedures for specific equipment; and
       (f) electrical systems and controls.

C. Instrumentation: The following elements for monitoring instrumentation shall be addressed

   (1) general description;
   (2) purpose;
   (3) critical readings;
   (4) reading and maintenance procedures; and
   (5) reading schedule.
D. **Maintenance:** Maintenance requirements and schedule shall be included.

E. **Inspection:** Inspection requirements, schedule and recommended checklist shall be included.

F. **Updates and revisions:** An update and revision procedure shall be included.

G. ** Appendices:** Appendices to include any design consideration and the instrumentation plan to ensure any restrictions imposed by the design are incorporated into the operation and maintenance manual shall be included. Copies of inspections forms and any other information that supports and supplements the material used in the development and maintenance of the operation and maintenance manual.


**19.25.12.18 EMERGENCY ACTION PLAN:** Owners of dams classified as high or significant hazard potential shall prepare, maintain and exercise an emergency action plan for immediate action in the event of a potential dam failure. The emergency action plan shall follow the format provided by the state engineer or a format that has prior approval of the state engineer. Because each site and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. The front cover shall show the name of the dam (identical to the application), the county in which the dam is located and type of report. The pages immediately behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located and signed certifications for the dam owner, engineer, state office of emergency management and state engineer in accordance with Subsections A, B, D and E of 19.25.12.12 NMAC. The dam owner shall coordinate with the local emergency management office in preparing the emergency action plan. The coordination is required to ensure that there is an agreement on responsibilities. The dam owner shall submit a copy to the state office of emergency management for acceptance prior to submittal to the state engineer. The dam owner shall review the emergency action plan annually, update as necessary and furnish a copy of updates to the state engineer, state office of emergency management and all copyholders. The dam owner shall exercise the emergency action plan to verify those involved in its implementation know their roles and responsibilities. It is recommended the dam owner conduct a functional exercise of the emergency action plan every 5 years with a table top exercise conducted 2 to 3 years before the functional exercise. The exercise may result in updates to ensure the emergency action plan maintains operational readiness, timeliness and responsiveness. Failure to act in accordance with the accepted emergency action plan that affects the safety of the dam will result in an order being issued requiring the dam owner to address the problem. Failure to comply with orders issued by the state engineer may result in the license to operate the dam being revoked and the dam being ordered breached in accordance with Subsection B or C of 19.25.12.19 NMAC. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare engineering elements of the emergency action plan as specified below. An emergency action plan shall contain the following minimum elements:

A. **Notification flowchart:** A notification flowchart showing who is to be notified, by whom and in what priority.

B. **Emergency detection, evaluation and classification:** Procedures for reliably and timely identifying an emergency situation to ensure that an appropriate course of action is implemented. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare this element.

C. **Responsibilities:** A list designating responsibilities for the emergency action plan related tasks including, but not limited to developing, maintaining, exercising, implementing, warning, evacuation and termination of the emergency.

D. **Preparedness:** A list of materials, equipment and manpower available to moderate or alleviate the effects of a dam failure or spillway release. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare this element.

E. **Inundation map:** An inundation map delineating the areas that will be flooded as a result of dam failure. The dam breach analysis shall be prepared in accordance with Subparagraphs (a) through (g) of Paragraph (1) of Subsection C of 19.25.12.11 NMAC for the failure with the water level at the reservoir storage capacity and at the maximum water level during the spillway design flood event. If a dam is located upstream, failure scenarios with the upstream dam shall also be evaluated. Flood control dams that have not experienced a fill to the spillway crest shall prepare a failure scenario with the water level at the spillway crest. Flood inundation maps shall also be prepared for the maximum release without failure of the dam. Evaluation of the effects of flooding from dam failure shall extend at least to the location downstream where the flood no longer poses a threat to life or property. A
professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare this element.

F. Appendices: All information that supports and supplements the material used in the development and maintenance of the emergency action plan.


19.25.12.19 CHANGES TO AN EXISTING DAM: A dam owner proposing to reconstruct, enlarge, modify, restore reservoir capacity, repair, remove or breach an existing dam must make application to and receive approval from the state engineer prior to undertaking any such action. The current condition of the dam, the type of repair or modification and the proposed means to achieve the repair or modification shall dictate the detail of the information provided to the state engineer in order to obtain approval. Because each site, design change and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. Existing dams present the same hazards to life and property downstream as new dams. Therefore, owners of dams classified as high or significant hazard potential shall evaluate the current condition of the dam and address in the submittal to the state engineer whether the dam is in compliance with the design requirements in Subsection C of 19.25.12.11 NMAC. If the state engineer determines compliance with requirements in Subsection C of 19.25.12.11 NMAC are critical to the safety of the dam, the state engineer shall issue an order requiring the deficiency be addressed as part of the proposed change. Owners of dams classified as low hazard potential shall comply with the design requirements in Subsection C of 19.25.12.11 NMAC for the proposed change only. Maintenance activity performed in accordance with 19.25.12.17 NMAC does not require prior state engineer approval. Dam owners shall not abandon a dam without breaching or removing the dam to ensure the dam no longer poses a risk to life, property, the environment surrounding the dam or downstream of the dam. In the event of any changes of ownership affecting the title to a dam, the new owner shall file a change of ownership form for a dam with the state engineer. Recognition of the responsibility and liability associated with dam ownership is required along with fees for filing the change in ownership form for a dam in accordance with Subsection F of 19.25.12.8 NMAC. This section exempts federal dams if no change to the water storage permit is required. In general, the following minimum submittal is required to make changes to an existing dam:

A. Proposed changes to an existing dam: For dam owners proposing to reconstruct, enlarge, modify, restore reservoir capacity, or repair an existing dam, the following supporting documentation is required prior to undertaking any such action:

1. An amended application if properties of the dam and appurtenant structures change. Fees for filing the amended application and for reviewing drawings and specifications shall be in accordance with Subsections A and B of 19.25.12.8 NMAC. Fees are waived if the state engineer requires the change to address a dam safety deficiency.

2. Documentation of sufficient water rights if changes in storage or release requirements are proposed in accordance with the requirements of Subsection B of 19.25.12.11 NMAC.

3. A design report addressing the proposed change in accordance with the requirements of Subsection C of 19.25.12.11 NMAC. Owners of dams classified as high or significant hazard potential shall submit a design report addressing whether the existing condition of the dam is in compliance with the design requirements listed in Subsection C of 19.25.12.11 NMAC. Where the existing condition of the dam is not in compliance with the design requirements of Subsection C of 19.25.12.11 NMAC, the design report shall propose changes to address compliance with the design requirements of Subsection C of 19.25.12.11 NMAC or request a waiver that the deficiency is not critical to the safety of the dam and provide adequate justification for the waiver.

4. Construction drawings and specifications addressing the proposed change in accordance with the requirements of Subsections D and E of 19.25.12.11 NMAC.

5. A plat of survey showing the dam owner’s property boundaries, easement, or right of way. The plat of survey shall be in accordance with the requirements of Subsection F of 19.25.12.11 NMAC.

6. For dams classified as high or significant hazard potential, a dam site security assessment in accordance with the requirements of Subsection G of 19.25.12.11 NMAC.

7. For dams classified as high or significant hazard potential, an instrumentation plan in accordance with the requirements of Subsection H of 19.25.12.11 NMAC.

8. For dams classified as high or significant hazard potential, an updated operation and maintenance manual and emergency action plan in accordance with the requirements of Sections 17 and 18 of 19.25.12 NMAC.
B. Removal or breach of dams classified as high or significant hazard potential: Dam owners intending to breach or remove a dam classified as high or significant hazard potential shall submit a plan to the state engineer for approval prior to breaching or removing the dam. The plan shall evaluate the potential effects of the dam removal or breach on life, property and the environment downstream. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare the plan. The state engineer will revoke the license to operate a dam upon completion of all construction conditions. The plan shall meet the following conditions:

1. The reservoir shall be emptied in a controlled manner, which will not endanger lives or damage property downstream.
2. The dam or breach area shall be excavated down to the level of natural ground and the breach shall be of sufficient width to safely pass the 100-year, 24-hour flood.
3. The side slopes of the breach shall be excavated to a stable angle.
4. The breach shall be armored as necessary to prevent erosion of the breach area.
5. The plan shall control sediment previously deposited in the reservoir.
6. Drawings and specifications shall be prepared in accordance with the appropriate requirements listed in Subsections D and E of 19.25.12.11 NMAC and shall include a title sheet with required certifications and signatures, the location, dimensions and lowest elevation of the breach and any other detail to sufficiently describe the proposal.
7. Designation of the professional engineer licensed in the state of New Mexico qualified in the design and construction of dams that will supervise construction of the breach or dam removal. Submittal of the professional engineer’s qualifications for state engineer approval is required.

C. Removal or breach of dams classified as low hazard potential: Owners of dams classified as low hazard potential shall submit a written notice to the state engineer of intent to breach the dam. The state engineer will revoke the license to operate a dam upon completion of all construction conditions. The breach notice shall meet the following minimum requirements:

1. The bottom width elevation of the breach shall be to original ground.
2. The bottom width of the breach shall be a minimum of one-half the height of the dam but not less than 10 feet.
3. The side slopes not steeper than one horizontal to one vertical.
4. The excavated material shall not be placed in the streambed.

D. Closure of a tailings facility. A closure plan is prepared to address the closure of a tailings facility. State engineer approval is required before any modification occurs to a jurisdictional tailings dam. A professional engineer licensed in the state of New Mexico qualified in the design and construction of tailings dams shall prepare the closure plan, which shall include a design report, drawings and specifications prepared in accordance with the appropriate requirements listed in Subsections C, D and E of 19.25.12.11 NMAC. The state engineer will revoke the license to operate a dam upon completion of all construction conditions. The plan shall address the following issues:

1. long-term stability under static and dynamic conditions;
2. control of surface runoff to avoid erosion;
3. plan for long term monitoring, if appropriate; and
4. identification of an engineer licensed in the state of New Mexico qualified in tailings dam design and construction to supervise implementation of the closure plan. Submittal of the engineer’s qualifications for state engineer approval is required.

E. Construction and operating conditions: After reviewing the required documentation, the state engineer will notify the dam owner if any deficiencies are found with the submittal. The dam owner will be given an opportunity to correct any deficiencies noted in the review process. Once all deficiencies have been addressed the state engineer will approve the amended application or proposed change with conditions under which construction and operation shall occur. Action by the state engineer will be in accordance with 19.25.12.13 NMAC, appropriately modified to address the proposed changes.

F. Proof of completion of works, certificate of construction and license to operate: Requirement for a proof of completion of works form for the dam, certificate of construction and license to operate a dam for changes to a dam shall be in accordance with the Sections 14, 15 and 16 of 19.25.12 NMAC, appropriately modified to address the proposed changes. If the dam is breached, the state engineer will cancel the permit and revoke the license to operate a dam.

19.25.12.20 CHANGES TO AN EXISTING NON-JURISDICTIONAL DAM: A dam owner proposing to reconstruct, enlarge, or modify a non-jurisdictional dam, resulting in a jurisdictional dam after construction is completed, shall comply with 19.25.12.11 NMAC before construction begins. If the purpose of a non-jurisdictional dam changes, resulting in a jurisdictional dam, or if ownership changes, resulting in a jurisdictional dam, the owner shall comply with 19.25.12.11 NMAC. The state engineer will give the owner a reasonable amount of time to comply with 19.25.12.11 NMAC. If the owner fails to comply with 19.25.12.11 NMAC, the dam will be ordered breached in accordance with Subsection B or C of 19.25.12.19 NMAC.


19.25.12.21 EXISTING DAMS: The state engineer inspects existing dams to verify dams are operated and maintained in a safe manner. Access to the dam site shall be made available to the state engineer upon request. If a critical dam safety problem is observed by the state engineer or reported to the state engineer, an order will be issued requiring the dam owner to address the problem. If a dam incident occurs at a dam, the dam owners shall report the incident to the state engineer within 72 hours. If a major repair is required at an existing dam, the plan to repair the dam shall be in accordance with 19.25.12.19 NMAC. Minor repairs not identified as maintenance activity in accordance with 19.25.12.17 NMAC require state engineer approval. Failure to comply with orders issued by the state engineer may result in the license to operate a dam being revoked and the dam ordered breached in accordance with Subsection B or C of 19.25.12.19 NMAC. Owners of existing dams shall comply with the following:

A. Owners acquiring property with a dam shall promptly notify the state engineer on a form provided by the state engineer of the change in ownership. Recognition of the responsibility and liability associated with dam ownership is required along with fees for filing the change in ownership form for a dam in accordance with Subsection F of 19.25.12.8 NMAC.

B. Owners of dams classified as low or significant hazard potential shall evaluate the hazard classification if downstream development occurs. The dam owner shall submit the results of the hazard potential evaluation prepared in accordance with Paragraph (1) of Subsection C of 19.25.12.11 NMAC to the state engineer for approval and a plan for addressing design deficiencies. If the hazard potential classification changes due to downstream development, the state engineer shall give the dam owner a time limit to address deficiencies. Deficiencies shall be addressed in accordance with Paragraphs (3), (12) and (13) of Subsection C of 19.25.12.11 NMAC and Sections 17 and 18 of 19.25.12 NMAC. If the dam owner fails to address a deficiency, the state engineer may revoke the license to operate the dam and order the dam breached in accordance with Subsection B or C of 19.25.12.19 NMAC.

C. Dams classified as high or significant hazard potential shall be inspected on an interval no greater than 5 years by a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams. The owner is responsible for securing the services of the professional engineer. The professional engineer shall provide a signed and sealed report to the state engineer describing the findings of the inspection and recommendations for corrective action or changes to the operating procedures. Routine inspection by the state engineer as described in 19.25.12.21 NMAC satisfies this requirement.

D. Owners of dams classified as high or significant hazard potential in an unsafe condition may receive an order from the state engineer to address the deficiency pursuant to NMSA 1978, Section 72-5-11 (1979). The state engineer may also issue an order to an owner of a non-jurisdictional dam if the dam is unsafe and a threat to life or property, as determined by the state engineer. Owners shall comply with orders issued by the state engineer pursuant to NMSA 1978, Section 72-5-12 (1979).

E. Owners of dams classified as high or significant hazard potential shall comply with 19.25.12.17 NMAC requiring an operation and maintenance manual. Upon compliance with 19.25.12.17 NMAC the state engineer will issue a license to operate the dam. Dams classified as high hazard potential shall comply by December 31, 2008. Dams classified as significant hazard potential shall comply by December 31, 2010.

F. Owners of dams classified as high or significant hazard potential shall comply with 19.25.12.18 NMAC requiring an emergency action plan. Dams classified as high hazard potential shall comply by December 31, 2008 unless the dam is for flood control purposes with no permanent storage, then compliance by December 31, 2010 is required. Dams classified as significant hazard potential shall comply by December 31, 2010 unless the dam is for flood control purposes with no permanent storage, then compliance by December 31, 2012 is required. Owners of 5 or more dams classified as high or significant hazard potential may propose a schedule for compliance with the emergency action plan requirement. The schedule must be submitted by the owner to the state engineer by December 31, 2005 and is subject to review and approval or modification by the state engineer. The schedule must
propose compliance dates for each dam. The first dam must be in compliance by December 31, 2008 and at least an additional dam must be in compliance each year thereafter. All dams must be in compliance by December 31, 2015.

Upon failure to meet an approved compliance schedule all dams will revert to compliance dates shown above.

G. Dam owners that transfer the entire water right out of the reservoir shall have their license to operate a dam revoked and may receive from the state engineer an order to breach the dam in accordance with Subsection B or C of 19.25.12.19 NMAC.

H. Dam owners that fail to obtain state engineer approval prior to construction of a dam shall comply with all conditions imposed by the state engineer within a time limit established by the state engineer or the state engineer may order the dam breached in accordance with Subsection B or C of 19.25.12.19 NMAC.

19.25.12.22 SEVERABILITY: If any portion of this part is found to be invalid, the remaining portion of this part shall remain in force and not be affected.

History of 19.25.12 NMAC: [RESERVED]
DRAFT COPY

Comments requested by December 13, 2002

DAM SAFETY
DESIGN AND OPERATION
CRITERIA

NEW MEXICO
OFFICE OF THE STATE ENGINEER
2002
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1. INTRODUCTION

The Dam Safety Design and Operation Criteria (Criteria) describes the State Engineer’s authority over dams in the State of New Mexico. It addresses design criteria and filing requirements in order to obtain a permit for the construction of a dam. The Criteria also addresses the State Engineer’s authority over the continued safe operation and maintenance of the dam, modification to the dam, abandonment of a dam or removal of a dam.

Dam owners and potential dam owners must recognize that impoundment of water entails risk, and the responsibility of constructing, operating and maintaining a safe dam rests with the owner. Because dam failures present the same consequence to life and property downstream, the standards for existing dams should be the same for new dams. Therefore, the Criteria are applicable to both new and existing dams.

The Criteria are intended to provide a minimum standard for dam design, operation and maintenance, with consideration given to current engineering practice and accumulated experience. The Criteria are not intended to be a textbook of dam design and construction, and are not a substitute for experience and sound judgment on the part of the design engineer. Compliance with the Criteria will not guarantee a safe structure or prevent failure. However, competent design by engineers experienced in dams and in compliance with the Criteria and current engineering practices, followed by careful construction, safe operation and diligent maintenance, can substantially reduce the risk of failure.

The State Engineer recognizes that certain requirements contained in the Criteria may be mitigated by site conditions, operating practices, design details, and other factors specific to the dam in question. In these cases, requirements can often be modified or waived. However, modification or waiver of requirements will only be considered when requested in writing by the responsible engineer and supported with adequate
documentation justifying the waiver. The request and justification will be evaluated by the State Engineer and accepted or rejected on its merits. Deviations from the Criteria that are not accompanied by a written request and justification will not be accepted. The State Engineer will be the ultimate authority for acceptance or rejection of the design, requests for waiver or modification of requirements.

The Criteria primarily address design and construction of earth embankment dams, as this is the predominant type of dam currently submitted for State Engineer review. Other types of jurisdictional dams, such as concrete arch, gravity, and buttress dams, roller compacted concrete dams, soil-cement dams, rockfill dams, etc. are occasionally constructed. While many elements of the Criteria will apply to these structures, dams constructed using these methods would also be expected to conform to sound engineering principles and current state of the practice for the proposed type of dam. It is recommended that owners and engineers considering dam types other than earth embankment dams confer with State Engineer dam safety personnel regarding appropriate design standards before executing the design.

Appendices in this publication provide additional information related to the Criteria. A Glossary of Terms used in the Criteria is listed in Appendix A and was derived from the Federal Emergency Management Agency’s (FEMA) Glossary of Terms for Dam Safety.

2. STATE ENGINEER’S JURISDICTION OVER DAMS

The State Engineer is charged with approving permits for all dams in the state with a few exceptions. Dams that store less than or equal to 10 acre-feet of water and are less than or equal to 10 feet in height from the lowest point on the downstream toe to the top of the dam do not require a permit for the dam; however, a permit to store water is required regardless of storage or height if the dam was constructed after June 20, 1997. Flood control and sediment control dams supervised by the U.S. Army Corps of Engineers (COE) do not require a permit before construction; however, if the dam is transferred to an owner other than the COE, the new owner must obtain a permit. Stock dams and erosion control dams storing less than or equal to 10 acre-feet are also
exempt from obtaining a permit for the dam, however, a Water Right permit may still be required. If the purposes of the stock or erosion control dam changes, then a dam permit shall be required. If the owner is unable to comply with the conditions to obtain a permit, an order to breach the dam will be issued by the State Engineer. The State Engineer’s permitting authority over dams is contained in Section 72-5-32, NMSA 1978 and the Manual of Rules and Regulations Governing the Appropriation and Use of the Surface Waters of the State of New Mexico (Rules and Regulations). The State Engineer’s authority over construction is contained in Section 72-5-9, NMSA 1978. The dam safety statutes, rules and regulations related to dams and application for permit is contained in Appendix B.

A dam is a potential hazard to life and property downstream if the dam were to fail or operate while storing water. Because of this hazard, dam safety is regulated by almost all states in the country. The Office of the State Engineer Dam Safety Bureau administers the New Mexico Dam Safety Program. The State Engineer’s authority over unsafe non-federal dams is defined in Section 72-5-11 through and 72-5-12, NMSA 1978. Bureau staff inspects existing non-federal dams to verify the dams are operated and maintained in a safe manner. Operation and Maintenance (O&M) Manuals are required for High and Significant Hazard potential dams to ensure the continued safe performance of the dam. Emergency Action Plans (EAP) are required for High and Significant Hazard potential dams to ensure a plan of action is available in the event of an emergency. Dam owners are responsible for the preparation of the O&M Manual and EAP.

3. PERMITTING / ACCEPTANCE OF PLANS

Any activity related to the safety of dams that are within the jurisdiction of the State Engineer require a permit or approval from the State Engineer before any construction begins. Activities that commonly fall within this category include the following:

- Construction of a new dam;
- Reconstruction of an existing dam;
- Enlargement of an existing dam;
• Modification or alteration of an existing dam;
• Repair of an existing dam;
• Removal of an existing dam;
• Abandonment of an existing dam;
• Operation and maintenance of an existing non-federal dam;
• Impoundment of water; and
• Change of ownership.

3.1. Application for Permit

Prior to initiation of construction for a new dam, reconstruction of an existing dam, enlargement of an existing dam or modification of an existing dam a permit or amended permit from the State Engineer is required. In order for the State Engineer to act on an application for permit, the following minimum items are required.

1. Application for Permit to Construct and Operate a Dam shall be submitted to the State Engineer in triplicate with original signatures by the Dam Owner on each copy. Fees for filing the application and reviewing the plans and specifications are $10 application fee and $2 per $1000 or fraction thereof of the estimated construction cost. Fees for reviewing plans are waived when the State Engineer requires plans to address a dam safety deficiency.

2. Water Right Permit shall be submitted for water impounded by the dam. The permit shall address the recommended fill rate that will satisfy downstream release requirements. A pending Application for a Water Right Permit does not meet this requirement. If the applicant has a permit for the diversion of water, a letter from the Water Rights Division is needed addressing storage and release conditions for the reservoir. This requirement is waived for flood control dams that adhere to the Flood Control Dam Detention Time policy or provide documentation that an exception by the State Engineer has been granted.

3. The Design Report shall be prepared by a Professional Engineer registered in New Mexico and experienced in the design and construction of dams. The Design Report shall address:

   a) Hazard Potential Classification;
   b) Hydrologic Analysis;
   c) Outlet Works Design;
   d) Spillway Design; and
   e) Geotechnical Design;
4. Construction drawings and specifications shall be prepared in accordance with the filing requirements in the Rules and Regulations. A professional engineer registered in New Mexico and experienced in the design and construction of dams shall prepare the construction drawings and specifications.

5. Flood and Maintenance Right-of-Way certification from the owner is required. Supporting documentation that a permanent easement has been obtained for the reservoir inundation zone, reservoir and spillway releases and adequate easement for operation and maintenance of the dam and appurtenances shall accompany the certification. A map with certification showing the Right-of-Way boundaries shall be provided with the construction drawings.

6. Designer’s Operating Criteria (DOC), if required, for inclusion in the Operation and Maintenance (O&M) Manual shall accompany the application. The O&M Manual shall be required on or before completion of construction.

7. Instrumentation Plan, if required, for inclusion in the O&M Manual shall accompany the application.

8. Draft copy of Emergency Action Plan and Final Dambreak Analysis and Flood Inundation Maps, if required, shall accompany the application. The Final EAP shall be required on or before completion of construction. The State Office of Emergency Management shall approve the EAP before being submitted to the State Engineer for approval.

Checklist addressing submittal requirements is provided in Appendix C.

**3.2. Design Report**

A Design Report shall be submitted with construction drawings and specifications. The Design Report shall include a description of the project, purpose of the dam, ownership of the dam and address the hazard potential classification, hydrologic design, spillway and outlet conduit design, structural design, geotechnical design and any other information needed to support the design of the dam. A professional engineer registered in New Mexico with experience in dam design and construction shall prepare and stamp the Design Report. The Design Report shall address compliance with all applicable State and Federal rules and regulations.
3.2.1. Hazard Potential Classification

The Hazard Potential Classification shall be indicated on the application form and on the first sheet of the construction drawings. The State Engineer has adopted the Hazard Potential Classification published by FEMA. These classifications take environmental consequences into account and restrict dams having a low hazard potential classification to primarily harming the dam owner's property. The hazard potential is not a reflection of the condition of the dam itself, but rather an indication of the damage if a dam failure should occur. The Hazard Potential Classifications are shown in Table 1.

The hazard potential classification assigned to a dam shall be based on the worst-case failure conditions. In other words, the classification is based on failure consequences resulting from the failure condition that will result in the greatest potential for loss of life and property damage. In most cases, the worst-case condition occurs if the dam were to fail during an extreme flood event.

Table 1
Hazard Potential Classifications

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Dams assigned the low hazard potential classification are those dams where failure or misoperation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the owner’s property.</td>
</tr>
<tr>
<td>Significant</td>
<td>Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifelines facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.</td>
</tr>
<tr>
<td>High</td>
<td>Dams assigned the high hazard potential classification are those dams where failure or misoperation will probably cause loss of human life.</td>
</tr>
</tbody>
</table>
In situations where the hazard potential is obvious, the classification may be based on engineering judgment provided the State Engineer concurs with the selected classification. For the remaining situations the hazard potential classification shall be based on dambreak/inundation studies. Dambreak studies shall assume a “sunny day” as the initial failure scenario. If other than a high hazard potential is valid for the “sunny day” assumption then the loading condition is increased to a probable maximum flood (PMF) with failure. If the dam break plus the PMF results in a higher hazard potential classification, determining the incremental effects of a dambreak flood and inflow flood becomes necessary. The Bureau of Reclamation (USBR)\(^3\) provides guidelines and criteria for identifying downstream hazards and evaluating the incremental effects of dam failure.

When evaluating the potential for loss of life from a dam failure, the presence of facilities that would attract people on a temporary basis (e.g., public facilities, improved campgrounds, recreation areas, State or National Parks) requires special consideration. The type of flow conditions from the flood wave such as flow velocity, flow depth, debris flow and terrain conditions may increase the potential for loss of life and need to be considered in temporary occupied areas.

The hazard potential classification determines the level of engineering analysis, the criteria that are applicable and the inspection frequency by the State Engineer. The hazard potential of a dam can change due to downstream development. Therefore, the likelihood of future downstream development must be considered when determining the hazard potential classification of a dam, and the hazard potential for low and significant hazard potential dams must periodically be reevaluated to ensure public safety if downstream conditions change.

### 3.2.2. Hydrologic Analysis

When designing a dam, consideration of how the dam will perform under flood conditions must be evaluated. The hydrologic analysis will produce a design storm volume and peak runoff that the dam must safely pass or impound without failure of the
structure. The hydrologic analysis shall include a detailed study of the watershed draining into the dam and design storm characteristics. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the hydrologic report. Appropriate data sheets and computer program output computations from the computerized analysis shall be provided. A plot of the inflow and outflow hydrographs shall be shown on the same figure in the hydrologic report. The outflow hydrograph shall be extended until discharge is negligible. The time of peak reservoir storage shall be shown on the outflow hydrograph for flood control dams in order to determine the time to drain the reservoir.

3.2.2.1. Spillway Design Flood
The State Engineer has adopted spillway design standards that focus on ensuring public safety; therefore, the capacity of a spillway shall be based on the hazard potential and size of a dam, or based on an incremental damage assessment. A summary of the Size Classifications and Spillway Design Flood (SDF) criteria are shown in Table 2 and 3, respectively. A dam must be less than or equal to both the height and storage criteria to qualify for the size classification. A spillway stage/discharge curve or table to the top of dam shall be provided. The SDF shall also be used for determining the maximum height of the dam, freeboard and flood storage requirements.

<table>
<thead>
<tr>
<th>Size</th>
<th>Height (Feet)</th>
<th>Storage (Acre-feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>&gt; 10 and ≤ 40</td>
<td>&gt; 10 and ≤ 1000</td>
</tr>
<tr>
<td>Intermediate</td>
<td>&gt; 40 and ≤ 100</td>
<td>&gt; 1000 and ≤ 50,000</td>
</tr>
<tr>
<td>Large</td>
<td>&gt; 100</td>
<td>&gt; 50,000</td>
</tr>
</tbody>
</table>
Table 3
Spillway Design Flood

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Size</th>
<th>Spillway Design Flood</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>All Sizes</td>
<td>PMF</td>
</tr>
<tr>
<td>Significant</td>
<td>Small</td>
<td>0.5 PMF</td>
</tr>
<tr>
<td></td>
<td>Intermediate</td>
<td>0.5 PMF</td>
</tr>
<tr>
<td></td>
<td>Large</td>
<td>0.75 PMF</td>
</tr>
<tr>
<td>Low</td>
<td>All Sizes</td>
<td>100-Year (Expressed as a percentage of the PMF)</td>
</tr>
</tbody>
</table>

At the discretion of the State Engineer, a SDF less than the standard shown in Table 3 may be acceptable if the SDF is based on an incremental damage assessment. FEMA has published guidelines for selecting an Inflow Design Flood (IDF)\(^4\), which provides procedures to determine the appropriate design flood based on incremental damage assessment. Additional discussion is also contained in Subsections 3.2.2.4 and 3.2.2.5.

3.2.2.2. 100-Year Frequency Storm
Low hazard potential dams by definition have minimal impact on property or no probable loss of life downstream; therefore the spillway shall have the minimum capacity to safely pass the 100-year flood event. The 100-year flood event shall be estimated from the 100-year precipitation\(^5\) and the peak discharge from the 100-year event shall be expressed as a percentage of the peak discharge from the PMF hydrograph. Where adequate flood records are available for the drainage area above the dam, a flood flow frequency analysis should be performed to evaluate the model results.

3.2.2.3. Probable Maximum Flood and Probable Maximum Precipitation
The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are
reasonably possible in the drainage basin under study. The Probable Maximum Precipitation (PMP) shall be used to determine the PMF and average conditions for the watershed may be assumed for the PMF analysis. Hydrometeorological Reports (HMR)\(^6,7\) provide regionalized estimates for the PMP. The HMRs provide step-by-step procedures for computing the local and general storm PMP. These procedures should be addressed in the design report. The PMP derived from both local and general storm will have to be individually evaluated in the PMF analysis and the more critical flood used in the design. The spatial and temporal distribution for the design storm shall be documented. When the volume of the runoff hydrograph is an important consideration (i.e. retention and detention ponds), the duration of the rainfall must extend for a period long enough to include all rainfall excess. The State Engineer may accept a detailed site-specific hydrometeorologic analysis if adequate justification is provided.

3.2.2.4. Inflow Design Flood (IDF)
The IDF is the flood flow above which the incremental increase in water surface elevation downstream due to failure of a dam is no longer considered to present an “unacceptable additional downstream threat”. The upper limit of the IDF is the PMF. The lower limit of the IDF is the 100-year frequency event. The peak discharge from the IDF shall be expressed as a percentage of the peak discharge from the PMF hydrograph.

The degree of study required to sufficiently define the impacts of dam failure for selecting an appropriate IDF will vary with the extent of existing and potential downstream development, the size of the reservoir (depth and storage volume), and type of dam. Evaluation of the river reach and areas impacted by a dam failure should proceed until sufficient information is generated to reach a sound decision or until there is a good understanding of the consequences of failure. Evaluation of the consequences of dam failure must be based on the dam being in place, and must compare the impacts of with-failure and without-failure conditions on existing development and known and prospective future development. The consequences of dam failure must be defined in order to evaluate whether a dam failure causes an
“unacceptable additional downstream threat”. In most cases, detailed studies, including dambreak analyses, will be required to fully evaluate the consequences of dam failure.

When preparing dambreak studies, the water surface profiles with and without dam failure, the flood wave travel times, and rates of rise should be determined for each flood flow condition. Dambreak studies require selection of the size, shape and time of formation of the breach as input parameters for the computations; therefore, sensitivity analyses are considered necessary as well as documentation of the methodology for selecting breach parameters.

3.2.2.5. Incremental Increase in Damage
Methods of assessing the incremental increase in damage vary from examining individual structures to applying general criteria. The Federal Energy and Regulatory Commission (FERC)\(^8\) have criteria where an incremental increase in flood level of 2 feet or less is not judged to pose a significant increase in the hazard. The USBR\(^3\) has guidelines for assessing the hazards posed by floods. The application of general criteria for evaluating incremental damage will be reviewed on a case-by-case basis.

3.2.3. Outlet Works Design
Outlet conduits shall be sized to provide the capacity to satisfy water rights of downstream priority users and meet owner’s release requirements and shall be a minimum of 18-inches in diameter. The 18-inch minimum diameter may be waived if documentation is provided supporting that the inspection of the interior of the conduit can be performed in accordance with Section 7. The conduit design shall address the required operation and maintenance items in Section 7.

Metal conduits may be used in low hazard dams and in significant hazard flood control dams with no permanent storage, provided they are designed to possess adequate strength after corrosion for a minimum period of 200 years, based on corrosivity testing (e.g. resistivity and pH) of onsite soils. Cathodic or other protection of metal conduits is permissible to obtain this value. Metal conduits will not be accepted for other dams
except as an interior form for cast-in-place reinforced concrete conduits, in which case no structural contribution for the metal conduit shall be considered in the design.

All dams shall be provided with a low–level outlet positioned in such a manner that the entire contents of the reservoir above the lowest point of the embankment can be efficiently drained. If environmental consequences prevent draining, a waiver shall be submitted fully justifying the waiver. Outlets for water storage reservoirs shall be capable of evacuating the reservoir contents in less than 45 days, unless a waiver supported by justification acceptable to the State Engineer is granted. The design report shall justify the size selected and shall provide an inspection, maintenance and emergency evacuation plan including documentation of technology to be used.

Outlet conduits for storage reservoirs shall be gated at the upstream end unless exception is granted by the State Engineer. At a minimum, outlet gate valves in earth dams should be located upstream of low permeability core materials and within the upstream third of the dam. Where gates are located other than at the upstream end of the conduit, a guard gate or bulkhead shall be provided at the upstream end to allow draining of the conduit for inspection, maintenance and repair. Pressurized conduits through the dam are discouraged. The conduit downstream of the gate or valve shall be adequately vented. Where the outlet conduit discharges directly to a downstream pipe, a bypass valve shall be provided.

Outlet gate operators and equipment shall be properly designed to be secure from damage due to vandalism, weather, ice, floating debris, wave action, embankment settlement, and other reasonably foreseeable causes. Outlets shall be secure from unauthorized operation. Direction of operation for outlet controls must be clearly marked to minimize the possibility of overstressing and damage to the mechanism by operating in other than the intended direction. Outlet controls must remain accessible during outlet works and spillway releases.
Outlets for flood control structures shall be ungated. Where a gate is required to satisfy downstream release restrictions, a waiver from the Water Rights Division is required. The waiver shall include justification for the request and an operating plan for eventual release of floodwater and exercise and maintenance of the gate. Gated flood control dams must meet design requirements for water storage dams. No dead storage shall be allowed unless a separate permit to store water is provided. The outlet conduit for Flood Control Dams shall be sized to adhere to the Detention Time Policy. The 96-hour time frame begins once the reservoir storage reaches its peak during any inflow event including the Spillway Design Flood (SDF). If the design does not meet the 96-hour requirement, an exception from the Water Rights Division is required. If an exception to the Flood Control Dam Detention Time regulation is requested, documentation estimating the time to drain less frequent events, such as the 2-year, 5-year, 10-year and 100-year, should be submitted to the Water Rights Division in support of the request.

Outlet works intake must be provided with trash racks or grates to prevent clogging with debris. Openings in trash racks or grates shall be sized to pass small debris without clogging the grate, but collect large debris that would potentially clog the outlet conduit. Grate opening size or bar spacing shall be adequate to satisfy applicable public safety requirements, if appropriate. Total size of grate openings must be at least three times the cross-sectional area of the outlet conduit. Where the intake requires discharge over a weir, the need for aeration of the nappe shall be evaluated. The design of the outlet structure shall address energy dissipation to prevent erosion with supporting calculations provided.

Outlet conduits shall be designed for full embankment loading and for hydrostatic pressure equal to the maximum reservoir head, acting separately and in combination, with an adequate factor of safety. If future increases in embankment height and/or reservoir head are foreseeable, allowance shall be made in the design. The conduit together with all joints and fittings shall be watertight at the design pressure, and shall be pressure tested prior to backfilling. Conduits shall be designed for all reasonably
foreseeable adverse conditions including corrosion, abrasion, cavitation, embankment settlement and spreading, thermal effects, and seismic loading. The required joint extensibility shall be addressed in the design of outlet conduits.

Outlet works must be supported by stable, well-consolidated foundation materials. Where the conduit is placed in embankment fill or native overburden materials, settlement analysis should be performed and consideration given to articulated design. The outlet works design shall address prevention of seepage along conduits. Typical methods for seepage control include concrete or grout encasement and filter diaphragms with drains. Past practices have allowed cutoff collars; however, cutoff collars are seldom effective in controlling seepage and may apply unwanted stresses to the conduit. For these reasons, use of cutoff collars is discouraged. Regardless of the method used for seepage control, methods for compaction of backfill around and beneath the conduit must be addressed.

The design report shall include all supporting documentation and calculations for the outlet works design. The outlet works design shall include all foreseeable loading conditions, including but not limited to ice loading, debris buildup, wave action and embankment settlement. Structural design calculations for the intake structure, conduit and outlet structure shall be submitted in the design report. A stage/discharge curve or table to the top of dam for the outlet works shall be provided in the Design Report.

3.2.3. Spillway Design

Spillways should be located in natural ground and not on the embankment if possible. Unprotected earth or vegetated earth spillways will be accepted for low hazard structures only. Spillways excavated in rock or weathered rock will be evaluated on an individual basis. Unprotected spillways should be provided with a check structure at the crest to minimize the possibility for headcutting. Where control weirs are used at the spillway crest, aeration of the nappe for cavitation control must be addressed. Where a potential exists for accumulation of large floating debris that could block the spillway, the use of log booms or other debris control features should be a design element.
The spillway must discharge away from the toe of the dam and abutment slopes. Where training dikes are used to divert the water away from the dam, the dike shall be designed with adequate compaction and erosion protection. Energy dissipation shall be addressed to allow spillway discharge to be released to the natural channel without destructive erosion.

The material required for spillway lining will depend on the spillway location and frequency of discharge. Design analysis shall address these factors and provide adequate justification for the material selected. Table 4 may be used as a general guideline for selecting spillway lining materials.

### Table 4
**Guidelines for Spillway Lining**

<table>
<thead>
<tr>
<th>Spillway Lining</th>
<th>Allowable Frequency of Discharge, Open Channel Spillways</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spillway in Native Ground</td>
</tr>
<tr>
<td>Concrete</td>
<td>Continuous</td>
</tr>
<tr>
<td>Soil Cement</td>
<td>1 year</td>
</tr>
<tr>
<td>Grouted Riprap</td>
<td>2 years</td>
</tr>
<tr>
<td>Wire-enclosed Riprap</td>
<td>2 years</td>
</tr>
<tr>
<td>Riprap</td>
<td>5 years</td>
</tr>
<tr>
<td>Unweathered Bedrock</td>
<td>5 years</td>
</tr>
<tr>
<td>Weathered Bedrock</td>
<td>10 years(^1)</td>
</tr>
<tr>
<td>Vegetated Earth</td>
<td>25 years(^{1,2})</td>
</tr>
<tr>
<td>Bare Earth</td>
<td>50 years(^{1,2})</td>
</tr>
</tbody>
</table>

1. Concrete check structure required at spillway crest.
2. For low-hazard structures only.
Channel lining must be placed on a suitably prepared, stable subgrade. All edges and joints in channel lining material must be designed to prevent undermining and erosion. Concrete channel lining must be provided with adequate jointing to permit thermal expansion and contraction, and adequate reinforcing to control thermal cracking. Adequate water stops are required at joints in the spillway lining. Concrete lining shall be adequately anchored against displacement and uplift, and shall be provided with adequate subdrainage to relieve hydrostatic pressures and prevent frost heave.

3.2.4. Miscellaneous Design Issues

Retaining walls associated with dams and appurtenances shall be designed for full at-rest earth pressure rather than active earth pressure. Where earth fill will be placed against vertical concrete surfaces, the surfaces shall be battered from vertical at least 1 horizontal to 10 vertical to facilitate compaction of fill. Hydrostatic pressure at retaining walls shall be addressed in the design. To the extent practical, the design should be such that self-propelled mechanical compaction equipment can be used effectively, and areas requiring hand-operated compacting equipment should be minimized or if possible eliminated.

The structural design information for all appurtenances, addressing water, earth, ice and any other applicable load shall be included in the Design Report. Reinforced concrete design including assumptions for loads and limiting stresses and sample calculations shall be provided.

Underground utilities located in the vicinity of the proposed embankment footprint shall be relocated and trenches backfilled and compacted with suitable material to the satisfaction of the State Engineer. If utilities are allowed to remain, they will be required to satisfy standards for outlet conduits. Since typical utility bedding, backfill, etc., does not meet these standards, these utilities will require reconstruction in most cases.
3.2.5. **Geotechnical Design**

When locating and designing a dam, a detailed geotechnical design must be submitted with the design report. The geotechnical design shall include a geological assessment, geotechnical investigation including a field investigation and laboratory testing of soil samples, seepage analysis, seismic analysis and design addressing potential for liquefaction, and recommended geometry of the dam.

3.2.5.1. **Geological Assessment**

A geological assessment of the dam and reservoir site is required for all high and significant hazard dams. The geological assessment may be included in the geotechnical investigation report or seismic study, or may be submitted as a separate document. The geological assessment shall be based on available literature and mapping, aerial photography interpretation, unpublished reports and data, site reconnaissance, and other sources as available and appropriate. At a minimum, the geological assessment shall address regional geologic setting, local and site geology, geologic suitability of the dam foundation, slide potential of reservoir rim and abutment areas, and seismic history and potential unless covered in a separate seismicity study.

3.2.5.2. **Geotechnical Investigation**

A geotechnical investigation is required for all dams meeting jurisdictional requirements regardless of hazard classification. Scope of the study will depend on a variety of factors including size, hazard classification, anticipated materials and construction methods of the dam, site geology and seismicity, anticipated soil strata, etc., and may be modified during the course of the investigation due to materials and conditions encountered. The investigation must adequately assess site conditions and support the design. The exact scope of the investigation should be determined by the geotechnical engineer. If in the judgment of the State Engineer the geotechnical investigation is not adequate for the structure in question, additional work will be required.

Typically, the geotechnical investigation shall include, but not be limited to, the following elements:
Field Investigation:

1. Test borings in the footprint of the proposed embankment, spillway excavations and appurtenances to the dam, extending to bedrock or to a depth equal to at least the height of the dam. Where appropriate, borings may include coring of bedrock materials to determine the quality and character of the rock.
2. Supplemental test borings to determine soil characteristics in borrow and cut areas, spillway excavations and beneath appurtenances to the dam, etc.
3. Standard penetration tests or other field testing to assess soil character and consistency.
4. “Undisturbed” sampling for further tests such as insitu density, shear strength, and compressibility.
5. Supplemental test pits to obtain bulk and undisturbed samples, assess soil layering, measure bedrock orientation, etc. as required.
7. Field permeability testing, if feasible.
8. Logs of test borings and test pits, location map, and profile along dam axis with soil information shown.

Laboratory Testing:

1. Classification testing (gradation and plasticity characteristics) and classification according to the Unified Soil Classification System.
2. Laboratory determination of insitu density and moisture content.
3. Shear strength testing of embankment and foundation materials.
4. Laboratory permeability testing.
5. Volume change testing (consolidation, expansion, collapse, etc.).
6. Proctor tests for potential embankment materials.
7. Test for dispersive clays.
8. Gradations for potential filter and drain materials if appropriate.
9. Evaluation of liquefaction potential, and dynamic shear strength testing if deformation analysis is required.

The investigation should identify the location of sufficient borrow material to construct the dam as designed. Sufficient testing should be done to determine or estimate relevant properties of each zone or layer of the embankment and foundation, including but not limited to shear strength, permeability, compressibility, and filter characteristics.

Shear strength testing shall be selected to be appropriate for the material being tested and to provide appropriate parameters for the intended analysis. Most commonly, triaxial testing is performed on clays, and direct shear testing is performed on nonplastic materials. Effective stress parameters for clayey soils, when required, can be
determined from consolidated-undrained triaxial testing with pore pressure measurements to permit calculation of drained parameters. In the event that the direct shear test is used to determine effective stress parameters of clayey soils, supporting documentation must be provided to assure that specimens are saturated during testing, that strain rates are adequate to allow drainage to occur, and that excessive consolidation is not induced during shearing.

Results of field investigations and laboratory testing shall be presented in a formal report, including recommended parameters to be used in design and other pertinent information or recommendations for design and construction of the dam and appurtenances. The geotechnical investigation report may be included as part of the design report or as a separate document.

3.2.5.3. Seepage Analysis and Internal Drainage
The effects of seepage and internal drainage and the potential for internal erosion shall be evaluated for all structures. For significant and high hazard structures, a seepage analysis shall be performed to address the performance of the embankment under steady-state conditions.

The seepage analysis requirement may be waived for flood control dams with ungated outlets that satisfy the 96-hour drainage requirement, provided a written request for the waiver is made, accompanied by supporting justification. However, the geotechnical investigation, engineering analysis, design details, and construction techniques must be adequate to ensure that these dams will not have high-permeability layers that serve as a conduit for seepage water. In some cases, low-permeability cutoff trenches or upstream blankets may be required. The seepage analysis requirement may also be waived for reservoirs having synthetic impermeable liners constructed on well-drained sites, provided a written request is made with supporting justification.

Seepage analysis may be performed with hand-drawn flow nets or with computer techniques. Permeabilities for this analysis should be determined by field and
laboratory tests where feasible; values derived from published sources or obtained from similar soils in the region may be accepted with adequate justification. The effects of anisotropy with respect to permeability must be addressed, particularly the ratio of vertical to horizontal permeability of a given soil material. Ratios of horizontal to vertical permeability of less than four for constructed embankments and less than nine for native deposits will not be accepted unless supported by permeability test data acceptable to the State Engineer.

The design shall address the effects of anticipated seepage beneath and around the dam. Where practical, a cutoff trench integral with the core zone extending through permeable deposits and into low permeability bedrock should be provided. Where permeable foundation deposits are too deep for a cutoff trench to be practical, other cutoff options such as slurry walls and grout curtains may be considered. Partial cutoffs are often ineffective and generally should be avoided. Where complete cutoff is not practical or economically feasible, possible solutions include upstream impermeable blankets, extended downstream embankment zones, downstream horizontal drainage blankets, toe drains, drainage curtains, and re-siting the dam.

The dam shall be designed so that seepage does not exit on the face of the dam and excessive exit gradients are avoided. Embankment zoning and/or internal drainage may be necessary in order to control seepage. All adjacent material zones in the dam and foundation shall satisfy filter criteria acceptable to the State Engineer. The State Engineer has previously accepted filter criteria used by the Natural Resource Conservation Service (NRCS), the U.S. Army Corps of Engineers (COE), and the USBR. Other criteria will be reviewed for acceptability on a case-by-case basis. Where materials do not meet filter criteria with respect to one another, transition zones meeting the filter criteria will be necessary. All filter, transition, and drainage zones within earth dams shall have a thickness adequate to address constructability and enhance seismic stability, with a minimum thickness of 3 feet for each zone. Clay core zones shall extend above the anticipated phreatic surface a sufficient distance that water will not be lifted above the core by capillary rise in the adjacent material zones.
Collector pipes and conduits for internal drains shall be made of non-corrodible material capable of withstanding the anticipated loads. Insofar as possible, pipes should be located where they can be exposed for repair or replacement without threatening the stability of the dam. Collector pipes for drains shall be enveloped in a free-draining medium meeting filter criteria for adjacent embankment or foundation zones. Pipe perforation size (e.g. hole diameter or slot width) depends on the surrounding medium and condition of use. Where surging or gradient reversal is likely, perforation size must be less than the D<sub>15</sub> of the surrounding medium. Where surging and gradient reversal are unlikely, the perforation size must be less than D<sub>85</sub> of the surrounding medium.

Drain pipes should be sized to provide a flow depth no more than ¼ of the pipe diameter when carrying the anticipated discharge. Drain pipes must be at least 6 inches in diameter unless the availability of technology for inspection and maintenance can be demonstrated. Individual pipes must discharge to a gallery, well, manhole, or to daylight such that the flow of each pipe can be monitored. Manifold connections, tees, and wyes will not be permitted. If the anticipated flow from a drain line exceeds 10 gpm, a measuring flume or weir shall be provided for that line. If the anticipated flow from a drain line is less than 10 gpm, the outfall shall be designed to allow a 5-gallon bucket to be used to collect and measure discharge. Where pipes from internal drains are discharged to daylight, a rodent screen shall be provided.

3.2.5.4. Stability Analysis
Cross-sectional design for dams shall be supported by adequate slope stability analysis. The analysis model shall adequately represent the geometry and zoning, shear strength parameters, material unit weights, pore pressure and seepage conditions, external loading, and other relevant factors of the critical cross section or sections. Computer-assisted limit-equilibrium analyses with automated search routines are typical and preferred. Manual computations will be accepted if judged to be sufficiently rigorous. Chart solutions and infinite slope analysis may be accepted in certain cases, with justification and supporting documentation that the solution is applicable to the problem.
and the results are conservative. Where appropriate, the analysis shall consider noncircular or block and wedge type failure surfaces as well as circular failures.

All parameters and assumptions used in the analysis shall be summarized in a table and justified in the geotechnical investigation. A scale drawing, utilizing the same scale for vertical and horizontal dimensions, shall be provided for each cross-sectional model used in the analysis, with the critical failure surface(s) identified. Appropriate data sheets and computer program output computations from computerized analysis shall be provided.

Dams shall be designed to provide the following minimum factors of safety from the stability analysis:

- Steady state long-term stability 1.5
- Operational drawdown conditions 1.5
- Rapid Drawdown conditions 1.2
- End-of-construction 1.2

Low hazard dams with upstream slopes no steeper than 3 horizontal to 1 vertical and downstream slopes no steeper than 2 horizontal to 1 vertical and which are 25 feet or less in height will not require slope stability analysis.

3.2.5.5. **Seismic Analysis and Design**
All High and Significant hazard dams shall be analyzed for seismic stability. Seismic analysis may also be warranted for low hazard structures if a future change in hazard classification can be reasonably foreseen or if otherwise deemed necessary by the State Engineer. The level of effort required for seismic analysis will be unique for each dam depending on the type of dam, site geology and seismicity, embankment and foundation materials, dam and foundation geometry, construction methods used, consequences of failure, and other factors.
Seismic analysis for water storage dams should be based on full reservoir under steady state seepage conditions. Flood control dams with ungated outlets that satisfy the 96-hour release requirement should be designed for earthquake loads under full reservoir conditions, but need not consider steady-state seepage since it is unlikely to develop.

At a minimum, seismic analysis shall include the following steps:

1. A seismological investigation shall be made for the dam area and reservoir area, considering local and regional earthquake history, available technical literature, unpublished reports or data if available, geologic mapping, and field mapping and measuring of faults if appropriate, and other information deemed relevant by the investigator. This study may be part of the geological or geotechnical report for the structure, or may be a separate effort. The study shall determine and justify the appropriate seismic parameters to be used for design. High hazard dams other than flood control structures shall be designed for the Maximum Credible Earthquake (MCE) or for an earthquake with a 5000-year return frequency. For significant hazard dams and high hazard flood control dams, a 2% chance of occurrence in 50 years (approx. 2500 year return frequency) used in determining the design earthquake will be accepted.

2. An analysis of materials in the foundation, reservoir area, and proposed embankment shall be completed, to determine the potential for liquefaction, earthquake-induced sliding, or other seismic sensitivity. This is generally accomplished as part of the geotechnical investigation for the structure. However, if potentially liquefiable materials are encountered or anticipated, additional field and laboratory testing and engineering analysis may be warranted.

3. Pseudostatic analysis will be acceptable for the following cases:
   a. The embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557 (or at least 70% relative density if Proctor testing is not appropriate), no materials prone to liquefaction are present in the foundation, and peak bedrock acceleration is 0.20g or less; or
   b. The embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557; potentially submerged portions of the embankment except for internal drain elements are constructed of clayey material (classified as CL, CH, CL-ML, SC, or GC under...
the Unified Soil Classification System), the dam is constructed on clayey soil or bedrock foundation, and peak bedrock acceleration is 0.35g or less; and

c. All safety factor requirements for static stability given in the Criteria are met; and

d. Minimum freeboard requirements of the Criteria are met.

The pseudostatic coefficient selected for analysis must be at least 50% of the predicted peak bedrock acceleration, but not less than 0.05g. Factor of safety under pseudostatic analysis shall be 1.1 or greater. In determining the factor of safety for pseudostatic analysis, a search for the critical failure surface shall be made, rather than simply applying pseudostatic coefficients to the failure surface from static analysis.

4. For dams not satisfying the requirements for pseudostatic analysis, a deformation analysis acceptable to the State Engineer will be required. The resulting embankment must be capable of withstanding the design earthquake without breaching and with at least 3 feet of freeboard remaining after deformation. The analysis shall also assess the potential for internal erosion as a result of cracking during deformation. Defensive design measures, such as treating or removing sensitive materials, flaring or widening cores and drainage zones, adjusting location of internal zones to minimize embankment saturation, providing additional freeboard, or adding outlet capacity to shorten reservoir drainage times should be considered for embankments in this category.

5. The seismic assessment shall also address the stability of appurtenances to the dam during the design earthquake as appropriate. However, if failure of an appurtenance due to earthquake does not represent an immediate threat to the dam, the Operating Basis Earthquake (OBE) may be used for this assessment.

Where possible, dams must not be sited on active faults. If this is unavoidable, the dam must be designed to withstand anticipated fault movement without compromise to its integrity.

3.2.5.6. Dam Geometry and Freeboard

**Dam Crest** - Crest width shall be at least h/5 + 8 feet, with the minimum permissible crest width being 10 feet and the maximum required crest width being 24 feet. Where access and maintenance roads are located on the crest, appropriate surfacing shall be placed to provide a stable base that resists rutting and provides adequate friction for safety in wet conditions. Crest design shall include adequate cover above clay cores to prevent cracking of the core due to desiccation or frost penetration. A minimum of 2 feet of cover is required above the core, with additional cover being required if
warranted by local conditions. Turnarounds should be provided on dead-end service roads on dam crests, located in such a manner that backing maneuvers longer than 300 feet are eliminated. The crest shall be provided with adequate cross slope to prevent ponding. The slope or slopes to which crest drainage is directed must be provided with adequate erosion protection to accept the crest drainage. The crest longitudinal profile shall be provided with adequate camber to maintain the profile after embankment settlement. Camber should be based on settlement analysis and shall be at least 2 percent of the total embankment height, with a minimum of 1 foot at the highest point of the dam. The tops of internal core zones shall also be provided with camber in a similar manner to the crest of the dam.

In the event that safety berms, street curbs, or other longitudinal features which block, control, or concentrate drainage are required on the dam crest, the design shall provide for collection and conveyance of accumulated water to discharge away from the embankment without erosion.

**Freeboard Requirements** - Dams shall be provided with adequate freeboard. Freeboard is defined as the vertical distance between the spillway crest and the lowest point of the top of the dam, without camber. Freeboard shall satisfy the following conditions:

- Anticipated wave runup resulting from a 100 mph wind with reservoir level at the spillway crest will not overtop the dam.
- Anticipated wave runup resulting from a 50 mph wind with maximum reservoir level from routed SDF will not overtop the dam.
- Clay core cover and capillary rise requirements are satisfied.
- A minimum of 3 feet of freeboard remains after seismic deformation.
- In any case, at least 4 feet of freeboard shall be provided.

Wave runup shall be determined taking into consideration wind speed, reservoir fetch, embankment slope, and roughness of the slope surface. Crest camber shall not be considered as part of available freeboard. The minimum of 4 feet of freeboard may be
waived for parameter embankments with no spillway, provided a written request is made with supporting justification.

3.2.5.7. Erosion Protection
The dam shall be protected against erosion. Erosion protection shall be extended onto abutments and toes of slopes a sufficient distance that erosion in these areas does not threaten the dam. Additionally, the dam owner is responsible for compliance with any applicable environmental laws and regulations concerning erosion and sediment control.

**Wave Erosion Protection** – The upstream slope of the dam shall be provided with armoring sufficient to protect against anticipated wave erosion. At a minimum, the armoring shall extend from the lowest operational water surface elevation to the highest anticipated wave runup elevation. Wave erosion protection materials typically include dumped riprap, soil-cement, hand-placed riprap, and concrete slope paving, in general order of preference. Selection of wave protection material is primarily based on economics. If riprap is used for armoring, it shall be placed on a properly designed filter bedding layer. Flood control structures that have ungated outlets and are designed to release their contents within 96 hours are exempted from the wave erosion protection requirement.

**Surface Erosion Protection** – Slopes and crest of earth dams, abutment and toe areas adjacent to dams, and any other constructed or graded slopes associated with the dam or appurtenances shall be protected from surface erosion. This may be accomplished with vegetative cover, gravel surfacing, slope paving, or other approved means. Where vegetative cover is used, a site-specific seed mixture shall be provided, with supporting documentation that the proposed vegetative cover will become established and survive under anticipated climate conditions. The seed mixture shall be free of woody vegetation types and potentially large brushy vegetation types. The dam design shall address methods of establishing and maintaining vegetation, including seeding season,
supplemental watering during establishment if necessary, future removal of undesirable vegetation, and management of burrowing rodents attracted to vegetation.

Dam safety inspections seem to indicate that a surface gravel or stone layer is much more effective than seed and mulch in preventing surface erosion in the arid portions of New Mexico. Angular crushed or quarried products, if available, stay in position and are more effective than rounded gravel, particularly where the material will be subject to foot or vehicle traffic. A heavy gravel layer also appears to be effective in discouraging small burrowing rodents, and may be adequate for relatively low volume concentrated flows, such as at abutment groins.

**Erosion From Concentrated Flows** – The design shall address erosion at locations where flows become concentrated, such as abutment groins, intersecting dikes, points of inflection of the embankment, areas behind spillway retaining walls, low points of crest roads, low ends of diversion berms, and bare slopes beneath paved areas. Possible solutions at these locations may include riprap, paved swales, heavy angular gravel, half-pipe sections, small check dams or grade stabilization structures, slope drains, etc.

### 3.2.5.8. Geotextiles

The acceptance of geotextiles by the State Engineer for dam design will be application-specific and will be determined for each design on a case-by-case basis. Geotextiles must be used in a manner consistent with the manufacturer’s recommendations and intended use for the product. Geotextiles generally should only be used where failure of the geotextile would not cause a catastrophic release of the contents of the reservoir. Geotextiles should not be used at a location where their exposure for repair or replacement may jeopardize the stability of the dam or appurtenances.

Geotextiles and geosynthetic membranes used for impermeable liners of reservoirs, lagoons, and retention ponds shall be placed in accordance with the manufacturer’s requirements, including certification of installation personnel if required. Liners either
must be certified by the manufacturer for long-term exposure to sunlight or must be covered with a suitable protective layer. Where the reservoir will be periodically or normally empty, the liner shall be adequately ballasted or anchored for stability in the wind. Ballast and anchoring material must be capable of withstanding sunlight and weather conditions; for example, where sandbags are used for ballast, the bag material must be resistant to degradation from sunlight exposure. Joints or seams between liner panels and anchorage details at edges must be in compliance with manufacturer recommendations. Penetrations in the liner such as at inlets and outlets must be designed and constructed to minimize leakage. Drainage zones or filter diaphragms may be an appropriate defense against damage caused by leakage at penetrations.

3.3. Construction Drawings and Specifications

Construction drawings and specifications shall be prepared in accordance with the requirements of the Rules and Regulations. Drawings shall be submitted with all appropriate review and application fees. A Professional Engineer licensed in New Mexico, with experience in the design and construction of dams, shall prepare the construction drawings and specifications. An as-built mylar drawing submittal is required at completion of construction. The State Engineer may waive mylar drawings during the review process and require mylar as-built drawings if a request is submitted in writing. In the event the requirement for mylar drawings is waived until submittal of as-built drawings, a mylar filing sheet will still be required as part of the permit application submittal.

3.4. Easement and Access

The owner shall obtain permanent right of way or easements to access the dam during normal operation and flood events; to impound water and safely discharge water; and to maintain the dam and appurtenances in a safe manner. Easements for returning spillway flows to the natural drainage are required. Urban dams have unique flood easement issues that will be evaluated on a case-by-case basis. A detailed map, with certifications, showing all right of way easements shall be provided with the construction drawings.
3.5. Designer’s Operating Criteria and Instrumentation Plan

The Designer’s Operating Criteria (DOC) is prepared by the design engineer to ensure the dam and appurtenances are operated within any restrictions imposed by the design. The Instrumentation Plan provides a means to monitor and evaluate the performance of a dam. The DOC and Instrumentation Plan are critical elements of the Operation and Maintenance (O&M) Manual, which shall be addressed in the design phase of the project for significant and high hazard potential dams. An O&M Manual is also required for all significant and high hazard potential dams. The O&M Manual shall conform to the requirements set forth in Section 7 and is required at completion of construction. The DOC and Instrumentation Plan shall be submitted during the review process for new dams or modification to an existing dam.

3.6. Emergency Action Plan

An Emergency Action Plan (EAP) is required for all significant and high hazard potential dams. The EAP shall conform to the requirements set forth in Section 8. The EAP shall be prepared under the direction of a Professional Engineer licensed in New Mexico, with experience in the design and operation of dams. A draft copy of the EAP shall be submitted during the review process for new dams or modification to an existing dam. The draft copy shall include final submittal of the dambreak analysis and flood inundation maps, including all supporting documentation and calculations. A final EAP is required at completion of construction.

4. CONSTRUCTION AND OPERATION APPROVAL

Final action by the State Engineer on the application to Construct and Operate a Dam will address construction and operation conditions. Following the State Engineer’s approval of the application and prior to commencement of construction, the owner nominates an engineer, registered in New Mexico, with experience in dam construction to supervise construction of the dam. If the State Engineer finds the engineer acceptable an order is issued approving the engineer and setting forth conditions under which the engineer will supervise construction. Construction shall be in accordance
with approved plans and specifications. The State Engineer must approve any modifications to the approved plans and specifications or design changes in writing prior to undertaking the modifications.

The engineer supervising construction shall submit monthly progress reports to the State Engineer, which shall include a summary of test results. The State Engineer has full authority to perform inspections at any time during construction of the dam and appurtenances. Inspections will vary with each project, based on the complexity of the design. Generally, representatives of the State Engineer inspect construction when:

- The foundation is exposed;
- The embankment is one-half complete;
- Construction of any major structural feature is in progress; and
- Final completion of the dam or modification.

Inspection fees are charged at the rate of $100/day. Inspection fees may be waived when construction is required by the State Engineer to address dam safety deficiencies.

Upon completion of construction, the engineer supervising construction shall submit to the State Engineer:

- A completion report, which shall include descriptions of problems and their solutions.
- A summary of materials test data and construction photographs.
- As-built mylar drawings including all signatures on the title sheet.
- A certificate that the dam as constructed is safe for the intended use.

Once all construction conditions in the approved permit are met, pending the issuance of a Certificate of Construction, use of the reservoir shall require written permission from the State Engineer. Use of the reservoir is restricted until the State Engineer approves the final O&M Manual and EAP.
5. **CERTIFICATE OF CONSTRUCTION**

Upon completion of construction, the owner shall submit an O&M Manual and EAP for approval by the State Engineer and Proof of Completion of Works form, with appropriate fees. Upon receiving this form, the State Engineer will determine if all conditions of the approved application were met. If there are no outstanding conditions, the State Engineer will issue a Certificate of Construction. The dam owner shall record the Certificate of Construction with the county clerk of the county where the dam is located.

6. **CHANGES TO THE APPROVED PERMIT**

State Engineer approval of reconstruction, enlargement, modification, reservoir capacity restoration, repair, removal, abandonment or ownership change of an existing dam is required prior to any construction taking place. The current condition of the dam, the type of repair or modification, and the proposed means to achieve the repair or modification all dictate the detail of the information that shall be provided to the State Engineer in order to obtain approval. Construction drawings shall adhere to the requirements in the Rules and Regulations and shall include a design report to support the proposed plan. Changes to the permit will require that all deficiencies with the Criteria be addressed. Routine maintenance work defined in the O&M Manual does not require prior approval. All other repair or modification activities not covered by the O&M Manual require State Engineer approval. Preliminary submittal of the drawings, specifications and design report is recommended to determine what criteria are appropriate.

6.1. **Removal or Breach of an Existing Dam**

The removal, breach or abandonment of an existing dam under the jurisdiction of the State Engineer requires the State Engineer’s advanced approval. An existing dam may not be abandoned without breaching, removing or reclaiming the dam to ensure the dam no longer poses a risk to life, property, the environment surrounding the dam or
downstream of the dam. The dam owner shall notify the State Engineer that the owner wishes to remove, breach or reclaim the dam and cancel the permit.

Owners of significant and high hazard potential dams shall submit to the State Engineer a plan evaluating the potential effects of the dam removal or breach on the environment and life and property downstream. A Professional Engineer licensed in New Mexico, with experience in the operation of dams, shall prepare the plan. The plan shall meet the following conditions:

- The dam shall be excavated down to the level of natural ground and the breach shall be of sufficient width to safely pass the 100-year, 24-hour flood;
- The side slopes of the breach shall be excavated to a stable angle;
- The breach shall be armored as necessary to prevent erosion of the breach area;
- The breach shall be designed to control sediment previously deposited on the reservoir bottom;
- The reservoir shall be emptied in a controlled manner, which will not endanger lives or damage property downstream; and
- Drawings shall include a filing sheet, the location, dimensions and lowest elevation of the breach, and any other detail to sufficiently describe the proposal.
- Identification of an engineer registered in New Mexico, with experience in dam construction, to supervise construction of the breach or dam removal. Submittal of engineer’s qualifications is required.

If the State Engineer finds the plan and construction engineer acceptable, an order is issued approving the engineer and setting forth conditions under which the engineer will supervise construction of the breach or dam removal. Upon completion of the breach or dam removal, the supervising engineer shall certify that the dam no longer posses a hazard to life and property.

Owners of low hazard potential dams shall submit a written notice to the State Engineer of intent to breach the dam. The breach shall meet the following minimum requirements:
- The bottom width of the breach shall be to original ground;
- The bottom width of the breach shall be a minimum of one-half the height of the dam but not less than 10 feet;
- The side slopes not steeper than one horizontal to one vertical; and
- The excavated material shall not be placed in the streambed.

### 6.2. Permanent Closure of a Tailings Facility

The permanent closure of a Tailings Facility typically involves numerous regulatory agencies including the State Engineer. Typically a Closure Plan is prepared to address the permanent closure. State Engineer approval is required before any modification occurs to a jurisdictional tailings dam. A Professional Engineer licensed in New Mexico, with experience in the design and construction of tailings dams, shall prepare the closure plan. The plan shall address the following issues:

- Long-term stability under static and dynamic conditions;
- Control of surface runoff to avoid erosion;
- Plan for long term monitoring, if appropriate; and
- Identification of an engineer, registered in New Mexico, with experience in tailings dam construction to supervise construction of the closure plan. Submittal of engineer’s qualifications is required.

If the State Engineer finds the plan and construction engineer acceptable, an order is issued approving the engineer and setting forth conditions under which the engineer will supervise construction of the closure plan. Upon completion of construction, the supervising engineer shall certify that the tailings dam no longer poses a hazard to life, property and the environment.

### 7. OPERATION AND MAINTENANCE MANUAL

An Operation and Maintenance (O&M) Manual shall be prepared for the purpose of documenting accurate, current and comprehensive information for operation, maintenance and monitoring a dam. Because failure of a dam has a potential catastrophic impact on dam owners, water users and downstream public and private
property, an O&M Manual is required for all new and existing high and significant
hazard potential dams. The O&M Manual shall contain, at a minimum, all information
and instructions necessary for dam owners and operating personnel to operate and
maintain a safe dam. A Professional Engineer licensed in New Mexico, with experience
in the design and operation of dams, shall prepare the O&M Manual.

An O&M Manual shall be reviewed and updated at least annually or (1) whenever
modifications or replacement of the facilities or equipment are completed, or (2) if a
need is recognized by the dam owner or operator. Updates shall be submitted to the
State Engineer with documentation to support the results of the review.

The O&M Manual shall be bound with a fastening system to facilitate revisions, and
each page shall bear the date of the original page or revision. Additional information
and discussion is provided in Appendix D. The O&M Manual shall contain the following
elements:

- Certification statements by the owner and engineer with approval by the State
  Engineer.
- General information on the project including the purpose, location, history,
  responsibilities and description of project and properties.
- Operation instructions for the reservoir, control mechanisms and any other
  feature of the project.
- Instrumentation details and monitoring requirements.
- Maintenance requirements and schedule.
- Inspection requirements and schedule.
- An update and revision procedure.
- Appendices to include the Designer’s Operating Criteria and Instrumentation
  Plan to ensure any restrictions imposed by the design are included in the O&M
  Manual.
8. **EMERGENCY ACTION PLAN**

The Emergency Action Plan (EAP) identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The EAP assists in pre-planning with the responsible local, state and federal emergency organizations to provide timely notification of a warning of a dam emergency and evacuation in the event of potential dam failure.

An EAP is required for all new and existing significant and high hazard potential dams. The EAP shall conform to the standardized format included in Appendix E and be bound with a fastening system to facilitate revisions. The EAP shall also be submitted to the State Office of Emergency Management (SOEM) for review and approval, prior to submittal to the State Engineer. Annual review and updates (as necessary) to the EAP shall be provided to the State Engineer and SOEM for review and approval. The EAP shall be prepared by a Professional Engineer licensed in New Mexico, with experience in the design and operation of dams.

The EAP should be user friendly and reflect the capabilities and responsibilities of the dam owner and each organization. The EAP must be tailored to each dam’s specific conditions, to the capabilities of the owner and operator, and to the emergency response organizations that will implement the EAP. Preparation of an EAP requires coordinated planning with all the principal parties responsible for emergency response and public safety.

The State Engineer requires that owners of high and significant hazard potential classified dams address the following:

- Prepare, maintain and exercise an EAP for immediate action in the event of an emergency at a dam.
- Have the Local Emergency Manager or government official responsible for public safety review their plan, and make appropriate modifications.
- Provide the primary persons and agencies responsible for executing the plan with copies of the EAP and distribute the EAP to all affected entities.
- Review, update and exercise the plan on an annual basis.

The State Engineer has adopted EAP guidelines and standardized format developed by FEMA\textsuperscript{13}. A summary of FEMA’s guidelines is discussed below.

The following six basic elements shall be included in an EAP:

1. **Notification Flowchart.** The notification flow chart shows who is to be notified, by whom and in what priority. The information on the notification flowchart is necessary for the timely notification of persons responsible for taking emergency action.

2. **Emergency Detection, Evaluation and Classification.** This element includes early detection and evaluation of the situation or event that would trigger the initiation of the EAP or require an emergency action. This element also includes the procedures for reliably and timely identifying an emergency situation to ensure that an appropriate course of action is implemented. Defining various types of emergency situations would be included in this element in order to determine the level of action required for each type of emergency.

3. **Responsibilities.** A determination of responsibility for EAP related tasks must be made during the development of the plan. Since the dam owner is responsible for the development, maintenance and implementation of the EAP, the dam owner will need to work with the emergency preparedness agency in the county in order to define the responsibilities. State and local emergency management officials have statutory obligations and are responsible for warning and evacuation within the affected areas. The dam owner’s responsibilities must also be clearly specified to ensure effective and timely action is taken in the event of an emergency at the dam. The EAP must be site-specific since the conditions at a dam and downstream of a dam are different for each dam.

4. **Preparedness.** This section of the EAP will include preparedness actions that can be taken before an emergency. A list of materials, equipment and
manpower available to moderate or alleviate the effects of a dam failure or spillway release should be included in this section.

5. **Inundation Map.** An inundation map delineating the areas that will be flooded as a result of dam failure is a key component of the EAP. The inundation map is used by both the dam owner and emergency management officials to assist in identifying the area that would need to be notified and evacuated as the result of a dam failure or flooding condition. These maps are a useful tool to graphically display the flooded areas, travel times for a wave front and flood peaks at critical locations.

6. **Appendices.** The appendices contain information that supports and supplements the material used in the development and maintenance of the EAP.

Because emergency management agencies rely on the inundation map to develop evacuation procedures, both a “sunny day” failure and a failure during the worst case flood flow conditions should be analyzed and shown on the inundation maps. If a dam is located upstream, failure scenarios with the upstream dam shall also be evaluated. Flood control dams, which have experienced a first fill to the spillway crest, may request a waiver from the “sunny day” failure scenario if adequate justification is provided. The inundation maps should be prepared to show the time and distance from the dam when the flood wave will arrive at critical areas in relation to the beginning of the dam failure hydrograph, the maximum discharge ($Q_p$) and the depth of flow. Critical public facilities (e.g. water supplies, hospitals, electric utilities, etc.) that would be affected by the flooding should be identified. The dam breach analysis and flood inundation maps shall be submitted to the State Engineer for approval before the EAP is finalized.

9. **REFERENCES**


GLOSSARY OF TERMS

**Abutment** – That part of the valley side against which the dam is constructed. The left and right abutments of dams are defined with the observer viewing the dam looking in the downstream direction, unless otherwise indicated.

**Acre-foot** – A unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet.

**Appurtenant structure** – Ancillary features of a dam such as outlets, spillways, power plants, tunnels, etc.

**Axis of Dam** – The vertical plane or curved surface, chosen by a designer, appearing as a line, in plan or in cross-section, to which the horizontal dimensions of the dam are referenced.

**Base Thickness** – Also referred to as base width. The maximum thickness or width of the dam measured horizontally between upstream and downstream faces and normal to the axis of the dam, but excluding projections for outlets, or other appurtenant structures.

**Bedrock** – The consolidated body of natural solid mineral matter which underlies the overburden soils.

**Berm** – A nearly horizontal step in the sloping profile of an embankment dam. Also a step in a rock or earth cut.

**Borrow Area** – The area from which material for an embankment is excavated.

**Breach** – An opening through a dam which drains the reservoir. A controlled breach is a constructed opening. An uncontrolled breach is an unintentional discharge from the reservoir.

**Cavitation** – The formation of a partial vacuum at the interface of fast-flowing water with a surface, typically at a point of turbulence such as a valve or impeller or immediately downstream from an obstruction or offset. Usually accompanied by noise and vibration, and is potentially destructive.

**Channel** – A general term for any natural or artificial facility for conveying water.

**Cofferdam** – A temporary structure to facilitate construction dewatering or to divert water away from construction, which is removed prior to completion of construction as part of construction phasing. Common types include steel sheet piles, earthen dikes, and water-filled bladders.
Compaction – Mechanical action which increases the density by reducing the voids in a material.

Conduit – A closed channel to convey water through, around, or under a dam.

Consequences of Failure – Potential loss of life or property damage downstream of a dam caused by floodwaters released at the dam or by waters released by partial or complete failure of dam; includes effects of landslides upstream of the dam on property located around the reservoir.

Construction Joint – The interface between two successive placings or pours of concrete where bond, and not permanent separation, is intended.

Contact Grouting – Filling, with cement grout, any voids existing at the contact of two zones of different materials, e.g. between a concrete tunnel lining and the surrounding rock.

Core – A zone of low permeability material in an embankment dam. The core is sometimes referred to as central core, inclined core, puddle clay core, rolled clay core, or impervious zone.

Core Wall – A wall built of relatively impervious material, usually of concrete or asphaltic concrete, in the body of an embankment dam to prevent seepage.

Crest of Dam – The lowest elevation of the uppermost surface of a dam, usually a road or walkway excluding any parapet wall, railing, etc.

Crest Width – The thickness or width of a dam at the crest level (excluding corbels or parapets). In general, the term thickness is used for gravity and arch dams, and width is used for other dams.

Cross Section – An elevation view of a dam formed by passing a plane through the dam perpendicular to the axis.

Cutoff Trench – A foundation excavation later to be filled with impervious material so as to limit seepage beneath a dam.

Cutoff Wall – A wall of impervious material usually of concrete, asphaltic concrete, or steel sheet piling constructed in the foundation and abutments to reduce seepage beneath and adjacent to the dam.

Dam – A barrier constructed across a watercourse or off channel for the purpose of storage, control, or diversion of water. Types of dams are listed below.
a. Arch Dam – A concrete or masonry dam, which is curved upstream so as to transmit the major part of the water load to the abutments.

b. Buttress Dam – A dam consisting of a watertight part supported at intervals on the downstream side by a series of buttresses. Buttress dam can take many forms, such as flat slab or massive head buttress.

c. Concrete Dam – A dam constructed primarily of concrete, usually cast-in-place but possibly including precast or roller-compacted elements. Types of concrete dams include arch, buttress, and gravity, among others.

d. Live storage. The storage volume of a reservoir that is available for use and lies above the invert of the lowest outlet.

e. Reservoir storage capacity. The sum of the dead and live storage of the reservoir.

f. Earth Dam – An embankment dam in which more than 50% of the total volume is formed of compacted earth material generally smaller than 3-inch size.

g. Gravity Dam – A dam constructed of concrete and/or masonry which relies on its weight and internal strength for stability.

h. Masonry Dam – any dam constructed mainly of stone, brick or concrete blocks jointed with mortar. A dam having only a masonry facing should not be referred to as a masonry dam.

i. Multiple Arch Dam – a buttress dam comprised of a series of arches for the upstream face.

j. Rockfill Dam – An embankment dam in which more than 50% of the total volume is comprised of compacted or dumped cobbles, boulders, rock fragments, or quarried rock generally larger than 3-inch size.

k. Roller Compacted Concrete Dam – A concrete gravity dam constructed by the use of a dry mix concrete transported by conventional construction equipment and compacted by rolling, usually with vibratory rollers.

l. Saddle Dam (or dike) – a subsidiary dam of any type of constructed across a saddle or low point on the perimeter of a reservoir. When a saddle dam is above the water surface for the permanent storage pool, it may be referred to as a saddle dike.

m. Tailings Dam – An industrial waste dam in which the waste materials come from mining operations or mineral processing. The waste products are conveyed as fine material suspended in water to the reservoir impounded by the embankment.
The embankment may be built of conventional materials but sometimes incorporates suitable waste products.

**Dam Failure** – The catastrophic breakdown of a dam, characterized by the uncontrolled release of impounded water. There are varying degrees of failure.

**Design Water Level** – The maximum water elevation including the flood surcharge, that a dam is designed to withstand.

**Dike** – See saddle dam.

**Diversion Channel, Canal, or Tunnel** – A waterway used to divert water from its natural course. The term is generally applied to a temporary arrangement, e.g. to by-pass water around a dam site during construction. "Channel" is normally used instead of "canal" when the waterway is short.

**Drain, Blanket** – A horizontal or gently sloping layer of pervious material placed to facilitate drainage of the foundation and/or embankment.

**Drain, Chimney** – A vertical or inclined layer of pervious material in an embankment to facilitate and control drainage of the embankment fill.

**Drain, Toe** – A system of pipe and/or pervious material along the downstream toe of a dam used to collect seepage from the foundation and embankment and convey it to a free outlet.

**Drainage Area** – The area draining to a particular point of study on a river or stream.

**Drainage Curtain** (also called drainage wells or relief wells) – A line of vertical wells or boreholes to facilitate drainage of the foundation and abutments and to reduce water pressure.

**Drawdown** – The difference between a water level and a lower water level in a reservoir within a particular time. Used as a verb, it is the lowering of the water surface.

**Earthquake** – A sudden motion or trembling in the earth caused by the abrupt release of accumulated stress along a fault.

**Earthquake, Maximum Credible (MCE)** – The most severe earthquake that can be expected to occur at a given site on the basis of geologic and seismological evidence.

**Earthquake, Operating Basis (OBE)** – The earthquake(s) for which the structure is designed to resist and remain operational. It reflects the level of earthquake protection desired for operational or economic reasons and may be determined on a probabilistic basis considering the regional and local geology and seismology.
Emergency Action Plan (EAP) – A plan of action to be taken to reduce the potential for property damage and loss of life in an area affected by a dam failure or large flood.

EAP Exercise – An activity designed to promote emergency preparedness; test or evaluate EAPs, procedures, or facilities; train personnel in emergency management duties; and demonstrate operational capability. Exercises consist of the performance of duties, tasks, or operations very similar to the way they would be performed in a real emergency. However, the exercise performance is in response to a simulated event.

EAP Exercise, Comprehensive – An in-depth exercise of an EAP that involves the interaction of the dam owner with the state and local emergency management agencies in a stressful environment with time constraints. Functional and full-scale EAP exercises are considered comprehensive EAP exercises.

Emergency Management Agency – The state and local agencies responsible for emergency operations, planning, mitigation, preparedness, response, and recovery for all hazards. Names of emergency management agencies may vary such as: Division of Emergency Management, Comprehensive Emergency Management, Disaster Emergency Services, Civil Defense Agency, Emergency and Disaster Services.

Emergency Operations Center (EOC) – The location or facility where responsible officials gather during an emergency to direct and coordinate emergency operations, to communicate with other jurisdictions and with field emergency forces, and to formulate protective action decisions and recommendations during an emergency.

Energy Dissipator – A device constructed in a waterway to reduce the kinetic energy of fast flowing water.

Erosion – The wearing away of a surface (bank, streambed, embankment) by floods, waves, wind, or any other natural process.

Fault – A fracture or fracture zone in the earth crust along which there has been displacement of the two sides relative to one another.

Fault, Active – A fault which, because of its present tectonic setting, can undergo movement from time to time in the immediate geologic future.

Fault, Capable – An active fault that is judged capable of producing macro-earthquakes and exhibits one or more of the following characteristics:

- Movement at or near the ground surface at least once within the past 35,000 years.
- Macroseismicity (3.5 magnitude Richter or greater) instrumentally determined with records of sufficient precision to demonstrate a direct relationship with the fault.
c. A structural relationship to a capable fault such that movement on one fault could be reasonably expected to cause movement on the other.

d. Established patterns of microseismicity which define a fault, with historic macroseismicity that can be reasonably be associated with the fault.

Fetch – The straight line distance across a body of water subject to wind forces. The fetch is one of the factors used in calculating wave heights in a reservoir.

Filter (filter zone) – One or more layers of granular material graded (either naturally or by selection) so as to allow seepage through or within the layers while preventing the migration of material from adjacent zones.

Flood – A temporary rise in water surface elevation resulting in inundation of areas not normally covered by water. Hypothetical floods may be expressed in terms of average probability of exceedance per year such as one-percent-chance flood, or expressed as a fraction of the probable maximum flood or other reference flood.

Flood Inundation Zone – The downstream area that would be inundated or otherwise affected by the failure of a dam or by large flood flows.

Flood Routing – A process of determining progressively over time the amplitude of a flood wave as it moves past a dam and continues downstream.

Flood Storage – The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel.

Freeboard – Vertical distance between the spillway crest and the lowest point of the top of dam, without chamber.

Gallery – A passageway in the body of a dam used for inspection, foundation grouting, and/or drainage.

Gate – A movable water barrier for the control of water.

   a. Bulkhead gate. A gate used either for temporary closure of a channel or conduit before dewatering it for inspection or maintenance or for closure against flowing water when the head difference is small, e.g., for diversion tunnel closure.

   b. Emergency gate – A standby or auxiliary gate used when the normal means of water control is not available. Sometimes referred to as guard gate.

   c. Outlet gate – A gate controlling the flow of water through a reservoir outlet.
d. Regulating gate (regulating valve) – A gate or valve that operates under full pressure flow conditions to regulate the rate of discharge.

e. Slide gate (sluice gate) – A gate that can be opened or closed by sliding in supporting guides.

**Gate chamber (valve chamber)** – A room from which a gate or valve can be operated, or sometimes in which the gate is located.

**Geotextiles** – Any fabric or textile (natural or synthetic) when used as an engineering material in conjunction with soil, foundations or rock. Geotextiles have the following uses: drainage, filtration, separation of materials, reinforcement, moisture barriers, and erosion protection.

**Groin** – The area along the contact (or intersection) of the face of a dam with the abutments.

**Grout** – A fluidized material that is injected into soil, rock, concrete, or other construction material to seal openings and to lower the permeability and/or provide additional structural strength. There are four major types of grouting materials: chemical; cement; clay; and bitumen.

**Grout Curtain** – One or more zones, usually thin, in the foundation into which grout is injected to reduce seepage under or around a dam.

**Hazard Potential Classification** – A rating for a dam based on the potential consequences of failure. The rating is based on potential for loss of life and damage to property that failure of that dam could cause. Such classification is related to the amount of development downstream of a dam.

**Head, Static** – The vertical distance between two points in a fluid.

**Heel** – The junction of the upstream face of a gravity or arch dam with the ground surface. For an embankment dam the junction is referred to as the upstream toe of the dam.

**Height** – The maximum height from the lowest natural ground surface, which is typically on the downstream side, to the top of the dam.

**Height, Structural** – The vertical distance between the lowest point of the excavated foundation to the top of the dam.

**Hydrograph, Breach or Dam Failure** – A flood hydrograph resulting from a dam breach.

**Hydrograph, Flood** – A graphical representation of the flood discharge with respect to time for a particular point on a stream or river.
Hydrology – One of the earth sciences that encompasses the natural occurrence, distribution, movement, and properties of the waters of the earth and their environmental relationships.

Inflow Design Flood (IDF) – The flood flow above which the incremental increase in downstream water surface elevation due to failure of a dam or other water impounding structure is no longer considered to present an unacceptable additional downstream threat. The upper limit of the IDF is the probable maximum flood (PMF).

Instrumentation – An arrangement of devices installed into or near dams (i.e., piezometers, inclinometer, strain gauges, measurement points, etc.), which provide for measurements that can be used to evaluate the structural behavior and performance parameters of the structure.

Intake – Any upstream structure in a reservoir, dam or river through which water can be discharged.

Inundation Map – A map delineating the area that would be flooded by a particular flood event.

Jurisdictional Dam – A dam greater than 10 feet in height or storing greater than 10 acre-feet, that is not exempt under Section 72-5-32 NMSA.

Length of Dam – The length measured along the dam axis at the top of dam. This also includes the spillway, powerplant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam these structures should not be included.

Liquefaction – A condition whereby soil undergoes continued deformation at a constant low residual stress or with low residual resistance, due to the buildup and maintenance of high pore water pressures, which reduces the effective confining pressure to a very low value. Pore pressure buildup leading to liquefaction may be due either to static or cyclic stress applications and the possibility of its occurrence will depend on the void ratio or relative density of a cohesionless soil and the confining pressure.

Loss of Life – The likely number of human fatalities that would result from a dam failure flood event. No allowances for evacuation or other emergency actions by the population should be considered.

Meteorology – The science that deals with the atmosphere and atmospheric phenomena, the study of weather, particularly storms and the rainfall they produce.

Minimum Operating Level – The lowest level to which the reservoir is drawn down under normal operating conditions.
**Notification** – To inform appropriate individuals about an condition so they can take appropriate action.

**Observation Well** – A hole used to observe the groundwater surface at atmospheric pressure within soil or rock.

**One-Hundred Year Flood** – A flood that has 1 chance in 100 of being equaled or exceeded during any year.

**Outlet** – An opening through which water can be discharged.

**Outlet Works** – A dam appurtenance that provides release of water (generally controlled) from a reservoir.

**Parapet Wall** – A solid wall built along the top of a dam (upstream or downstream edge) used for ornamentation, for safety of vehicles and pedestrians, or to prevent overtopping caused by wave runup.

**Phreatic Surface** – The free surface of water seeping at atmospheric pressure through soil and rock.

**Piezometer** – An instrument used for measuring fluid pressure (air or water) within soil, rock, or concrete.

**Piping** – The progressive development of internal erosion by seepage.

**Probability** – The likelihood of an event occurring.

**Probable Maximum Flood (PMF)** – The flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the drainage basin under study.

**Probable Maximum Precipitation (PMP)** – Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular geographical location during a certain time of year.

**Purpose** – The purpose for which the reservoir is used. Typical choices are: Irrigation, Hydroelectric, Flood Control, Water Supply, Recreation, Stock, Fish and Wildlife, and Tailings.

**Reservoir** – A body of water impounded by a dam and in which water can be stored.

**Reservoir Inundation Zone** – The area bounded by the water surface elevation associated with the routing of the IDF.
Reservoir Regulation (or operating) Procedure – Operating procedures that govern reservoir storage and releases.

Reservoir Rim – The boundary of the reservoir including all areas along the valley sides above and below the water surface elevation associated with the routing of the IDF.

Reservoir Surface Area – The area covered by a reservoir when filled to a specified elevation.

Riprap – A layer of large uncoursed stone, precast blocks, bags of cement or other suitable material, generally placed on the upstream slopes of an embankment or along a watercourse as protection against wave action, erosion or scour. Riprap is usually placed by dumping or other mechanical methods and in some cases is hand placed. It consists of pieces of relatively large size as distinguished from a gravel blanket.

Risk – The relationship between the consequences resulting from an adverse event and its probability of occurrence.

Slope – Inclination from the horizontal. Sometimes referred to as batter when measured from vertical.

Sluice – An opening for releasing water from below the static head elevation.

Spillway – A structure over or through which flow is discharged from a reservoir. If the rate of flow is controlled by mechanical means such as gates, it is considered a controlled spillway. If the geometry of the spillway is the only control, it is considered an uncontrolled spillway.

a. Auxilliary – Any secondary spillway which is designed to be operated very infrequently and possibly in anticipation of some degree of structural damage or erosion to the spillway during operation.

b. Principal (or service) – A spillway designed to provide continuous or frequent releases from a reservoir, without significant damage to either the dam or its appurtenant structures.

c. Emergency – A spillway that is designed to provide additional protection against overtopping of dams, and is intended for use under extreme flood conditions or misoperation or malfunction of the service spillway and/or the auxiliary spillway.

Spillway Channel – An open channel or closed conduit conveying water from the spillway inlet downstream.

Spillway Crest – The lowest level at which water can flow over or through the spillway.
**Spillway Design Flood (SDF)** – The required flood that a spillway must pass without failure of the dam.

**Spillway Effective Length** – The measured length of the crest of the spillway reduced by contraction of flow. Effective length is used to determine the spillway discharge.

**Stilling Basin** – A basin constructed to dissipate the energy of rapidly flowing water, e.g., from a spillway or outlet, and to protect the riverbed from erosion.

**Storage** – The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood wave through a natural stream channel. Definitions of specific types of storage in reservoirs are:

a. **Dead storage.** The storage volume of a reservoir that lies below the invert of the lowest outlet and that, therefore, cannot readily be withdrawn from the reservoir.

b. **Flood surcharge storage.** The storage volume between the maximum operating level and the design water level.

c. **Maximum storage.** The sum of the reservoir storage capacity and flood surcharge storage.

**Storm** – The depth, area, and duration distribution of precipitation.

**Sunny Day Failure** – Failure from other than a large flood such as earthquake induced, structural weakness, piping, etc. The maximum operating water level is assumed.

**Toe of Dam** – The junction of the downstream slope of a dam with the ground surface; also referred to as the downstream toe. The junction of the upstream slope with the ground surface is called the heel or the upstream toe. For concrete dams, see heel.

**Top of Dam** – See crest of dam.

**Top Thickness (top width)** – See crest width.

**Trashrack** – A device located at an intake to prevent floating or submerged debris from entering the intake.

**Tunnel** – A long underground excavation with two or more openings to the surface, usually having a uniform cross section used for access, conveying flows, etc.

**Type of Dam** – See descriptions listed for Dam.
**Upstream Blanket** – An impervious blanket placed on the reservoir flood and abutments upstream of a dam. For an embankment dam, the blanket may be connected to the core.

**Valve** – A device fitted to a pipeline or orifice in which the closure member is either rotated or moved transversely or longitudinally in the waterway so as to control or stop the flow.

**Volume of Dam** – The total space occupied by the materials forming the dam structure computed between abutments and from top to bottom of dam. No deduction is made for small openings such as galleries, adits, tunnels, and operating chambers within the dam structure. Portions of powerplants, locks, spillway, etc., should be included only if they are necessary for the structural stability of the dam.

**Wave Runup** – Vertical height above the stillwater level to which water from a specific wave will run up the face of a structure or embankment.

**Watershed** – The region draining into a river, river system or body or water.

**Weir** – An overflow structure built across an open channel to raise or control the upstream water level and/or to measure the flow of water.

a. **Weir, broad-crested.** An overflow structure on which the nappe is supported for an appreciable length in the direction of flow.

b. **Weir, measuring.** A device for measuring the rate of flow of water. It generally consists of a rectangular, trapezoidal, triangular, or other shaped notch, located in a vertical, thin plate over which water flows. The height of water above the weir crest is used to determine the rate of flow.

c. **Weir, ogee.** An overflow structure with its cross-section in the form of a reverse curve, shaped like an elongated letter “S”. The downstream faces of overflow spillways are often made to this shape.
APPENDIX B
72-5-9. Supervision; inspection; completion of works; alterations.

For the supervision of the construction of works for the storage, diversion or carriage of water there shall be in charge a registered professional engineer, whose qualifications have been approved by the State Engineer. This engineer shall have full authority to carry out such inspections and instructions that are deemed necessary by the State Engineer. On the date set for the completion of the work, or prior thereto, upon notice from the owner that the work has been completed, the State Engineer shall cause the work to be inspected, after due notice to the owner of the permit. Such inspection shall be thorough and complete, in order to determine the actual capacity of the works, their safety and efficiency. If not properly and safely constructed, as plans approved, the State Engineer may require the necessary changes to be made within a reasonable time, to be fixed by him and shall not issue his certificate of completion until such changes are made. If at or before the expiration of said time, good cause is shown why said change could not be made within said time, then additional time may be allowed in which to make said change. Failure to make such changes shall cause the postponement of the priority under the permit for such time as may elapse from the date for completing such changes until made to the satisfaction of the State Engineer, and applications subsequent in time shall have the benefit of such postponement of priority: the State Engineer, if he deems it necessary to the public safety, may bring in consulting engineers, geologists or other expert consultants, compensation for which will be paid for by the owner of the permit; provided, that for works involving the diversion of not exceeding twenty cubic feet of water per second or a dam not exceeding ten feet in height from the lowest natural ground surface elevation the State Engineer may, in his discretion, waive the above provisions and accept the report of the inspection by a registered professional engineer.

History: Laws 1907, ch. 49, § 30; Code 1915, § 5688; C.S. 1929, § 151-139; Laws 1937, ch. 178, § 4; 1941, ch. 126, § 12; 1941 Comp., § 77-508; 1953 Comp., § 75-5-8.
72-5-10. [State Engineer's certificate of construction.]

When the works are found in satisfactory condition, after inspection, the State Engineer shall issue his certificate of construction, setting forth the actual capacity of the works and such limitations on the water right as shall be warranted by the condition of the works, but in no manner extending the rights described in the permit.

**History:** Laws 1907, ch. 49, § 31; Code 1915, § 5689; C.S. 1929, § 151-140; 1941 Comp., § 77-509; 1953 Comp., § 75-5-9.

72-5-11. Inspection and correction of unsafe works.

If the State Engineer shall in the course of his duties find that any works constructed for the storage, diversion or carriage of water are unsafe and a menace to life or property, he shall at once notify the owner or agent, specifying the changes necessary and allowing a reasonable time for putting the works in safe condition. Upon the request of any party, accompanied by the estimated cost of inspection, the State Engineer shall cause any alleged unsafe works to be inspected. If they shall be found unsafe by the State Engineer, the money deposited by such party shall be refunded, and the fees for inspection shall be paid by the owner of such works; and, if not paid by him within thirty days after the decision of the State Engineer, shall be a lien against the property of such owner, to be recovered by suit instituted by the district attorney of the county at the request of the State Engineer. The State Engineer may, when in his opinion necessary, inspect any works under construction for the storage, diversion or carriage of water and may require any changes necessary to secure their safety; and the fees for such inspection shall be a lien on any property of the owner and shall be subject to collection as provided herein; provided that nothing contained in this section shall be construed to make works being constructed or owned by the United States while under supervision of officers of the United States subject to inspection by the State Engineer.

Nothing contained in this section and no action or failure to act under this section shall be construed:

A. to create any liability in the state or its officers or employees for the recovery of damages caused by such action or failure to act; or

B. to relieve the owner or operator of water impoundment works of the legal duties, obligations or liabilities incident to the ownership or operation of water impoundment works.

**History:** Laws 1907, ch. 49, § 32; Code 1915, § 5690; C.S. 1929, § 151-141; 1941 Comp., § 77-510; 1953 Comp., § 75-5-10; Laws 1979, ch. 314, § 1.
72-5-12. Failure to comply with State Engineer order; penalty.

Any owner of works for the diversion, storage, carriage or impoundment of water, his agent or employees, who, following notice to place such works in a safe condition as provided in Section 72-5-11 NMSA 1978, fails to take action specified by the State Engineer within the time allowed, shall be guilty of a misdemeanor. Any violation of this section shall be punishable by a fine of not more than two hundred fifty dollars ($250) for each offense or by imprisonment for a definite term not to exceed six months, or both. It is the duty of the State Engineer to give prompt notice to the district attorney of the county in which the works are located in case of such violation. The district attorney shall at once proceed against the owner and all parties responsible therefor.

History: Laws 1907, ch. 49, § 33; Code 1915, § 5691; C.S. 1929, § 151-142; 1941 Comp., § 77-511; 1953 Comp., § 75-5-11; Laws 1979, ch. 314, § 2.


Any person, association or corporation, public or private, the state or the United States hereafter intending to construct a dam shall meet the requirements of filing applications for appropriations and use of water pursuant to Section 72-5-1, 72-5-22, 72-5-23 or 72-5-24 NMSA 1978. Any person, association or corporation, public or private, the state or the United States intending to construct a dam that exceeds ten feet in height from the lowest natural ground surface elevation to the crest of the dam or impounds more than ten acre-feet of water shall submit on a form prescribed by the State Engineer detailed plans to the State Engineer for approval before construction. If the State Engineer finds that the dam design is safe, he shall approve the plans; provided that this section shall not apply to stock dams or erosion control structures whose maximum storage capacity does not exceed ten acre-feet or any dam constructed for the sole purpose of sediment and flood control under the supervision of the United States army corps of engineers.

History: Laws 1941, ch. 126, § 25; 1941 Comp., § 77-530; 1953 Comp., § 75-5-30; Laws 1979, ch. 114, § 1; 1997, ch. 66, § 1.
MANUAL OF RULES AND REGULATIONS GOVERNING THE
APPROPRIATION AND USE OF THE SURFACE WATERS OF THE
STATE OF NEW MEXICO

Revised August, 1953

(Copies of pertinent Sections Only)

I. CONSTITUTIONAL PROVISIONS AND
GENERAL PRINCIPLES OF APPROPRIATION

All existing rights to the use of water for beneficial purposes in New Mexico were
recognized and confirmed by the State Constitution at the time of its adoption.

The State Engineer is empowered to make all rules and regulations necessary to
administer the duties devolved upon his office.

All natural waters flowing in streams and water courses in New Mexico are declared to
be public and subject to appropriation for beneficial use.

Beneficial use is the basis, measure and limit of the right to use water. No water right,
therefore, may be granted or claimed for more than the amount that can be beneficially
used.

The unauthorized use of water to which another is entitled, or the willful waste of water
to the detriment of another or of the public is a misdemeanor. Excessive, wasteful and
otherwise non-beneficial uses do not constitute a valid water right.

Priority in time shall give the better right.

All water appropriated for irrigation purposes, except as otherwise provided by written
contract between the owner of the land and the owner of any ditch, reservoir, or other
works for the storage or conveyance of water, is appurtenant to the land upon which it is
used and shall so continue as long as it can be beneficially used on or until it is lawfully
severed from the land. Water which is appurtenant to certain lands may not be
transferred to other lands or used for other beneficial purposes excepting with the
consent of the owner of the land and as provided by law.

No appropriation of water shall be exercised to the detriment of anyone having prior,
valid and existing rights to the use of the waters of the stream system.
Excepting for water rights acquired prior to March 19, 1907, any right to the use of public waters must originate by application to the State Engineer as provided by statute. Unauthorized use shall be a misdemeanor.

The public is notified of proposed appropriations by publication in a newspaper of general circulation in the stream system and any water right owner who feels that the use of water under such application would be detrimental to his prior right may file a protest thereto. After due consideration of the facts, the State Engineer shall approve or reject the application.

It is unlawful to commence any construction of works until the formal application to appropriate water has been approved and signed by the State Engineer.

The diversion and distribution of water for irrigation and domestic purpose in New Mexico is a public purpose, and an appropriator may exercise the right of eminent domain to acquire rights-of-way for canals, ditches, reservoirs, etc., necessary to accomplish such purpose.

License to appropriate water is issued by the State Engineer after the works are satisfactorily completed and the water is applied to beneficial use.

Excepting stored waters, failure of an owner to beneficially use all or any part of the water in which he has a vested right for a period of 4 consecutive years constitutes forfeiture and such unused water shall revert to the public; except that forfeiture does not necessarily occur should such non-use be caused by circumstances beyond the owner's control.

To the end that the waters of the several stream systems of the state may be so utilized as to prevent waste and damage and in order that the benefits of such waters be distributed among the land owners along said streams as equitably as possible without interfering with vested rights, the natural right of the people living in the upper valleys to impound and utilize a reasonable share of such waters has been recognized and declared, subject always to the provisions of the water right statutes.

The appropriation statutes do not apply to stockmen who shall build or construct tanks or ponds for watering stock which do not exceed 10 acre feet in capacity. The owners are, however, at all times responsible for any detriment or damage to prior water rights which may result from the construction of and storage of water in such stock ponds.

The State Engineer has the right and duty of supervision of the apportionment of water according to the licenses issued by his office and to the adjudications of the courts. Although water rights acquired prior to March 19, 1907, may be adjudicated only by the courts, all such rights are subject to regulation, adjudication and forfeiture for non-use as provided in the statutes; provided, that in all cases where the rights to the use of the waters in interstate streams of owners of land not included in conservancy districts, irrigation districts, or Federal reclamation projects have been the subject of litigation in
the State or Federal courts of an adjoining state, the State Engineer shall assume control of all or any part of such interstate stream and the diversions and distribution of the waters of the same in the public interest.

II. PROCEDURE FOR APPROPRIATING PUBLIC SURFACE WATERS

A. Initiation of Water Right---Filling Fees---Priority.
The right to appropriate the public surface waters of New Mexico may be acquired by any person, firm, association, corporation, the State of New Mexico or the United States of America. Excepting projects of the Bureau of Reclamation (see page 21), all rights acquired after March 19, 1907, must be initiated in the office of the State Engineer by filing an application to make such appropriation. Acceptance of the filing by the State Engineer gives the applicant a tentative right to proceed according to statute in establishing his water right. It is unlawful, however, to commence any construction of works prior to the formal approval of the application by the State Engineer. The necessary blank forms for making water right application will be furnished by the State Engineer upon request. All other regular blank forms will be sent to applicant as required.

A water right may be initiated by filing Notice of Intention, to be followed within a designated time by Formal Application; or the right may be initiated by filing Formal Application directly. In either case there is a filing fee which is a necessary part of the application. The fee for filing Notice of Intention is $25.00. The fee for filing Formal Application is graduated in amount and depends upon the size and complexity of the project (see Article VII Fees). Excepting as it may be changed by the provisions of Sections D, E, F or K of this Article, the priority date of any water right is the date of receipt of initial filing papers accompanied by proper fee.

B. Notice of Intention.
Notice of Intention to make Formal Application for Permit shall be filed in duplicate on the proper forms, accompanied by a $25.00 filing fee. Upon receipt of the Notice properly filled out, the State Engineer shall endorse thereon the date of receipt and shall establish the date for filing Formal Application. Initiation of a right by Notice of Intention is optional and is designed as the lawful means of establishing a priority date for a reasonable length of time sufficient to make surveys and prepare necessary maps, plans, etc., as required by statute. The time granted is usually 6 months but depends somewhat upon the size and complexity of the proposed project. Additional time may be granted at the discretion of the State Engineer in special or unusual cases where the original time allowance proves insufficient, but in no case may the time between filing of Notice of Intention and filing of Formal Application exceed an aggregate of 3 years.

C. Surveys---Maps---Plans.
Field surveys of the project shall be made and maps, plans, field notes, specifications, etc., of the proposed works prepared by a qualified registered professional engineer.
Small projects for simple diversion and distribution and which involve no planning or design of dams, canal structures, etc., may be prepared for filing by a registered surveyor, if qualified to do the work. The engineer is responsible for the reasonable correctness of maps, plans, etc., which he prepares for filing with the State Engineer.

The maps, plans, etc., must be prepared from actual field surveys and must be detailed and complete enough to determine the feasibility, safety and adequacy of the proposed works. In cases involving storage or diversion of large amounts of water, the State Engineer may require any additional information he deems necessary to describe and define the proposed use.

Description and details of the data, certificates, etc., which must be shown on the maps and plans will be found under Article VI, “Filing Maps, Plans, Specifications.”

D. Formal Application

Formal Application shall be filed in duplicate on the proper forms. If Formal Application is an initial filing, it shall be accompanied by the required filing fees; if it follows a Notice of Intention it shall be filed not later than the date set by the State Engineer for such filing and shall be accompanied by the required filing fees from which amount has been deducted the $25.00 fee paid at the time of filing such Notice of Intention. Upon receipt of the proper application forms, completed in every detail, the Notice of Publication shall be issued. The information, maps, field notes, and detail required in plans and specifications to be submitted with the application will depend upon the nature and complexity of the works and will be specified by the State Engineer in each case. In general, it will not be necessary to submit plans and specifications with the application. After receipt of the affidavit of Proof of such Publication and the end of the protest period (and hearing on said protested application if necessary said application shall be approved or denied. Application shall be approved only with the provision that complete plans and specifications shall be submitted within a reasonable length of time to be designated by the State Engineer, and that no construction of the works shall commence until such plans and specifications have been approved. Additional fees required for the examination and study of detailed plans and specifications are set forth in Article VII.

The date of receipt of Formal Application by the State Engineer shall be endorsed thereon and noted in his record. If Formal Application is filed later than the limiting date fixed by Notice of Intention or by subsequent extensions of time thereto, it shall, excepting as to filing fee, be treated as a new application and the priority date shall become the date of the filing of Formal Application.

Formal Application defines and limits the maximum amount of water which may be appropriated, and no subsequent act, excepting as provided by statute, can extend or amplify such appropriation. A right can be acquired for any amount less than that asked for in the Formal Application, however, it should be emphasized here, also, that proposed irrigated areas described in the Formal Application cannot be changed or
other areas substituted in lieu thereof, nor can the proposed point of diversion be changed, excepting as provided by law.

**H. Fees for Examining Plans and Specifications.**
Before he shall approve an application the State Engineer shall require the deposit of the fees prescribed by statute for the examination and study of the plans and specifications of the proposed works (see Article VII, "Fees"). These fees are graduated in amount and depend upon the size and complexity of the project, excepting that no fees are charged in the case of small, simple diversion projects where the submission of plans and specifications are not required, and no fees may be charged for studying plans and specifications in the case of projects initiated by the United States or its authorized agencies.

**I. Approval---Permit.**
In approving an application, the State Engineer shall sign his endorsement upon the Formal Application and shall set the time within which applicant shall construct the works and apply water to beneficial use, but not to exceed five years for construction of works and four years in addition thereto for application to beneficial use. If, in his opinion, sufficient unappropriated waters are not available to satisfy the project, the State Engineer may approve the application for a smaller amount of water than that applied for. In no case may the amount be increased excepting by a new or amended filing. Applications are always approved with the provision that they must not be exercised to the detriment of any appropriators having prior, valid and existing rights to the use of the water of the stream system. For special conditions, special additional provisions may be imposed.

Upon approval the application becomes a permit to appropriate water. A permit does not in itself constitute a water right but merely allows the permittee to demonstrate to the State and others that he can and will, in good faith and with due diligence, construct the works and apply water to beneficial use as provided by the terms thereof. The permit defines and limits the water right which may be required and should be filed of record with the clerk of the county within which the works are to be situated.

**K. Construction of Works---Inspection.**
The works shall be constructed by the permittee under the supervision of a qualified registered professional engineer unless this provision is specifically waived by the State Engineer. If he deems it necessary to the public safety, the State Engineer may call in consulting engineers or geologists to study and pass upon the project. Cost of such supervision and consulting work shall be borne by the permittee. Construction shall be carried on according to the plans and specifications approved by the State Engineer and no changes or alterations shall be made without his knowledge and consent. As soon as possible after notification of completion of works, the State Engineer, or a proper assistant, shall make a thorough inspection of the works to determine their actual capacity, their adequacy, safety and efficiency, and shall file his report thereon as a part of the permanent record; provided that, in the case of work involving the diversion of not to exceed 20 cubic feet of water per second of time or a dam not exceeding 10 feet in
height above stream bed, the State Engineer may appoint a registered engineer or land surveyor to make the inspection. If the works have been materially changed from the original plans on file, corrections shall be made on the originals, or amended plans shall be submitted for the record. If found to be improperly constructed or unsafe, the State Engineer shall require the making, within a reasonable time limit fixed by him, of all changes or repairs indicated as necessary. If the time allowed proves insufficient, the State Engineer may, upon sufficient showing by the permittee, grant additional time for making the required changes. Failure to make such corrections shall cause the postponement of the priority date of the permit for the length of time elapsing between the date set by the State Engineer and the date when the changes have been satisfactorily completed.

Upon completion, the permittee shall file in duplicate on the proper forms Proof of Completion of Works, which shall be duly sworn to and signed by the inspecting engineer after he has made a thorough field inspection. If not done previously, the owner shall at this time make affidavit or submit proof that he holds all necessary rights-of-way for his works without controversy. A fee of $25.00 for the issuance of a Certificate of construction shall accompany this filing.

L. Certificate of Construction.
The State Engineer shall then issue a Certificate of Construction which shall include the location of the point or points of diversion, the capacities of canals and reservoirs, and shall certify to the adequacy of the works for the intended use. Owner shall record the Certificate of Construction with the clerk of the county within which the works lie.

N. Final Inspection
Upon due notice to the owner of the permit, the State Engineer, one of his assistants, or a qualified registered professional engineer or land surveyor appointed by him shall make an inspection at the owner's expense and shall prepare and file as a part of the record a final report on the project, incorporating therein his recommendations of water use. Such report shall describe in detail by legal subdivision the land irrigated, giving acreages and as closely as possible the quantity of water applied on the lands. Such report is not required to determine losses in transit as they are uncertain and vary widely according to methods of delivery and character of soils thru which the works are constructed. A license to apply a given quantity of water on the land carries with it the right to divert from the stream an additional quantity sufficient to cover actual necessary losses in transit.

In the case of small diversion or storage projects, the State Engineer may in his discretion, when requested by the owner, cause the inspection of works and final inspection of application of water to beneficial use to be made at the same time.
V. ADDITIONAL PROVISIONS AND REQUIREMENTS

The following sections describe additional provisions and requirements of the law in connection with appropriation and use of the surface waters of the State. They are included herein to delineate more clearly certain rights and duties of the water users and of the State Engineer.

Federal Reclamation Projects
Whenever the proper officers of the United States authorized to construct reclamation projects under the terms of the Federal reclamation act shall notify the State Engineer that the United States intends to make use of certain unappropriated waters of the State, the waters so reserved shall not be subject to further appropriation for a period of three years, within which time such officers shall file comprehensive maps and plans of the proposed project. The waters so reserved are not subject to adverse claim or appropriation unless no plans have been filed within the 3-year period or unless such waters are formally released in writing by the proper officer of the United States.

This section involves only works initiated and built under the terms of the Federal Reclamation Law, and does not apply to other Federal agencies.

Unsafe Works---Inspection---Repair
If, upon the request of any party, accompanied by the estimated cost of inspection, or in the course of his regular duties, the State Engineer shall find by inspection that any works used for the storage, diversion or carriage of water are unsafe and a menace to life and property, he shall at once notify the owner thereof, specifying the changes necessary and allowing a reasonable time for putting the works in safe condition. The cost of such inspection shall be a lien upon the property, unless the works are found to need no repair or change, in which case the cost shall be borne by the party requesting the inspection. The continued use of unsafe works after notification by the State Engineer and contrary to his instructions shall be a misdemeanor.

Excepting for works under construction or being owned by the United States while under supervision of officers of the United States, the State Engineer may inspect any works under construction and may require any changes necessary to secure their safety, and the costs of such inspection shall be a lien upon the property.

VI. FILING MAPS, PLANS, SPECIFICATIONS

A. General Filing Requirements
TRACINGS---All filing maps, as well as supplementary plan and detail sheets, shall be original tracings, carefully and neatly done. If more than one sheet is required, they shall be properly numbered in sequence (example---Sheet 1 of 3 Sheets). In general the filing map shall be separate from the plans and detail sheets, excepting that, in the case of small simple diversion projects, all necessary information may be contained on a single sheet. All sheets shall conform to the standards given below.
DIMENSIONS---They shall be prepared on good quality tracing cloth, 24 inches by 36 inches, outside dimensions, with a one-inch margin on all sides. Tracings which vary from this standard size will not be accepted. Writing or other data must not appear in the margins of the sheets.

WATERPROOF INDIA INK---As all tracings are a part of the permanent record, they must be prepared with a good quality permanent black waterproof India drawing ink. This requirement also applies to all signatures, dates, acknowledgments, etc., appearing on the sheets. No sheets which do not fully comply with this provision can be accepted.

CARELESS OR UNSATISFACTORY WORK---CORRECTION---Illegible, mutilated, careless or otherwise poorly prepared maps and plans are not acceptable for filing purposes and may be returned to be redone and retraced. Maps and plan sheets upon which the data are incomplete, faulty or missing will be returned for correction or addition.

TRACINGS NOT FOLDED---Tracings must never be folded but should be rolled about a strong round stick or in a heavy cardboard mailing tube for transportation and handling purposes.

SCALE OF MAPS, PLANS AND DETAIL SHEETS---The scale or scales used on the filing sheets will, of course, vary according to requirements and space available. However, a standard engineer's scale of sufficient size to show all necessary data clearly and in detail should be chosen. All distances shall be shown in feet and decimals thereof; detail dimensions of structures, headgates, drops, etc., may be given in feet and inches. If part of the works is located on State or Federal lands over which right-of-way must be obtained, the scale chosen should preferably be the scale required by such agency, so that replatting to meet their requirements for obtaining right-of-way will not be necessary.

DIRECTION OF NORTH---Maps shall be platted to the true meridian and all bearings shown shall be true bearings. The direction of North shall be placed on the map. Magnetic declination should also be shown if used in making the field survey.

ENGINEER'S AND NOTARY'S SEALS---The impressions of the seals of the engineer or land surveyor preparing the filing and of the notary public shall be placed on the tracing cloth following or near the signatures thereof.

FIELD NOTES---TRAVERSES---Field notes showing courses and distances of canals or pipelines, or of extreme high water line of a reservoir, are a necessary part of a filing, particularly when the works lie on or cross lands thru which right-of-way must be acquired. As nearly as possible a station should be located on each public survey line wherever the traverse crosses such lines. Stations should be numbered consecutively from the point of beginning to the end of the works and bearings and distances shown
by tabulation on the filing map. Where traverses approach public survey corners along their routes, ties should be made to such corners as can be found. Corners which are located in the field and used in the survey should be indicated on the map by encircling them with a diamond or other mark to distinguish from corners not located.

HYDRAULIC PROPERTIES OF MAIN CANALS, PIPELINES, ETC.---All pertinent hydraulic properties of main canals, pipelines, etc., including their dimensions, gradients, coefficients of roughness, freeboard and working capacities, shall be determined and shown on the plan and detail sheets. All elevations, plans, sections, construction details, etc., necessary to properly describe the works shall be shown.

RESERVOIR AREA AND CAPACITY---The topography of any proposed reservoir site shall be determined with reasonable accuracy and a contour map thereof prepared and placed on the filing map, the contour intervals not to exceed 5 feet each in elevation. The State Engineer may require a smaller contour interval than 5 feet if necessary for obtaining reasonable accuracy. Detailed topography of the dam site including sufficient area upstream and downstream and at the sides to properly design spillways, outlets, coffer-dams, etc., shall be taken. An area and capacity table of each reservoir shall also appear on the map, the contour intervals of which may be designated as “feet above bottom of outlet,” or they may be given in “elevations above mean sea level,” or above some assumed datum. It is important that a permanent bench mark above high water line should be established and fully described in order that the established reservoir datum may be available at all times.

DESIGN OF DAMS---The design and specifications of any dam for the storage or diversion of water shall conform in all respects with the State Engineer's code of dam construction, a copy of which code will be sent applicants upon request. This requirement is essential, as much for the protection of the investment of the appropriator as it is for the protection of the lives and property of those living below the dam and for the conservation of the public water supply.

In general, earthen storage dams shall be constructed with a slope not less than 2: horizontal to 1 vertical on the upstream or water side and 2 horizontal to 1 vertical on the downstream side. Fill shall be placed in layers not to exceed 1 foot in thickness and each layer should be thoroughly compacted. In designing uncomplicated low earthen structures a suggested formula for computing width of crest is: Crest width = 2 /height + 3 feet, which width shall never be less than a minimum of 8 feet. The freeboard above high water line shall not be less than 5 feet. The upstream face shall be protected from wind and wave erosion by an adequate facing of rock, concrete or other suitable riprap material. Masonry and concrete dams shall be structurally safe as determined by acceptable design formulas. Foundations, cut-off walls, outlet works, etc., shall be adequate and properly designed. (Inspections made by the State Engineer's office indicate that many earlier earthen storage dams of the State had inadequate spillways, were constructed on steeper slopes than the above or were not properly compacted nor were the foundations properly prepared. As evidence that such construction is inadequate or worse, it may be mentioned here that perhaps half of the dams inspected
have failed either partially or completely, or else seep water so badly that their usefulness is impaired. It is poor economy to build storage structures which are not safe and adequate).

HIGH WATER LINE TRAVERSE---The extreme high water line of each reservoir (the maximum boundaries of the land temporarily covered by water when the spillway is discharging at maximum capacity) shall be determined by a closed transit traverse and included on the topographic map. A station should be located as nearly as possible on each public survey line wherever the traverse crosses such lines and the distance from that station to the nearest survey corner shown. Stations should be numbered consecutively from the point of beginning, and the courses and distances of the traverse tabulated on the map. Error of closure shall not exceed 1 foot per 5000 feet of distance measured. Such a traverse is necessary in procuring easements or rights-of-way. With the approval of the State Engineer a high water line contour indicated on the topographic map may be substituted for the high water line traverse on ungated flood retention projects where reservoir basins will be drained within a specified time after each filling. Said contour to be obtained from actual field survey or by stereoplotting methods. Method used in obtaining the contours shall be noted on the map.

INITIAL POINT OF RESERVOIR TRAVERSE---POINT OF OUTLET---The location of the control gates (point of outlet from reservoir) shall be determined by course and distance from some known public survey corner. If the initial point of the high water line traverse does not coincide with this point, it also should be tied to a known survey corner or else tied to the point of outlet.

RESERVOIR DRAINAGE AREA---SPILLWAY CAPACITY---The drainage area above and tributary to the reservoir shall be determined with reasonable accuracy and a spillway of size adequate to handle the runoff therefrom shall be designed. It is desirable that the filing map shall show a small scale map of the basin above the dam which will indicate the length, size and shape of the contributing area, the location with respect to towns, railroads, highways, shipping points, etc. A proper design of the approach section of the spillway is important because any overflow section, no matter how large, is useless if the water cannot flow to it at a rate sufficient to safely carry away excess waters. A spillway of ample size is essential to protect the dam itself and it insure the safety of those living below the reservoir. The size and capacity of the spillway and of the outlet gates from the reservoir shall be indicated on the plans.

DIVERSIONS BELOW RESERVOIR---The point or points of diversion below a reservoir shall be determined and shown on the map by course and distance from some public survey corner. Traverses of main canals diverting below reservoirs, their directions of flow and their names or locations, if more than one, shall also be indicated.

STOCK-WATER DAMS---In general the following will govern the design and construction of stock-water dams impounding more than 10 acre-feet:

1. Preparation of Foundation All vegetation of every description together with all boggy or unstable materials within the area upon which the dam will rest shall be
removed and deposited outside the toes of the dam. The banks of the stream channel shall be dressed to a slope of about 12 horizontal to 1" vertical. A core trench, with sloping sides and a bottom width of not less than 5 feet and depth of 4 feet, shall be excavated along the center line for the full length of the dam and shall be refilled with the most impervious materials available. The foundation shall then be scarified or plowed lengthwise of the dam to secure proper bonding between the foundation and the embankment.

2. **Embankment** The fill material shall be placed in the core trench and the embankment in layers not exceeding 6 inches in thickness. Each layer shall be thoroughly compacted by a sheep's-foot roller, caterpillar treads, or trucks used during construction. The embankment material shall be placed in a horizontal plane for the full width and length of the work. No side dumping of material shall be permitted. When necessary, water shall be added to the fill material to obtain proper compaction. Puddling of material with water shall not be permitted. No frozen material, large clods, boulders, or organic matter shall be incorporated in the embankment. The upstream slope shall be constructed not steeper than 3 horizontal to 1 vertical and the downstream slope not steeper than 2 horizontal to 1 vertical. The crest width of the finished embankment depends upon the maximum height. Minimum crest widths are as follows:

<table>
<thead>
<tr>
<th>Maximum height of dam (feet)</th>
<th>less than 10</th>
<th>10-14</th>
<th>14-18</th>
<th>16-22</th>
<th>22-26</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum crest width (feet)</td>
<td>8</td>
<td>9</td>
<td>11</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

The upstream two-thirds of the embankment section should consist of the most impervious materials available such as clay loam, or a mixture of clay and sand, and the downstream one-third of more previous materials, such as sand or gravel. On all dams where it is necessary to protect against wave action, the upstream face shall be adequately riprapped with stone or other suitable material.

3. **Outlet** Should the State Engineer so require, a pipe not less than 18 inches in diameter equipped with a suitable control gate and operating mechanism shall be installed. Such outlet pipe, when required, shall be provided with anti-seep collars of approved design. The pipe shall be placed in a trench and shall be completely surrounded with well compacted impervious material.

4. **Spillway** For the protection of the dam, an adequate spillway shall be constructed, of sufficient capacity to carry the entire discharge from the drainage basin above the dam during periods of excessive runoff. The spillway shall be located in stable material and shall discharge at a safe distance from the dam. The vertical distance from the crest of the spillway to the crest of the dam shall not be less than 5 feet. When necessary to provide the minimum free-board required (as specified below) this vertical distance may have to be increased. Unless the spillway is located in well-grassed earth, hard clay, shale, or rock the discharge velocity shall not exceed 3.5 feet per second. In earth this requires that the slope of the control section shall not exceed 0.25 foot per 100 feet. The freeboard (vertical distance between the water surface elevation at maximum discharge and the crest of the dam) shall be not less than 2.5 feet. The following
method shall be used to determine the minimum area of the control section (below maximum high water) based upon a maximum spillway slope of 0.25 foot per 100 feet and an assumed peak runoff of between 0.6 and 0.7 cubic feet per second per acre of drainage area:

Area of spillway control section (earth) in square feet = 0.2 x drainage area in acres.

Where a drainage basin is in hilly or rough country, with steep gradients or rocky ground cover, peak runoffs may considerably exceed those assumed above and the area of the spillway control section should be increased accordingly. If the spillway is located in shale or hard rock formation throughout its length, the cross sectional area of the control section may be reduced by increasing the velocity of discharge. The width of the entrance to the spillway should be one-third wider than the control section and the bottom should slope from this section toward the reservoir at a rate of approximately 1.0 foot per 50 feet.

5. Borrow Pits  Borrow pits from which materials are taken shall be cleared of all vegetation and no material shall be borrowed within a distance of 50 feet of any part of the dam. Material excavated from the spillway, outlet works and core trench, when suitable, may be used in constructing the dam.

The above are considered to be the minimum requirements necessary for the construction of satisfactory stock-water dams. However, each structure will be considered upon its own merits. Depending on the magnitude of the structure and the proximity to downstream development, such as houses, roads, bridges, railways, etc., more stringent requirements may be imposed by the State Engineer. Water right filing procedures and the requirement of having a registered professional engineer prepare the plans and supervise construction will remain unchanged.

POWER PROJECTS---A map submitted in connection with a power project shall, in addition to the usual data, contain a statement of the effective head on the turbines, the maximum, minimum and average required flow in second feet and the effective horsepower to be developed.

PLANS---The plans sheets shall cover detailed information of the various works to be constructed, including plan, elevation, cross-section and profile of any dams and spillways with dimensions and construction details shown; also cross-sections, dimension and other pertinent detail of canals, headgates, flumes, siphons, measuring devices, pipelines, etc. All data necessary for the State Engineer to determine the safety and feasibility of the works shall be included.

SPECIFICATIONS---Specifications are usually necessary to supplement the plans of construction, defining and circumscribing the work to be done and the materials to be used. Simple projects involving little or no engineering may require no specifications. Projects of appreciable size or complexity, however, especially those involving contract work, shall be controlled by an adequate set of specifications covering work to be done,
methods of construction, types, qualities and sizes of materials, unit amounts to be used, supervision, inspection, etc. Such specifications should be clear, concise, definite and impartial to both owner and contractor. Arbitrary, unfair, ambiguous or unreasonable requirements should be carefully avoided.

Two copies of the specifications must accompany the formal application, maps and plans, and must receive the approval of the State Engineer. They should be typewritten or mimeographed on one side of legal size paper and firmly bound or clipped together. The project engineer's and the State Engineer's certificates should appear at the front or on the first sheet of the specifications. They shall contain a clause giving the State Engineer authority of inspection during construction and full power to act in the event specifications are not met, unless the appropriator is otherwise specifically exempted by law.

The designing engineer shall prepare detailed estimates of the cost of the construction, which shall be submitted to the State Engineer at the time of filing formal application.

The State Engineer may, in his discretion, waive the requirements for detailed plans and specifications in the case of small direct diversion or storage projects where there is no possibility of the constructed works being a menace to life or property.

CLAIMANT'S CERTIFICATE---A claimant's certificate shall be placed on and made a part of the filing map and shall be signed by the applicant and acknowledged by a Notary Public, using a permanent black India ink for the purpose. An alternate certificate is shown which should be used in case the applicant is a corporation. If the filing map (not including plan sheets) consists of more than one sheet, such certificate should be placed on the first sheet, due reference being made to all succeeding sheets.

ENGINEER'S CERTIFICATES---The qualified registered professional engineer or land surveyor (see Article II, Sec. C, “Surveys---Maps---Plans”) making the survey or under whose direction the survey was made, shall place on the filing map (or first sheet, if more than one) the engineer's certificate, which he shall sign before a notary public. The engineer's license number together with impressions of his seal and that of the notary public shall accompany this certificate.

The registered engineer preparing the plans and specifications shall also place upon the first sheets of the plans and of the specifications, certificates to the effect that they were prepared by him and such certificates shall be signed by him and witnessed by a notary public. The engineer's license number and the impressions of his and of the notary’s seals shall accompany these certificates.

STATE ENGINEER'S CERTIFICATES---A certificate form for the State Engineer's approval shall be placed on the first sheet of the filing maps and similar certificates on the first sheet of the plans and of the specifications. These certificates are to be signed by the State Engineer after all necessary corrections or additions, if any, have been
made to the Formal Application, filing maps, plans, etc., and such endorsement is to certify his approval of the adequacy of the works for the proposed use.

B. Map Title, Statements and Affidavits
The following map title and statements shall be placed on and made a part of the filing map. They may be altered somewhat, if required, to fit the individual application.

MAP of the
_______________________________________________________
(name of ditch, ditch and reservoir, irrigation, power, etc., system)

________________________________________, Applicant
Located in ___________________________________________County, State of New Mexico.
All courses true Magnetic Variation______________________East*

Scale of Map, 1 In. = ______feet.

The undersigned, ________________________, claimant, whose post office address is _______________________________, County of ___________________, State of ____________________has caused to be located by a qualified registered

_____________________________________________________________________
(professional engineer, land surveyor, or professional engineer and land surveyor)
the __________________________________________________________________
(name of ditch, power, irrigation, etc., system)
as hereinafter described and indicated, hereby makes these several statements relative thereto and offers this map (these maps) and statements for acceptance and filing in compliance with the laws of the State of New Mexico.

* Include only if magnetic needle courses have been used in making survey.

For direct diversion system or diversion to an off-channel reservoir:

The headgate, which is the point of diversion from ______________________, from which the works derive their water supply, (river, creek, spring, arroyo, etc.) is located in the ______ quarter of the ______ quarter of section ________, Township ________ Range ________, N.M.P.M., (as projected, being on unsurveyed land), at a point whence the ______ corner of section ________, Township ________, Range ________, bears ______________________ feet distant. (direction) (distance)
For any storage reservoir, for any power or similar project where the water returns to the stream undiminished in quantity, or for the location of any other important point of the works:

The ________________ is located in the ______ quarter of the
(see note) __________ quarter of section ________, Township ________, Range ________,
N.M.P.M., (as projected, being on unsurveyed land) at a point whence the ______
corner of section ________, Township ________, Range ________, bears
________________________ feet distant.
(direction) (distance)

(Note: Use the following: (a) “outlet gate from the reservoir (or lake)”; (b) “initial point of the high water line traverse”; (c) “point of return to the stream,” in the case of power or similar projects; (d) any other important point to be described and located.)

The main canal, pipeline, etc., from the stream in the case of a direct diversion project or diversion to an off-channel reservoir, and the main canal or canals carrying water to the lands below a reservoir shall be described according to the following form:

The hydraulic properties of the ______________________ are as follows:
(name of canal) bottom width, ________ feet; depth of water at full operating capacity, ________ feet; total depth (maximum water depth plus freeboard), ________ feet; side slopes, ________ horizontal to 1 vertical; diameter (in case of pipeline or circular flume), ________ feet; slope, ________ feet per 1000 feet; hydraulic radius, ________ feet; coefficient of roughness in (see Article VIII “Hydraulic Data”), ________; velocity at full operating capacity (see Article VIII), ________ feet per second; capacity ________ cubic feet per second.

(Note: This form shall be repeated for all main canals or conduits to be described.)

The storage dam or dams shall be described according to the following form:

The ______________________ has the following properties: maximum height
(name of storage dam) above foundation, ________ feet; maximum length, ________ feet; maximum
width at base, ________ feet; crest width, ________ feet; slope of upstream face, ________ horizontal to 1 vertical; slope of downstream face, ________ horizontal to 1 vertical; elevation (mean sea level or assumed datum) of spillway crest, ________ feet; elevation of bottom of outlet conduit (flow line) at upstream face of dam, ________ feet; ________ vertical distance between top of dam and
elevation to which water will rise when spillway is discharging maximum
capacity, _______ feet; width of spillway, _______ feet; discharge capacity of
spillway, _______ cubic feet per second. The outlet conduit is
_________________________ (give size and character) and has a maximum
discharge capacity of ______________ cubic feet per second.

Following the above, state the type of dam (arch, gravity, hollow arch, etc.), the
construction material (concrete, masonry, earth and rock, etc), and the type of
impermeable core or cut-off wall preventing percolation thru the dam.

The following area and capacity table shall follow the dam description:

<table>
<thead>
<tr>
<th>Elevation (sea level or assumed datum), or Depth above Bottom of Outlet</th>
<th>Water Surface Area, Acres</th>
<th>Cumulative Live Storage Capacity Acre-feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>___________________________</td>
<td>______________</td>
<td>__________________</td>
</tr>
<tr>
<td>___________________________</td>
<td>______________</td>
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</tr>
<tr>
<td>___________________________</td>
<td>______________</td>
<td>__________________</td>
</tr>
</tbody>
</table>

Dead storage (if any) below reservoir flow-line equals __________ acre-feet.

Note: The first line shall show the water surface area at reservoir flow-line; the second
line shall show area and capacity at the first contour above flow-line (may be an odd
interval); the third and following lines shall show area and capacity at succeeding
contour intervals; the last line shall show maximum live storage capacity at spillway
crest elevation, unless automatic gates are placed in the spillway section for additional
storage, in which case the last line shall show the maximum live storage at the tip of
spillway gates.

The estimated cost of ________________________ is $________________
(canal or conduit)

(Repeat for each canal, lateral, etc., in system)

The estimated cost of ___________________________ is $________________
(storage or diversion dam)

(Repeat for each dam in system)

Total estimated cost of the works is $___________________________

The area to be irrigated consists of ___________________________ acres located
and described by legal sub-division as follows:
The efficient but not excessive duty of water in this area is
____________________ acre feet per acre delivered on the land, claim for which is
hereby made for irrigation purposes.

(Note: For appropriation of water for other proper purposes than irrigation, the above
statements should be altered or revised to fit individual requirements.)

Following is the Dam Owner's certificate, to appear on the first sheet of the filing maps:

State of______________________________ )
                          )ss.
County of____________________________ )

I, ______________________________, being first duly sworn, upon my oath, state
that I have read and examined the accompanying map and statements (maps and
statements consisting of ________ sheets) and know the contents thereof and
representations thereon, and state that the same are true to the best of my
knowledge and belief.

_____________________________________
Dam Owner.

Subscribed and sworn to before me this ________ day of ______________, 20__.

_____________________________________
Notary Public.

My commission expires__________________________________(SEAL)

If the Dam Owner is a corporation use the following:

State of______________________________ )
                          )ss.
County of____________________________ )
I, ______________________________, being first duly sworn, upon my oath, state that I am the ___________________ (Officer) of the _______________________, a corporation duly organized under the laws of the State of __________________, that the accompanying map and statements (maps and statements consisting of ________ sheets) were made under authority of the Board of Directors of said corporation, and that, in their behalf, I have read and examined the statements and representations thereon and state that the same are true to the best of my knowledge and belief.

_____________________________________
Dam Owner.

By___________________________________

Subscribed and sworn to before me this ________ day of ______________, 20___.

_____________________________________
Notary Public.

My commission expires______________________________________ (SEAL)

Following is the engineer’s certificate to be placed on the first sheet of the plans and the first sheet of the specifications:

State of New Mexico___________________ )
 )ss
County of____________________________ )

I, ______________________________, being first duly sworn, upon my oath state that I am a registered professional engineer (or professional engineer and land surveyor), qualified in __________________________ engineering, and that the (civil, mining, hydraulic, etc.) accompanying ___________________ consisting of ________ sheets were (plans, specifications) prepared by me and are true and correct to the best of my knowledge and belief.

____________________________________________
Registered Professional Engineer (and Land Surveyor)

License No. __________________ (SEAL)

Subscribed and sworn to before me this _______ day of ______________, 20___.

____________________________________________
Notary Public.

My commission expires_______________________________(SEAL)

Following is the surveyor's or engineer's certificate to be placed on the first sheet of the filing maps:

State of New Mexico___________________ )
  )ss
County of____________________________ )

I, ______________________________, being first duly sworn, upon my oath state that I am the registered professional engineer and land surveyor (or registered professional engineer, or registered land surveyor) who made the map(s) of the __________________________ that such map was (maps consisting of ____ (name of irrigation or other system) sheets were) prepared from field notes of actual surveys made by me or under my direction and that the same are true and correct to the best of my knowledge and belief.

________________________________________________
Registered Professional Engineer and/or Land Surveyor

License No. _____________________________ (SEAL)

Subscribed and sworn to before me this ________ day of ______________, 20___.

___________________________________________
Notary Public.

My commission expires_______________________________(SEAL)

The State Engineer's approval of the filing maps, to appear on the first page thereof, follows:

State of New Mexico___________________ )
  )ss
County of____________________________ )

I hereby certify that the accompanying map(s) and statements have been examined by me and approved as to form and content, and were duly accepted for filing on the ________ day of ____________________, 20___.

___________________________________________
Notary Public.
The State Engineer's approval to be placed on the first sheets of the plans and the first sheet of the specifications, follows:

State of New Mexico___________________ )
County of____________________________ )

I hereby certify that the accompanying (plans, specifications) have been duly examined by me and approved as to form and content, and were duly accepted for filing on the ______ day of ____________________, 20___.

_____________________________________
State Engineer.

VII. FEES

The State Engineer shall receive the following fees, to be paid by him into the general fund:

(a) For filing notice of intention to make formal application for permit to appropriate surface water, twenty-five dollars ($25.00), which shall be paid at the time of filing notice of intention.

(b) For filing a formal application for permit to appropriate water where the project is chiefly for diversion and direct use of the water, twenty-five dollars ($25.00) if the amount claimed does not exceed five (5) cubic feet of water per second, and five dollars ($5.00) for each cubic foot per second in excess of five (5); or if the project is chiefly for storage of excess and flood waters, ten dollars ($10.00) for each one thousand (1000) acre-feet or fraction thereon of storage capacity; or, if the project is for power purposes only, in which the water is returned to the river bed in substantially undiminished quantity, twenty-five dollars ($25.00), if the amount claimed does not exceed five (5) cubic feet of water per second, and one dollar ($1.00) for each cubic foot per second of time in excess of five (5); provided, however, that if application for permit is preceded by a notice of intention, the fee accompanying the notice of intention shall be applied on the subsequent fees. Fees included under this paragraph, which shall be paid to the State Engineer at the time of filing formal application for permit, shall include the filing of maps, plans, specifications, field notes, proof of publication and all other papers relating to the application, up to the issuing of the permit to appropriate water, and shall include the examination and study of all data therein with the exception of plans and
specifications, for the examination and study of which additional fees shall be collected as prescribed in this article.

(c) For examining in connection with any water right application the plans and specifications for a dam, two dollars ($2.00) for each one thousand dollars ($1,000) or fraction thereon of the estimated cost of such dam; for examining the plans and specifications for a canal or other water conduit, twenty-five dollars ($25.00), where the capacity does not exceed fifty (50) cubic feet of water per second, and ten dollars ($10.00) for each additional fifty (50) cubic feet per second or fraction thereof, the fees shall be paid to the State Engineer before he issues the permit to appropriate water; provided that no fee shall be paid for examining plans and specifications submitted by the United States or any agency or department of the United States.

(d) For issuing any certificate of construction or license to appropriate, twenty-five dollars ($25.00).

(e) For issuing a permit for an extension of time, fifty dollars ($50.00).

(f) For issuing any miscellaneous water right instrument or copy of any water right document filed in his office, one dollar ($1.00) for the first page thereof, and fifteen cents ($.15) for each additional page thereof.

(g) For filing any other paper necessarily forming a part of the permanent record of the water right application, permit or license, one dollar ($1.00).

(h) For a contact reproduction of any map or plan sheet accompanying an application for permit to appropriate water, three dollars ($3.00) for each sheet; for a negative of any map or plan sheet suitable to reproduce copies thereof, five dollars ($5.00) for each sheet.

(i) For inspecting dam sites, dams, irrigation systems or other construction work as required by law, one hundred dollars ($100.00) per day and actual and necessary traveling expenses. Fees for any inspection deemed necessary by the State Engineer and not paid on demand shall be a lien on any land or other property of the owner of the works and may be recovered by the State Engineer in any court of competent jurisdiction.

(j) For such other work as may be required of his office, such reasonable fees as in the judgment of the State Engineer the character and extent of the work justifies.
NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT
TO CONSTRUCT AND OPERATE A DAM

1. OWNER:
Name: ______________________________________ Work Phone: ____________
Title: _____________________________________ Home Phone: ____________
Address: __________________________________________________________
___________________________________________________________
City: _______________________________ State: _____________ Zip: __________

2. PURPOSE: ___________________________________

3. HAZARD POTENTIAL CLASSIFICATION: ____________

4. LOCATION:
A. ____1/4 ____1/4 ____1/4 Section:____  Township:____  Range:____ N.M.P.M.
in _____________________ County.
or  X = ______________ feet, Y = ______________ feet, N.M. Coordinate System
   Zone Datum of _________ in the _________________________ Grant.
B. Latitude: ____ Degrees  ____ Minutes  ____ Seconds
   Longitude: ____ Degrees  ____ Minutes  ____ Seconds
C. On land owned by: _______________________________________________________
D. Source of Water Supply:
   a. Name of Surface Watercourse: ___________________ Tributary of ________________
   b. Name of Groundwater Basin: ____________________________________
   c. Name of Ditch or Spring (Off Channel Dams): _________________________________
E. Distance to the nearest downstream City/Town (miles): ________

5. DRAINAGE AREA AND PRECIPITATION CHARACTERISTICS:
A. Drainage area: _______________ acres and _______________ square miles
B. 100-year, _______________ hour precipitation: _______________ inches
C. Volume of runoff from the 100-year, _______________ hour storm: _______________ acre-feet
D. Peak runoff from the 100-year, _______________ hour storm: ______________ cubic feet/second
E. Probable maximum precipitation (PMP), _______________ hour storm: ______________ inches
F. Volume of runoff from the PMP, _______________ hour storm: _______________ acre-feet
G. Peak runoff from the PMP, _______________ hour storm: ______________ cubic feet/second
H. Peak runoff of the Spillway Design Flood (SDF): _______________ cubic feet/second
I. SDF is _______________ % of the PMF
NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT
TO CONSTRUCT AND OPERATE A DAM

6. PROPERTIES OF DAM AND RESERVOIR:
   A. Length of dam: _______________ feet;
   B. Crest width (or thickness): _______________ feet;
   C. Base thickness: _______________ feet;
   D. Height of dam: _______________ feet;
   E. Structural height: _______________ feet;
   F. Elevation of the crest of dam: _______________ feet;
   G. Slope of upstream face: _______________ horizontal to 1 vertical;
   H. Slope of downstream face: _______________ horizontal to 1 vertical;
   I. Volume of dam: _______________ cubic yards;
   J. Type of dam: __________________________________________________________________;
   K. Dead storage capacity: _______________ acre-feet;
   L. Reservoir storage capacity: _______________ acre-feet;
   M. Maximum storage capacity: _______________ acre-feet;
   N. Design water level elevation: _______________ feet;
   O. Reservoir surface area at reservoir storage capacity: _______________ acres
   P. Stage/Area/Storage capacity (to the crest of dam):

<table>
<thead>
<tr>
<th>Elevation or depth above outlet (Feet)</th>
<th>Area of Water Surface, (Acres)</th>
<th>Storage Capacity (Acre Feet)</th>
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7. PROPERTIES OF OUTLET CONDUIT:
   A. Outlet conduit is: __________________________________________________________________ (give size and material);
   B. Length of conduit: _______________ feet;
   C. Slope of conduit: _______________ percent
   D. Manning coefficient: _______________ ;
   Q. Maximum discharge capacity (at crest of dam): _______________ cfs;
   R. Elevation of upstream end of the invert of the outlet conduit: _______________ feet;
   S. Size, Type and Number of Gates: __________________________________________________________________;
   T. Time to empty the reservoir: _______________ hours or _______________ days.
NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT
TO CONSTRUCT AND OPERATE A DAM

8. PROPERTIES OF SPILLWAY:
   A. Spillway is: ____________________________ (give type and material);
   B. Location: ________________________________;
   C. Discharge coefficients:__________________________ (dependent on type);
   D. Effective length: _______________ feet;
   E. Discharge capacity (at design water level): _______________ cfs;
   F. Maximum discharge capacity (at top of dam): _______________ cfs;
   G. Spillway crest elevation: _______________ feet;
   H. Freeboard _______________ feet;

9. ADDITIONAL STATEMENTS OR EXPLANATIONS:
   ____________________________________________________________________
   ____________________________________________________________________
   ____________________________________________________________________

10. ESTIMATED COST:
    Dam and appurtenances...$ ____________________
    Other Constructed works...........$ ____________________
    Total Cost........................$ ____________________

11. CONSTRUCTION DATES:
    ESTIMATED DATE TO BEGIN CONSTRUCTION: ________________
    ESTIMATED DATE TO COMPLETE CONSTRUCTION: ________________

12. Dam will be constructed under the supervision of: ________________________________
    (License No.)

13. ACKNOWLEDGEMENT FOR DAM OWNER
I,_____________________________ affirm that the foregoing statements are true to the best of my
    (Please Print)
knowledge and belief. I fully understand the responsibility and liability related to dam ownership.

By: ______________________________________________________________
    (Signature) (Date)

Subscribed and sworn to before me this ______ day of __________________, 20___.

__________________________________
Notary Public

My commission expires ________________________(SEAL)
NEW MEXICO OFFICE OF THE STATE ENGINEER
APPLICATION FOR PERMIT
TO CONSTRUCT AND OPERATE A DAM

ACTION OF STATE ENGINEER

This application to construct and operate a dam is approved provided it is not exercised to the detriment of any others having prior, valid and existing rights to the use of waters of this stream system or groundwater basin and further provided that:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

Witness my hand and seal this __________ day of ____________________, 20___.

State Engineer

By: __________________________

INSTRUCTIONS

This form shall be filed in triplicate, with original signatures on each form and accompanied by plans, specifications, design report, etc. and filing fee of $10.00 for the application and plan review fee of $2.00 per $1000 of construction cost for dam and appurtenances.

File Number and National ID Number provided by Office of the State Engineer. Refer to the Dam Safety Design and Operation Criteria for definitions and choices.

Section 1 Fill in the blanks.
Section 2 Fill in the blank. See Glossary of Terms - Purpose.
Section 3 Fill in the blank. See Table 1.
Section 4 Information for Parts A through E required.
Section 5 Low Hazard Potential Dams fill in Parts A through D and I. Significant and High Hazard Potential Dams fill in Parts A and E through I.
Section 6 Fill in all blanks. See Glossary of Terms.
Section 7 Fill in all blanks. Flood Control Dams fill in hours. Storage Dams fill in days.
Section 8 Fill in all blanks. See Glossary of Terms.
Section 9 Fill in if necessary.
Section 10 Fill in the blank. A detailed estimate is required with the submittal.
Section 11 Fill in the blanks.
Section 12 Fill in the blank. Qualifications of the N.M. Professional Engineer with experience in dam construction are required.
Section 13 Dam Owner's Signature and Notary Public seal are required.
NEW MEXICO OFFICE OF THE STATE ENGINEER
CHANGE OF OWNERSHIP OF A DAM

1. OWNER OF RECORD
Name: ______________________________________ Work Phone: _________________
Title: ________________________________________ Home Phone: _________________
Address: ____________________________________________________________________
                                                                                       
City: _______________________________ State: _______ Zip: __________

NEW OWNER
Name: ______________________________________ Work Phone: _________________
Title: ________________________________________ Home Phone: _________________
Address: ____________________________________________________________________
                                                                                       
City: _______________________________ State: _______ Zip: __________

2. OWNER CERTIFICATION
State of _______________________  )
County of ______________________  ) ss.
I, _______________________________________________ being first duly sworn, upon my oath,
state that I am the owner of __________________________ Dam and I recognize
that this Dam is under the jurisdiction of the State Engineer; I recognize the responsibility and
liability of dam ownership; and all that is shown hereon is done with my free consent and in
accordance with my wishes and state that the same are true to the best of my knowledge and
belief.

__________________________________
Owner

Subscribed and sworn to before me this _______ day of __________________, 200__.

_____________________.
Notary Public

My commission expires ______________________)(SEAL)

3. ACTION OF STATE ENGINEER
This Change of Ownership form is hereby accepted for filing. The acceptance by the State Engineer
Office does not constitute validations of the right conveyed.
NEW MEXICO OFFICE OF THE STATE ENGINEER
CHANGE OF OWNERSHIP OF A DAM
FOR CORPORATIONS OR POLITICAL SUBDIVISIONS

1. OWNER OF RECORD
Name: ______________________________________ Work Phone: ____________
Title: _____________________________________ Home Phone: ____________
Address: __________________________________________________________
____________________________________________________________________
City: _______________________________ State: ________ Zip: __________

NEW OWNER
Name: ______________________________________ Work Phone: ____________
Title: _____________________________________ Home Phone: ____________
Address: __________________________________________________________
____________________________________________________________________
City: _______________________________ State: ________ Zip: __________

2. OWNER CERTIFICATION
State of _______________________  )
 ) ss.
County of ______________________  )
I, _________________, being first duly sworn, upon my oath, state that I am the
____________(Officer) of the ____________________, a _______________ (corporation or
political subdivision) duly organized under the laws of the State of ____________________, that
the ____________________, (corporation name or political subdivision name) is the owner of
____________________ Dam, and that, in their behalf, I recognize that this Dam is under the
jurisdiction of the State Engineer; I recognize the responsibility and liability of dam ownership;
and all that is shown hereon is done with their free consent and in accordance with their wishes
and state that the same are true to the best of my knowledge and belief.
__________________________________
Representative, Title

Subscribed and sworn to before me this _______ day of __________________, 200__.
________________________________
Notary Public
My commission expires ____________________________(SEAL)

3. ACTION OF STATE ENGINEER
This Change of Ownership form is hereby accepted for filing. The acceptance by the State Engineer
Office does not constitute validations of the right conveyed.
NEW MEXICO OFFICE OF THE STATE ENGINEER
PROOF OF COMPLETION OF WORKS
(SURFACE WATERS)

1. PERMITTEE
   Name: _________________________________________  Work Phone: ____________
   Contact: _________________________________________  Home Phone: ____________
   Address: _________________________________________
   _____________________________________________
   City: _________________________________________ State: __ Zip: __________

2. POINT OF DIVERSION (A, B, C, or D required, E or F if known)
   A. ____1/4  ____1/4  ____1/4 Section:____ Township:____ Range:____ N.M.P.M.
      in ______________________________________________________________ County.
   B. X = _______________ feet, Y = _________________ feet, N.M. Coordinate System
      __________________ Zone in the ___________________________________________ Grant.
      U.S.G.S. Quad Map _____________
   C. Latitude: ______d _____m _________s  Longitude: ______d _____m _________s
   D. East __________ (m), North __________ (m), UTM Zone 13, NAD __ (27 or 83)
   E. Tract No. _____, Map No. _____ of the ________________ Hydrographic Survey
   F. Lot No. _____, Block No. _____ of Unit/Tract _____________________ of the
      ___________________ Subdivision recorded in ____________________ County.
   G. Other: __________________________________________________________________
   H. Give State Engineer File Number if existing well:  ______________________
   I. On land owned by (required): __________________________________________
   J. Source of surface water supply:
      a. Name of ditch, acequia, or spring: ___________________________________
      b. Stream or water course: _____________________________________________
      c. Tributary of: ______________________________________________________

3. CONSTRUCTED WORKS CONSIST OF:
   (Enumerate Diversion dams, main canals, headgates, pipelines, flumes,
   reservoirs, laterals, etc.)_________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________

File Number: _______________                       Trn Number: _______________
NEW MEXICO OFFICE OF THE STATE ENGINEER
PROOF OF COMPLETION OF WORKS
(SURFACE WATERS)

4. DIVERSION DAM (if applicable)

The diversion dam is constructed of ________________________________;
Crest length ________ feet; Crest width ________ feet;
Height above stream bed ________ feet; Depth below stream bed ________ feet;
Side slopes of ________ horizontal to 1 (one) vertical on upstream face
And ________ horizontal to 1 (one) vertical on downstream face;
And contains about ________ cubic yards of material.

5. HYDRAULIC PROPERTIES OF MAIN CANAL OR PIPELINE (if applicable)

Name of ditch ____________________________________________________________;
Bottom width ________ feet;
Depth of water at full operating capacity ________ feet;
Side slopes ________ horizontal to 1 (one) vertical;
Diameter (pipe line or circular flume) ________ feet;
Type of pipe line ________________________________;
Slope ________ feet per 1000 feet; Capacity ________ cubic feet per second;
Length of canal or pipeline ________ feet.

6. HYDRAULIC PROPERTIES - STORAGE DAM (if applicable)

Maximum storage capacity ________ acre feet;
Maximum height above downstream toe ________ feet; length of crest ________ feet;
Maximum width at base ________ feet; Crest width ________ feet;
Slope of upstream face ________ horizontal to 1 (one) vertical;
Slope of downstream face ________ horizontal to 1 (one) vertical;
Elevation of crest of dam ________ feet; Elevation of spillway crest ________ feet;
Elevation of flow line of outlet conduit ________ feet;
Freeboard (above high water line at maximum spill) ________ feet;
Width of spillway ________ feet;
Discharge capacity of spillway ________ cubic feet per second;
Location of spillway: ________________________________;
Cross-sectional area at maximum flow: ________ square feet;
Size and character of outlet conduit ________________________________;
______________________________;
Type of dam, construction material, etc. ________________________________;
______________________________;
______________________________;
______________________________;

<table>
<thead>
<tr>
<th>Elevation or (feet)</th>
<th>Area of Water Surface, (Acres)</th>
<th>Storage Capacity (Acre Feet)</th>
<th>Remarks</th>
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</table>

File Number: _______________ Trm Number: _______________
NEW MEXICO OFFICE OF THE STATE ENGINEER
PROOF OF COMPLETION OF WORKS
(SURFACE WATERS)

7. CONSTRUCTION OF WORKS WAS COMPLETED: ____________
   (mm/dd/year)

8. ADDITIONAL STATEMENTS OR EXPLANATIONS:

____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

ENGINEER’S CERTIFICATE

State of New Mexico
County of ______________________________

I,_________________________ state that I am a qualified registered professional engineer, that I have
inspected the works as above set forth and find them to be completed in accordance with the foregoing
statement of facts; that they are properly and safely constructed and are now in a satisfactory condition
for acceptance.

(Engineer’s Seal)

Signed: _______________________________
License No.: _______________________________

ACKNOWLEDGEMENT FOR NATURAL PERSONS

(I, We) __________________________________________ affirm that the
foregoing statements are true to the best of (my, our) knowledge and belief.

Permittee Signature

Permittee Signature

File Number: _______________ Trn Number: _______________
APPENDIX C

SUBMITTAL REQUIREMENTS FOR AN APPLICATION TO CONSTRUCT AND OPERATE A DAM
## Office of the State Engineer
### Engineering Review Project Check List
#### I. Design Report

<table>
<thead>
<tr>
<th>Applicant:</th>
<th>File No.:</th>
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<table>
<thead>
<tr>
<th>I. Design Report</th>
<th>YES</th>
<th>NO</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Design Report is stamped and signed by a NM Professional Engineer</td>
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</tbody>
</table>

### Hydrologic

2. Hazard Classification including justification and supporting documentation

3. Drainage Area tributary to a proposed reservoir

4. Hydrologic Calculations, summary table, discussion of input parameters & assumptions

5. Inflow and Outflow Hydrographs

6. Hydraulic calculations including engineering data used to determine the capacities of the spillways and outlet conduits, stage/discharge

7. Stage/Storage Curve or Table

8. Flood control dam ungated and drains within 96 hours

### Geotechnical

9. Geologic Investigation of dam site and reservoir basin

10. Boring logs, geologic cross-sections, location and logs of test pits

11. Laboratory testing and analysis of data

12. Seepage Analysis

13. Stability Analysis both static and dynamic, input and output listings, name of computer model

14. Internal drainage design including instrumentation to monitor the drainage system, filter design to protect against piping

15. Foundation treatment and abutment contact design

16. Dam Geometry and Freeboard

### Other Design Elements

17. Erosion control

18. Instrumentation

19. Designer’s Operating Criteria

20. Operation and Maintenance Manual

21. Emergency Action Plan (required for high and significant hazard dams)

---

Signature: ___________________________  Date: ____________________
### Office of the State Engineer
### Engineering Project Review Checklist

#### II. Construction Drawings

<table>
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<th>YES</th>
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<tbody>
<tr>
<td>1. Map Quality, Scale and Size (Mylar sheets 24&quot;x36&quot; with one inch margins on all sides)</td>
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<td>2. Filing sheet separate from detail sheets.</td>
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<tr>
<td>3. Title (Filing) sheet, Map title and statements shown on the filing sheet</td>
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<td>4. Engineer’s Certification and Engineer’s stamp or seal on the filing sheet</td>
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<td>5. Owner’s Certification including acknowledgement by a Notary Public</td>
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<tr>
<td>6. State Engineer’s Certificate</td>
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<tr>
<td>7. Vicinity Map</td>
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<td>8. Direction of North</td>
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<tr>
<td>9. Site Topography of the dam site including sufficient area up and downstream and at the abutments</td>
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<tr>
<td>10. Flood and Maintenance Right of Way Map showing all ROW easements</td>
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<td>11. Reservoir Area – Capacity Curve or Table</td>
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<tr>
<td>12. Outlet Conduit and Spillway Rating Curve or table showing elevation vs. Discharge capacity</td>
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<tr>
<td>13. Geologic information with Profile</td>
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<tr>
<td>14. Dam Profile along the centerline showing the existing ground, foundation profile and proposed finished grade elevations</td>
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<tr>
<td>15. Dam Sections a sufficient number of cross-sections and the maximum section and along the outlet works</td>
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<td>16. Outlet Works plan, profile and details of the outlet works including intake structure, gate system conduit details, trashrack, filter diaphragm, concrete encasement details and downstream outlet structure, minimum size of 18&quot;</td>
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<td>17. Spillway plan, profile, control section and cross-sections.</td>
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<td>18. Permanent Bench Mark above high water line</td>
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<td>19. Outlet works tied to public survey corner</td>
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**Signature:** ___________________________  **Date:** ______________
## III. Specifications

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<tr>
<td>1. Engineer’s Certification and Seal</td>
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<tr>
<td>2. State Engineer’s Certificate</td>
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<td>3. Statement Recognizing State Engineer’s Authority</td>
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<td>4. Earthwork Specification includes all material descriptions, placement criteria, and construction requirements.</td>
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<tr>
<td>5. Foundation Specification includes depths, acceptable material criteria, cleaning, and grouting requirements</td>
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<tr>
<td>6. Concrete, Grout and Shotcrete Specifications</td>
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<td>7. Quality Assurance/Quality Control</td>
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<td>8. Control of Stream During Construction</td>
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<tr>
<td>9. Blasting, Dust Control or Other Environmental Protection Requirements</td>
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## IV. Other

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<tr>
<td>10. Cost Estimate</td>
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<tr>
<td>11. Completed Application for Permit in triplicate with original signature by owner</td>
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<tr>
<td>12. Filing Fee and plan review Fees</td>
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</tbody>
</table>

Signature: ___________________________  Date: ___________________________
OPERATION AND MAINTENANCE MANUAL

For

___________________________ Dam

State ID Number __________
National ID Number __________
Date ___________

Owner/Operator: _____________________________________________
Address: ____________________________________________________
Phone No.: __________________________________________________

1st Revision: _________________
2nd Revision: _________________
3rd Revision: _________________
CERTIFICATIONS

Owner Certification

The O&M Manual and each revision shall include the following owner certification:

State of _______________________ )
) ss.
County of ______________________ )

I, _______________________, being first duly sworn, upon my oath, state that I have read and examined the Operation and Maintenance Manual and know the contents thereof and representations thereon, and all that is shown hereon is done with my free consent and in accordance with my wishes and state that the same are true to the best of my knowledge and belief.

__________________________________
Owner

Subscribed and sworn to before me this _____ day of ________________ , 20__.

__________________________
Notary Public

My commission expires _____________________ (SEAL)

If a claimant is a corporation, political subdivision or other governmental entity the following shall be used:

State of _______________________ )
) ss.
County of ______________________ )

I,___________________________ , being first duly sworn, upon my oath, state that I am the _______________ (officer) of the __________________________, a corporation duly organized under the laws of the State of ____________________, that the accompanying Operation and Maintenance Manual was made under authority of the Board of Directors of said Corporation, and that, in their behalf, I have read and examined the statements and representations thereon and all that is shown hereon is done with their free consent and in accordance with their wishes and state that the same are true to the best of my knowledge and belief.
Representative, Title

Subscribed and sworn to before me this ___day of ____________ , 20___.

___________________________
Notary Public

My commission expires ____________________ (SEAL)

Engineer Certification

The O&M Manual and each revision shall include the following engineer certification:

State of _______________________  )
County of _______________________  ) ss.

I , _____________________, hereby certify that I am a registered professional engineer, qualified in ____________________ (civil, geotechnical, etc.) engineering and that the accompanying Operation and Maintenance Manual was prepared by me or under my direction, and that the same are true and correct to the best of my knowledge and belief.

_______________________________
Registered Professional Engineer

License Number ________________

Date Submitted ________________ Certification shall be stamped.

State Engineer Certification

The O&M Manual and each revision shall include the following State Engineer certification:

State of New Mexico        )
County of Santa Fe        ) ss.
I hereby certify that the accompanying Operation and Maintenance Manual has been duly examined by me and accepted for filing on the _____ day of________________, 20__.

________________________________
State Engineer
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<td>Inspection Checklists</td>
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GENERAL INFORMATION

Purpose of the Dam and Reservoir

Explain the purpose of the dam and reservoir. For projects with more than one purpose, the primary purpose is listed with secondary purposes listed in order of importance.

Location and Access to the Dam

Provide a description of the stream on which the dam is located, the name of the county the dam is located in and the distance to the nearest town. Provide traveling directions to the site during both normal and flood conditions. A location map shall be included.

Project History

Provide a brief description of the history of the dam and reservoir including design engineer, construction engineer, contractor, original construction period and dates of modifications or major repairs. Describe State Engineer Orders or directives concerning the dam and the performance of the dam during any significant event such as flooding or earthquake.

Assignment of Responsibilities

Identify all areas of responsibility for the project and the specific personnel responsible for completing each assignment. This section shall also identify a Professional Engineer licensed in New Mexico that is available to advise the owner as needed.

Areas of responsibility shall at a minimum include the following:

- Overall safety of the dam
- Operation of equipment
- Maintenance
- Collecting and Recording Instrumentation Data
- Evaluation of Instrumentation Data
- Submittal to State Engineer
- Engineer (Include Firm, address and phone number)
Description of the Dam and Appurtenances

All major project features shall be identified and the data shall be provided in tabular form. The following information shall be furnished if applicable:

**Dam**
- Type
- Height
- Crest Elevation
- Crest Length
- Crest Width
- Upstream Slope (H:V)
- Downstream Slope (H:V)

**Reservoir**
- Drainage Area
- Capacity at Spillway Crest (Provide separate tabulation for each spillway)
- Surface Area at Spillway Crest
- Maximum Elevation of SDF
- Dead Storage Capacity
- Dead Storage Elevation
- Reservoir Gage
- Sediment in Storage (if known)
- Sediment Storage Rate (if known)
- Date of most recent last area-capacity survey (if none, use original date)

**Spillway** (Provide separate tabulation for each spillway)
- Type (Include description of gates or other controls if applicable)
- Location
- Crest elevation
- Effective Length
- Discharge Capacity
- Maximum Discharge at SDF

**Outlet Works**
- Location
- Type of Intake
- Conduit size and material
- Invert Elevation
- Flow Controls (Size, type and location of gates)
- Type of Terminal Structure and Energy Dissipation Device
- Reservoir gage type(s)
PROJECT OPERATION

Reservoir Operation

A Reservoir Operation Section provides instruction to dam operators for both normal and emergency operations. An operating log shall be maintained to indicate the dates and times of operations (beginning and ending), adjustments, problems encountered and other data or observations as may be needed for the particular dam.

The first step in developing a reservoir operation plan is to determine and define what constitutes both normal operations and emergency operations, then procedures are developed for both situations. Procedures for both situations shall include the following minimum elements:

- Schedule of reservoir filling including maximum and minimum rates
- Release procedures (can vary with the season) including maximum and minimum rates
- Maximum storage level and drawdown limits
- Reservoir capacity allocations

Control Mechanisms and Other Equipment

The Control Mechanisms and Other Equipment Section provides equipment-operating instructions for all mechanisms associated with the dam and appurtenances. Step-by-step instructions for seasonal start up and shut down shall be included. Details on the correct method to open and close gates, proper sequence and gate usage shall be identified. Instructions for operating all equipment associated with the dam shall be included. This section shall also contain manufacturer-furnished operating and maintenance instructions, test procedures, shop drawings, catalog cut sheets, parts lists and replacement part sources.
INSTRUMENTATION AND MONITORING

Instrumentation at a dam provides critical data to evaluate the performance of the dam and identify potential problems. Dams with an Instrumentation Plan prepared during the design phase shall incorporate the recommendations in the instrumentation plan or provide justification why recommendations are not feasible. Minimum elements of the Instrumentation and Monitoring Plan are as follows:

- General description of instrumentation and a map showing the location of each instrument.
- Specifics for each installation
  - Purpose
  - Detailed description
  - Installations, repair and replacement procedures
  - Reading instructions
  - Maintenance instructions and schedule
  - Interpretation data including action thresholds and response measures up to and including implementing the EAP.
- Data submittal requirements to the State Engineer

MAINTENANCE

Preventive maintenance is necessary to ensure the dam will perform its intended function. Generally, the Maintenance Plan shall establish tasks, frequency and record keeping requirements. Typical tasks in a Maintenance Plan are as follows:

- Dam, Spillway, Reservoir and Outlet Channel
  - Woody vegetation control
  - Animal penetrations
  - Erosion
  - Concrete and metal protection
  - Unauthorized access
- Outlet Works
  - Exercise schedule
  - Lubrication routine for valves
  - Scheduled replacement of components
- Miscellaneous Maintenance Instructions
INSPECTION

Routine inspections by the dam owner are essential for timely identification of potential problems in order to maintain a safe dam. Minimum inspection frequency by the dam owner is monthly for water storage dams and after each large storm event but not less than every 3 months for flood control dams with no permanent pool. Site specific conditions may require a more frequent inspection schedule. Inspection forms shall be included in the Appendix.

Recommended inspection frequency of the interior of the outlet conduit by a Professional Engineer registered in New Mexico with experience in the operation of dams is every 5 years. Site-specific conditions may require a more frequent inspection schedule.

UPDATES AND REVISIONS

The O&M Manual shall be reviewed at least annually for updating needs. Generally, updates are required if there are changes of personnel, equipment or equipment operation, operation instructions, upstream or downstream conditions that require reservoir operation changes, contacts or procedures, or modification of the dam or its appurtenances. Revisions shall be submitted to the State Engineer for review and approval.
APPENDICES

The Appendices shall include any addition information needed to support the . The Designer’s Operating Criteria and Instrumentation Plan prepared during the design phase shall be included in the Appendices along with Inspection Checklists.

Designer’s Operating Criteria

The Designer’s Operating Criteria (DOC) is prepared by the design engineer to ensure the dam and appurtenances are operated within any restrictions imposed by the design. All new dams are required to submit a DOC concurrent with the submittal of an Application to Construct and Operate a Dam. The DOC is a critical element of an O&M Manual, and is required for dams having Significant and High Hazard Potential Classification.

It is recognized that some existing dams may not have a DOC. If a dam has no prior-existing DOC, this shall be clearly stated in the O&M Manual. Any modification of the dam, mechanical equipment or appurtenances requiring approval from the State Engineer shall require the development of a DOC for the modification, including effects or limits that the modification may impose on existing structures or mechanical equipment that remain in service.

The DOC for a proposed dam shall be submitted concurrently with the Application to Construct and Operate a Dam. Each DOC shall be developed specifically to address the actual facility and conditions for operation. The following outline for the DOC is provided for general guidance.
I. General Description

II. Dam Properties

III. Reservoir
   A. Storage Allocations
   B. Design Flood and Flood Routings
   C. Emergency Reservoir Evacuation
   D. First Filling Criteria/Monitoring Requirements

IV. Outlet Works
   A. General
   B. Procedures for Operation of Outlet Works
      1. First Operation
      2. Seasonal Startup
      3. Seasonal Shutdown
      4. Installation and Removal of Bulkhead
      5. Operation of Specific Equipment (including purpose, manufacturer, materials of construction, special operating instructions, etc.)
      6. Electrical Systems and Controls

V. Spillway
   A. General
   B. Overall Plan of Operation
   C. Maintenance

VI. Instrumentation
   A. General
   B. Purpose
   C. Critical Readings
   D. Reading and Maintenance Procedures
   E. Reading Schedule

VII. Reference List

Appendices (as required)
**Instrumentation Plan**

An Instrumentation Plan provides a means to obtain data necessary to evaluate the performance of a dam. Generally, the dam design shall incorporate sufficient instrumentation to monitor horizontal and vertical movement of the dam and significant structures, seepage, and reservoir stage. Other instruments, such as piezometers, inclinometers, extensometers, strain gages, plumb lines, tape gages, crack measurement devices, flow gages and seismographs, may be required, depending upon the purpose and design of the specific dam and appurtenant structures.

Frequently, conditions at an existing dam will require installation of new instrumentation or replacement of existing instrumentation. In these cases, an amendment to the instrumentation plan shall be developed, incorporating all new instrumentation as well as any existing instrumentation that remains in service. The O&M Manual shall be updated to reflect the amended instrumentation plan.

The Instrumentation Plan shall: (1) include drawings showing the location of dam monitoring instruments; (2) provide specific information for each type of instrument; (3) establish instrumentation reading procedures and schedules for normal and emergency conditions, (4) provide descriptions of expected performance, and (5) provide instructions for dam operators in the case of a reading or readings that vary from expected performance.

Elements of the instrumentation plan shall be as follows:

- General Description of Instrumentation and Reading Schedule
- Identification of Unexpected Data
- Specifics for Each Installation
  - Detailed Description of Installations
  - Purpose
  - Reading and Maintenance Schedule Instructions
- Special Instrumentation/Monitoring Requirements
Inspection Checklists

Inspection Checklists tailored specifically to the dam are important for documenting observations. The owner for the life of the dam shall retain copies of the inspection checklists.
APPENDIX E

STANDARDIZED FORMAT AND TEXT
FOR AN EMERGENCY ACTION PLAN
EMERGENCY ACTION PLAN

For

_________________________ Dam

State ID Number ____________

National ID Number __________

Owner/Operator: __________________________

Address: ________________________________

Prepared By: ____________________________ License No.: ____________

Address: ________________________________

Date: ____________________________ (Stamp or Seal)

APPROVALS

State Office of Emergency Management Date

_________________________

County Office of Emergency Management Date

_________________________

State Engineer Date

* (The dam owner/operator is responsible for the annual review and updating of the EAP)

1st Revision: ____________________________

2nd Revision: ____________________________

3rd Revision: ____________________________
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## III. Project Description
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## IV. Emergency Detection, Evaluation, and Classification
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## V. General Responsibilities Under the EAP
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   Approval
   Distribution
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I. Notification Flowchart

((Insert Notification flowchart))
Notification Information

Dam emergency information for the emergency classifications

Name of person reporting the emergency: ________________________________

Affiliation: __________________________________________________________

Phone Number: _______________________________________________________

Name & State ID number of dam: _______________________________________

Location of dam

County: __________________________

Municipality: ______________________

Stream: __________________________

Road(s): __________________________

Time and date of dam emergency: ________________________________

Type of Emergency: ________________________________________________

Phone and appropriate parties: (refer to the Emergency Notifications Flow Chart)

“This is (your name, title & affiliation).
There is a dam (Advisory, Warning, Emergency, or Breach) condition at (name of dam).
Observation was at (time).
The situation is (explain the condition).
What is your anticipated time of arrival at the dam and what are my instructions?”
(Refer to Site Description, page X, for directions to the dam)

Communication priority list:

1. Municipal Office of Emergency Management
2. County Office of Emergency Management
4. State Dam Safety Agency
5. Owner’s Engineer
II. Statement of Purpose

Purpose

This plan defines responsibilities and provides procedures designed to identify unusual and unlikely conditions, which may endanger ______________ Dam in time to take mitigative action and to notify the appropriate emergency management officials of possible, impending, or actual failure of the dam. The plan may also be used to provide notification when flood releases will create major flooding.

Scope

This Emergency Action Plan:

1. Establishes a monitoring system, which can activate the Plan.
2. Identifies the officials, organizations, agencies, and their respective responsibilities for implementing the plan.
3. Identifies those areas, residences, facilities and roads, which might be affected by a dam failure.
III. Project Description

Project Site Description

Dam Name: ______________________ Hazard Potential Classification: ________________

State ID No.: ______________________ National ID No.: ______________________

City/Town: ______________________ County: ______________________

Location & Access (provide a location map & directions to the dam from a major highway):

____________________________________________________________________________

____________________________________________________________________________

Latitude: ______________________ Longitude: ______________________

River/Stream: ______________________

Quad sheet: ______________________ Nearest City/Town: ______________________

Height (ft): ______________________ Normal Surface (ac): ______________________

Length (ft): ______________________ Normal Capacity (ac-ft): ______________________

Dam Type: ______________________ Maximum Capacity (ac-ft): ______________________

Spillway: ______________________ Spillway Capacity (cfs): ______________________

Drainage Area: ______________________

Outlet other than Spillway: ______________________

Instrumentation (if any): ______________________

Significant Upstream or Downstream Dams (if any): ______________________

Overview of Inundation Area: ______________________

______________________________

Method of Emergency Drawdown: ______________________
Project Site Drawings

*Provide/Attach project Site drawings
IV. Emergency Detection, Evaluation, and Classification

This section should discuss the procedures for timely and reliable detection, evaluation and classification of an existing or potential emergency condition. Preventative action shall be addressed for each condition. Suggested emergency classifications are:

- Failure is imminent or has occurred
- Potential failure situation is developing
- Non-failure emergency condition
V. General Responsibilities Under the EAP

Dam Owner/Operator Responsibilities:

1. Identification of the emergency condition.

Person responsible for the notification: ____________________________

3. Implementation and direction of emergency repairs.
4. Update the emergency status to the State Office of Emergency Management and Office of the State Engineer Dam Safety Bureau.

Person responsible for the updates: ____________________________

5. Provisions for security measures at the dam.
6. Provision of technical assistance to State Office of Emergency Management officials, when necessary.
7. Reporting termination of emergency situation on-site at the dam.

In non-emergency conditions, owner/operator must also provide for:

8. Routine maintenance and operations of the dam.
9. Routine surveillance of the dam.
10. Routine inspection of the dam.
11. Annual review, updating, and distribution of the EAP.

Owner/Operator’s EAP Coordinator Responsibility:

Once the dam owner/operator has designated an EAP Coordinator, that person shall be responsible for EAP related activities including:

1. Inclusion and distribution of document revisions.
2. Establish training seminars.
3. Coordinate EAP exercises.
4. Contact person for any EAP related inquiries.

EAP Coordinator Name: ____________________________
Phone Number: ____________________________
Municipal Office of Emergency Management Responsibilities:

1. Warn the public of emergency conditions at the dam.
2. Implement and direct required evacuations of threatened areas.
3. Establish reception centers for evacuated people.
4. Secure and control access to evacuated areas.
5. Conduct rescue and recovery operations as required.
6. Determination and declaration of termination of an emergency/disaster response activity off-site.

County Office of Emergency Management Responsibilities:

1. Pass warning of emergency conditions at the dam to all affected municipalities.
2. Provide assistance to municipalities to help fulfill the emergency responsibilities.

State Office of Emergency Management Responsibilities:

1. Assumption of control and coordination (when appropriate) of all emergency actions in accordance with state statutes.
2. Provision of assistance to the affected municipalities and counties (when requested and beyond their capabilities).
3. Coordination of specialized assistance.
4. Notification of appropriate state agencies.
5. Notification of appropriate counties of any declared emergency condition.
6. Periodic testing of the emergency notification procedures.

Office of the State Engineer Dam Safety Bureau Responsibilities:

1. Provide technical assistance to the dam owner/operator.
2. Evaluation and acceptance of dambreak model and flood inundation map.
3. Assist in the evaluation and resolution of potential emergency conditions.
4. Has the authority to direct the owner/operator to take necessary safety measures.

Responsibility for Termination

The owner/operator is responsible for evaluating a declared emergency condition. The State Engineer is responsible for making the decision, when appropriate, that an emergency condition no longer exists on-site at the Dam. The State Office Of Emergency Management representatives are responsible for declaring termination of an emergency condition off-site. As such, it will be the responsibility of the owner/operator to notify the OEMs of an emergency condition termination promptly.

As part of the termination phase, the County/Municipal OEM will be responsible to conduct a critique of the overall emergency response and to prepare a report documenting emergency procedures and actions. The critique process will be a
discussion of the events that occurred prior to, during, and after a dam emergency. Participants review and evaluate their particular actions. The purpose of the critique is to determine what, if any, practicable improvements could be made for potential future emergencies, and conversely to identify deficiencies in procedures, manpower, materials and equipment.

**Responsibility for Recovery**

The basic goal of the recovery phase is to demobilize and return to the pre-emergency situation. The owner/operator is responsible for implementing all actions necessary to achieve this goal on-site at the dam. The State Office of Emergency Management has the responsibility to effectuate recovery off-site in the affected communities.

The owner/operator is responsible for directing all on-site recovery activities. The basic recovery actions common to the dam emergency classifications are:
- Secure access to emergency site,
- Restore basic facilities and services, and
- Assess damage.
## VI. Preparedness

**Emergency Notification Directory**

1. **Dam Owner:**  
   - Contact Person:  
   - Address:  
   - Phone No.: ________________  24-Hr No: ________________

2. **Dam Operator:**  
   - Address:  
   - Phone No.: ________________  24-Hr No: ________________

3. **EAP Development Crew:**  
   - Coordinator:  
   - Phone No.: ________________

4. **Maintenance and Operations Crew:**  
   - Supervisor:  
   - Phone No.: ________________

5. **Inspectors:**  
   - Name: __________________________  Phone No: ________________  
   - Name: __________________________  Phone No: ________________  
   - Name: __________________________  Phone No: ________________
6. Owner’s Engineers: _____________________________________________
   Contact Person: _______________________________________________
   Address: _____________________________________________________
   Phone No.: _____________________________ 24-Hr No: _______________

7. Municipalities:
   Municipality: _______________ Phone No.: __________ Police No.: _____
   Municipality: _______________ Phone No.: __________ Police No.: _____

8. Counties:
   County: _________________ Phone No.: __________ Police No.: _____
   County: _________________ Phone No.: __________ Police No.: _____

9. State Agencies:
   Agency: _________________ Phone No.: __________ 24 Hr No.: ______
   Agency: _________________ Phone No.: __________ 24 Hr No.: ______

Emergency Operation Center (Should be located upstream of the dam)

Address: _______________________________________________________________________

________________________________________________________________________________

Direction to the Emergency Operations Center from the nearest State or County Highway:

________________________________________________________________________________

________________________________________________________________________________

*Include a location map of the Emergency Operations Center.
Emergency Operations Center Location Map
Surveillance Checklist

The surveillance checklist must be specific to the site conditions of the dam and shall be approved by the State Engineer.

The surveillance checklist should be utilized by the Inspectors listed on the Emergency Notification Directory during their inspections. A record of these inspections and their findings should be kept by the owner/operator for ready reference.

Routine inspection intervals should be specified and individuals responsible for the inspection identified.

Access to the Site

A narrative description of primary and secondary access routes should be included. Attach map if necessary.

Response During Adverse Weather, Weekends, Darkness and Holidays

Supply a discussion of emergency response during periods other than office hours and during periods of adverse weather. Actions should be described in detail. The effects on response time should also be included.

Alternative Systems of Communication

Alternative channels of communication to be used in case of failure of the primary system or failure of other systems immediately available should be listed.

List of Contractors

It is the responsibility of the owner to maintain a current list of contractors that may be contacted during an emergency condition for equipment, materials, and repairs.

For each contractor on the list, the following must be provided:

1. Contractor:
   
   Contact Person: ___________________________ Phone No.: __________________
   Address: ________________________________
   Services contracted for: ____________________________
2. Contractor:

   Contact Person: ___________________________ Phone No.: __________________
   Address: ___________________________________________________________________

   Services contracted for: ___________________________________________________________________

### Available On-Site Materials

<table>
<thead>
<tr>
<th>Material</th>
<th>Location</th>
<th>Quantity</th>
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### Available On-Site Equipment

<table>
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<th>Equipment</th>
<th>Location</th>
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### Available Off-Site Materials

<table>
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<th>Company &amp; Location</th>
<th>Phone No.</th>
<th>Arrival Time to Dam (min.)</th>
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### Other Site Specific Actions

Describe any other site-specific actions devised to moderate or alleviate the extent of potential emergencies.
VII. Inundation Maps

Description of Inundated Area

Attach map that delineates area of inundation.

The official inundation map attached to the EAP should be, whenever possible, in foldout format, no larger than 11 inches by 17 inches, and provide the most accurate, up-to-date data available. As such, it may be necessary to reduce the map scale once the inundated areas are identified.
VIII. Appendices

Appendix A. Investigations and Analysis of Dambreak Floods

Input data, printouts, and survey information from the dam failure analysis should be included in this section.

Appendix B. Plans for Training, Exercising, Updating, & Posting

The owner of the dam is responsible for the training of personnel, and the exercising and updating of the EAP. The training plan and exercise schedule should be included in this section. The revision schedule and distribution of the EAP should also be discussed. The location of each copy of the EAP and notification flowchart, if posted separately, should be stated in this section.

Appendix C. Definitions

Appendix D. Site Specific Concerns

This section of the appendix should provide a discussion of any site-specific concerns that provide valuable information affecting the EAP. The EAP should emphasize where appropriate structural drawings and flood data are maintained on-site.

Appendix E. Approval and distribution of the EAP

Once the EAP has been developed and approved by local and state emergency officers, the owner/operator shall submit the completed EAP to the State Engineer for approval. Once the State Engineer approves the EAP, the owner must distribute the EAP to all individuals who will be involved during an emergency. Any revisions to the EAP should be furnished to all individuals to whom the original EAP was distributed.

Each party receiving an EAP must sign and return a receipt to the distributor (owner/operator) of the EAP. The signed receipt is to assure that all parties are aware of and understand the EAP and agree to their assigned roles should an emergency occur. A standard distribution letter and receipt is included for reference.

The document holder and location of each copy of the up-to-date EAP should be included in this section of the EAP.
Standard Distribution Letter & Receipt

(Date)

(Name of EAP document holder)
(Company or affiliation)
(Mailing address)

Re: EAP for (name of dam) Dam ID No.

Dear (Name of EAP holder):

(Name of the owner/operator) has (prepared or revised) the Emergency Action Plan for (name of the dam) Dam located within (name of township), (name of county). The EAP is a public safety regulatory required document. The (year) revisions are described in the REVISION SUMMARY.

Please insert the new material with the revision date in your controlled copy and remove the obsolete material (the effective dates generally are printed at the lower right corner of the pages). Please acknowledge your receipt of the controlled copy distribution by returning the obsolete pages to the undersigned with the attached acknowledgement, signed and dated.

We appreciate your continued cooperation in the revisions of the EAP. Should you have any recommendations or questions regarding the EAP, please do not hesitate to contact the undersigned.

Sincerely,

(Your Name)
(Affiliation)

I acknowledge receipt of the (revision date) revision to the (name of dam) EAP and have inserted the revision pages in my controlled copy. This EAP will be maintained at the designated location for use in the event of a drill or actual emergency declaration.

Controlled Document holder name: ___________________________ Document No. ______

Signature: ___________________________ Date: ___________________________
NEW MEXICO OFFICE OF THE STATE ENGINEER  
Dam Safety Bureau  
Hydrologic Analysis for Dams  
August 15, 2008

Hydrologic analysis requirements for dams are cited in the Rules and Regulations Governing Dam Design, Construction and Dam Safety, which were filed with the New Mexico State Record Center as Title 19, Chapter 25, Part 12 of the New Mexico Administrative Code (19.25.12 NMAC). Hydrologic analysis shall be performed in accordance with Subsection C of 19.25.12.11 NMAC. The design life of a dam is much longer than the record retention period of most engineering firms and memories of most design engineers. It is important that the analysis stand on its own in a manner that is comprehensible to future engineers who may be involved with the structure. Therefore, the Office of the State Engineer (OSE) requires that the hydrologic analysis be fully documented and supported independent of computer programs or other computational methodology used in the analysis.

Most dams are constructed on a watercourse or have a contributing drainage area upstream from the dam. Intense rainfall creates inflow to the reservoir of the dam, which is routed through the reservoir and allowed to pass the dam through a spillway or multiple spillways. Earlier dams typically were provided with spillways that were sized to pass the largest observed floods. These dams frequently overtopped and failed, and roughly half of all known dam failures have been the result of flood overtopping. During the 20th Century, methods were developed to better evaluate infrequent or extreme flood events, and provide adequate spillway capacity to safely pass these floods. Hydrologic analysis is one of the most important aspects in the design of a safe dam, and will be closely reviewed by the New Mexico Office of the State Engineer (OSE) Dam Safety Bureau.

Presented below is an outline of the typical steps for completing a hydrologic analysis satisfying the requirements outlined in Subsection C of 19.25.12.11 NMAC. In order to facilitate review by the OSE Dam Safety Bureau the hydrologic analysis report must be organized in an easy to follow layout and format. Submittals that are not consistent with this document and the requirements outlined in Subsection C of 19.25.12.11 NMAC will cause a delay in the review by the OSE Dam Safety Bureau and may be returned to the owner with no review provided. Inadequate hydrology submittals may also require review fees to be resubmitted prior to subsequent review by the OSE Dam Safety Bureau.

The following steps are typically required in completing hydrologic analysis for dams for submittal to New Mexico Office of the State Engineer:

1. Determine hazard potential classification for the dam location.
2. Determine appropriate design storm requirements for location.
3. Determine geographic location, limits and area of watershed contributing to dam and reservoir.
4. Divide watershed into subbasins as appropriate, and determine subbasin areas, channel locations for routing, etc.
5. Determine basin or subbasin geometry such as longest flow path for each basin or subbasin, channel slope and cross section, highest and lowest points, basin centroid(s), mean basin elevation, etc. as required for methodology to be used.
6. Determine appropriate timing and routing parameters for the elements in the watershed model.
7. Determine reservoir characteristics including stage-storage and stage-discharge relationships.
8. Develop total watershed model by arranging subbasins, routing reaches, etc. in the proper sequence with appropriate parameters.
9. Derive the precipitation to be used for design.
10. Develop incremental precipitation from depth-duration relationship and arrange increments to create an appropriate temporal distribution of precipitation.
11. Develop spatial distribution of precipitation if appropriate.
12. Determine loss parameters or functions and apply to incremental precipitation.
13. Deduct losses from precipitation increments to estimate precipitation excess.
14. Select an appropriate transform methodology for converting excess rainfall to runoff.
15. Apply the transform methodology to each subbasin using incremental precipitation excess.
16. Add stream base flow, etc., to obtain flood hydrograph for each subbasin.
17. Combine and/or route subbasin hydrographs to determine the inflow design flood.
18. Route flood through reservoir and spillway to obtain estimates of reservoir peak stage, peak outflow, peak storage, flood duration, etc.
19. Review results for reasonableness, comparing to known floods or otherwise calibrating if possible.
20. Adjust model parameters, spillway characteristics, etc. as necessary and appropriate and repeat process.
21. Prepare hydrologic analysis report for OSE review and for the permanent record.

Discussion:

The steps taken in the analysis, along with assumptions made and parameters used, must be fully documented. Documentation requirements are discussed in the final section of this paper. Discussion of each of the steps for performing hydrologic analysis is as follows:

**1. Hazard Potential Classification**

Hazard Potential Classification is a function of dam location and downstream conditions, and is not a measure of the integrity of the dam or the adequacy of the design. High hazard potential classification applies if loss of life is probable if the dam fails catastrophically. This is usually fairly obvious, based on downstream development conditions. In some cases, breach and flood wave analysis is needed to establish hazard potential classification. If site is not High hazard potential, in most cases it will be Significant, due to substantial risk to property or assets (highways, barns, irrigation ditches, etc.) or potential for significant environmental consequences. Low hazard potential is typically limited to remote, small structures such as ranch ponds for cattle watering and limited irrigation. Flood control dams typically are High or Significant hazard potential, because the need to control flooding suggests life and/or assets being protected downstream. Evaluations for Low or Significant hazard potential dams must consider the potential for future downstream development.
2. Design Precipitation Requirements
Generally, high hazard potential dams require consideration of Probable Maximum Precipitation (PMP). Significant hazard potential dams require consideration of 50% PMP if 100 feet or less in height and having 50,000 acre-feet or less storage, or 75% PMP if greater than 100 feet in height or having over 50,000 acre-feet of storage. For significant hazard potential dams, percentages are applied to precipitation prior to hydrologic analysis. Low hazard potential dams require consideration of 100-year storm, expressed as a percentage of PMP. Therefore, most dams will require evaluation of PMP. In some cases, waiver of evaluation of PMP will be entertained for low hazard potential dams with no realistic possibility for future hazard potential change.

In addition to precipitation requirements for spillway design, flood control dams must be able to drain from spillway crest or 100-year, 24-hour peak reservoir level within 96 hours. This implies determination of 100-year, 24-hour precipitation in most cases. For high and significant hazard potential flood control dams conforming to local flood control authority or NRCS requirements for 100-year, 24-hour flood routing, OSE will defer to these requirements for determination of compliance with the 96-hour rule.

3. Watershed Location, Limits, and Area
Watershed location, limits and area have traditionally been obtained from 7-1/2 minute USGS quad maps by tracing the divide, and then determining the area by planimeter or other measurement. For smaller drainages, a site topo map is sometimes used. Recent analyses frequently use ArcView or other GIS software in conjunction with DEM or DTM. Determination of precipitation will require geographic location (latitude and longitude) of the approximate basin centroid or a georeferenced perimeter at an appropriate scale. Methodology used must be described and supported as appropriate. Drainage area for existing dams must be independently verified rather than relying on area indicated on drawings or in design report, particularly for older dams. Precipitation depths may require adjustment based on watershed area. Average elevation of the watershed is needed for determination of Local Storm PMP.

4. Subdivision of Watershed
Logical subdivision can be made where topography or surface features and development are dissimilar. SCS methodology would suggest maximum subbasin size of about 20 square miles. USBR – Cudworth recommends 500 square miles maximum area per subbasin. Subbasin areas should be reasonably similar – for example, don’t combine 20 square mile and 0.5 square mile subbasins in the same model if you can help it. Avoid dividing into unnecessary subbasins, as this complicates the model and usually does not improve results. Particularly, avoid overdividing small basins, such as dividing 5 square miles into 20 subbasins. Subbasins should generally correspond with logical junction points and routing reaches.

5. Basin and Subbasin Geometry
Specific information required will depend on methodology used for timing parameters and runoff transform. Typical requirements might include length of longest watercourse, length to a point opposite the basin centroid, watercourse slope, average basin slope, estimated length of overland flow, length, slope, and cross-section of channel reaches, etc.
6. **Timing and Routing Parameters**

Typical parameters may include time of concentration, lag time, time-to-peak, time of travel, kinematic wave travel time, channel geometry and roughness, etc. depending on requirements of the transform methodology and channel routing used. To add to confusion, a parameter may be defined in different ways for different methodologies, even if the name is the same. The parameter(s) used must be appropriate for and compatible with transform methodology as defined within that methodology. Also, assumptions or limitations for the timing parameters must be consistent with the watershed being studied. These may include basin size or watershed length, channel condition (natural vs. improved or hardened), degree of development, etc. Method of determining timing and routing parameters must be indicated and justified as appropriate for location and transform methodology, with sample derivation and references.

7. **Reservoir Characteristics**

This may be developed as elevation-area or elevation-storage, depending on modeling requirements or input parameters for the method used. However, OSE Rules and Regulations require reservoir characteristics to be reported as elevation-storage table in one-foot intervals. Water storage reservoirs generally are assumed to be full to the point of uncontrolled discharge, e.g. spillway crest. Flood control dams with uncontrolled outlets and no permanent storage generally are assumed to be empty at the start of the modeling period.

8. **Watershed Model**

The basin and subbasin geometry and characteristics, routing reaches and parameters, reservoir characteristics, etc. are assembled to create the watershed model for the dam. It is useful to create a schematic or flow chart for the watershed model, particularly if software being used does not provide a graphical or schematic representation. A schematic or graphical representation of the model and tables of relevant model parameters will be required in the report submitted to OSE.

9. **Precipitation Derivation**

PMP east of the Continental Divide is derived using methodology of HMR 55A, PMP west of the Continental Divide is derived using HMR 49. Both HMR documents provide for 1) a Local Storm (thunderstorm), with 6 hours total duration, and 2) a General Storm, with 72 hours duration. Neither HMR includes procedures or allowances for durations less than the complete storm, such as a 1-hour thunderstorm or a 24-hour general storm. If a shorter duration is used, justification must be provided.

Concerning durations less than the complete storm, FEMA as quoted in City of Albuquerque Development Process Manual states, “FEMA’s position regarding the duration of rainfall is that the storm must extend for a period long enough to include all rainfall excess when the volume of the runoff hydrograph is an important consideration. This includes conditions when detention storage is involved, when sediment processes are a significant factor, and when combining and routing subbasin hydrographs to obtain watershed runoff. When the peak flow is the primary concern, and it is established that the use of a longer duration storm would not increase the peak flow, shorter duration storms are acceptable.” This would suggest that using the most intense 24 hours of the General Storm would only be appropriate if it can be shown that no excess
precipitation will occur outside of this period, or if it can be shown that the peak flow is not sensitive to storm volume if peak flow is the primary concern.

Both HMR documents require obtaining index precipitation from maps, and then adjusting precipitation depths for area, elevation, and orographic effects specific to the watershed being studied. The index precipitation depths are plotted against duration to develop a smooth depth-duration passing through the origin. Area adjustments typically are based on the total contributing area above the dam or other point of interest, rather than on individual subbasin areas. Since precipitation depth for PMP is adjusted for storm area during the derivation, no additional reductions should typically be taken during the hydrologic analysis.

The 1984 reprint of HMR 49 contains an Errata sheet following the title page. The entry for page 154 on this Errata sheet changes the basis for local storm elevation adjustments from the lowest elevation in the drainage to the mean elevation. This generally will result in greater reductions in precipitation depth for cases where the elevation adjustment applies. This change is not well documented anywhere else in the literature. Electronic versions of HMR 49 not containing this correction may still be available online.

Both Local and General Storm should be evaluated, unless clear evidence and justification can be provided showing that one storm or the other obviously controls. For example, in the Eastern portion of the New Mexico HMR 55A area, the 1- and 6-hour ordinates for the General Storm frequently are greater than the 1- and 6-hour ordinates of the Local Storm. Conversely, in certain locations of HMR 49 where the orographic component of General Storm precipitation is low, total storm volume for the General Storm can be less than the Local Storm. In most other cases, it is not sufficient to simply compare precipitation depths, since routing effects may result in greater spillway discharge from the General Storm, even though the Local Storm precipitation depths are greater at 1 and 6 hours.

Alternatives to HMR 49 and HMR 55A include site-specific analysis for PMP and Incremental Damage Assessment, either of which should be discussed first with OSE. In the future, an Extreme Precipitation Analysis Tool may be available for portions of the state, to provide an updated estimate of extreme precipitation.

Precipitation for frequency-based events, such as the 100-year storm, is obtained from NOAA Atlas 14, available online. Precipitation is obtained by latitude and longitude, and is point precipitation. The precipitation values from Atlas 14 are considered appropriate for storm areas of 10 square miles or less, and the full precipitation depth should be used for watersheds less than 10 square miles. For larger areas, an approved procedure for reducing precipitation based on area may be applied. The online documentation for Atlas 14 does not provide areal reduction factors specific to Atlas 14, but instead references three possible sources:


These methods will allow reductions for areas less than 10 square miles; however, Atlas 14 seems to recommend using the point precipitation values for 10 square miles or less. If areal reductions are made for drainage areas less than 10 square miles, justification must be provided. Areal reductions for frequency storms should be based on the total watershed contributing to the point of interest, and not on individual subbasin areas. For watersheds with total area exceeding the limits of the reduction method (400 square miles for NOAA Atlas 2/U.S. weather Bureau Technical Paper 40) the services of a qualified meteorologist may be necessary to determine appropriate reductions of point precipitation.

10. Precipitation Increments and Distribution

Precipitation increment size should generally correspond to the computational time step used, although this is not mandatory for many computer programs including HEC-HMS. Increments are obtained from the depth-duration curve by subdividing the curve by increment length and successively subtracting curve ordinates. For small, fast basins in particular it is important to use a sufficiently small increment size and computational time step to avoid under-prediction of peak runoff.

Once the increments have been determined, they must be arranged in an appropriate distribution. One of the most common arrangements sometimes called “center-peaking” or “balanced” distribution, places the largest increment at the center of the storm duration. The second largest increment is placed directly in front of the first, the third largest placed behind the first, and the procedure is continued with successively smaller increments until the distribution is filled. A similar distribution, favored by Bureau of Reclamation for 72-hour general storm PMP, can be termed “late-peaking.” This distribution places the largest increment at the 2/3 point of the storm, then places the second and third largest increment successively in front of the largest increment, then the fourth largest increment immediately behind the largest increment, then continuing the sequence with two increments in front, one behind until the distribution is filled and all increments are used. Either the center-peaking or late peaking distribution will be acceptable for 72-hour General Storm PMP.

Both HMR 49 and HMR 55A refer to two recommended distributions for the 6-hour Local Storm. One is obtained from HMR 5, and the other from the USACE EM1110-2-1411. The distributions are similar, with the USACE EM1110-2-1411 distribution peaking later in the storm. HMR 49 states, “In application, the choice of either of these distributions is left to the user since one may prove to be more critical in a specific case than the other.” This suggests that both methods should be evaluated and the more critical distribution should be used. In practice, the USACE EM1110-2-1411 appears to provide the higher peak discharge in the majority of cases. While not specifically discussed in either HMR 49 or HMR 55A, a center-peaking distribution of local storm PMP has been used in the past and is acceptable to OSE. In any case,
the distribution used must be justified as being appropriate for the specific drainage area being evaluated.

The center-peaking and late-peaking distributions described above are frequently approximated in HEC-HMS or HEC-1 using the Frequency Storm definition for precipitation. Using the Frequency Storm to distribute PMP can cause unintended consequences if one is not careful, and probably should be avoided by infrequent users. The Frequency Storm requires input of precipitation depths for durations corresponding to the frequency series of 5 min, 15 min, 1 hour, 2 hours, 3 hours, 6 hours, 24 hours, 48 hours, etc. The frequency series does not include a 72-hour duration, and so will not emulate the full General Storm PMP. The General Storm index values from HMR 55A do not include values for 5 min, 15 min, 2 hour, 3 hour, or 48 hour durations, and the index values from HMR 49 do not include 5 min, 15 min, 1, 2, or 3 hour values, requiring values to be interpolated or read from curve plots, introducing a possible source of error. The Frequency Storm method can result in unintended reductions of precipitation due to inappropriate use of Storm Area and Probability inputs in HEC-HMS and HEC-1. It is probably best to discuss with OSE before using the Frequency Storm to distribute PMP.

In cases where 100-year precipitation is required (primarily for low-hazard potential dams) the preferred distribution is a center-peaking distribution based on the frequency series from NOAA Atlas 14. The Frequency Storm functions in HEC-HMS, HEC-1, and possibly other programs, are suitable and are intended for this type of storm. Since the precipitation from Atlas 14 is point precipitation, reductions for storm area may be taken as appropriate. The common SCS Type II distribution used for most of the US east of New Mexico will not be appropriate in New Mexico in most cases. The Type IIA distributions used by NRCS in New Mexico may be appropriate, but it is recommended that their use be discussed with OSE prior to using these distributions.

The following distribution methods, which have all been used in submittals to OSE, are not generally appropriate:

- Using the depth-duration curve as the distribution.
- Straight-line distribution of equal increments throughout the storm or during peak periods of the storm.
- Using SCS Type II or NRCS Type II-a distribution for PMP.
- Compressing SCS or NRCS distributions for durations less than 24 hours
- Using a Huff distribution.

### 11. Spatial Distribution of Precipitation

Spatial distribution of precipitation intensity within a basin through use of isohyetal storm patterns is typically done only for relatively large basins. This method is not common in submittals to OSE, and the services of a qualified meteorologist is required if this method is used. The method is illustrated in HMR 52, which contains information for applying this method east of the 105th meridian, comprising roughly the eastern third of New Mexico.

The more typical submittal applies precipitation uniformly across the basin, with reductions in precipitation depth for larger areas as appropriate. The reductions in these cases are applied during the derivation of precipitation using HMR 49 or HMR 55A. When the isohyetal method
of spatial distribution is used, the full index precipitation is used without reduction, since reduction is effected by application of the isohyetal pattern.

12. Loss Function Parameters
Not all of the precipitation that falls is available to generate runoff. The primary losses to precipitation are interception, evaporation, retention, and infiltration. The first three of these are grouped, along with part of the infiltration loss, and termed “initial losses.” For large, infrequent events such as the PMP, initial losses are relatively low compared to infiltration losses, and are assumed to have occurred due to antecedent rainfall prior to the start of the PMP. Therefore, initial losses are commonly neglected in evaluating PMP. Common loss characterizations include SCS curve numbers, initial/constant loss rates, exponential losses, and Green-Ampt method. Other methods are available as well. SCS curve numbers are typically used with SCS hydrograph methodology, and are not recommended for other hydrograph methods. Initial/Constant loss rate methodology is used with USBR and other unit hydrograph methods. Green-Ampt and exponential methods have not been frequently used in submittals to OSE. Parameters must be justified, both in terms of appropriateness for basin conditions (soil and vegetative cover or land use) and appropriateness with the selected transform methodology. For PMP, loss rates frequently are lower than those used with typical return frequency storms such as the 100-year event. Constant loss rates in excess of 0.5 inches/hour will require adequate supporting justification. Typical loss rates for the four SCS soil groups are as follows:

<table>
<thead>
<tr>
<th>SCS Soil Group</th>
<th>Descriptive Characteristic</th>
<th>Ultimate Infiltration Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Low Runoff Potential</td>
<td>0.3 to 0.5 inches/hour</td>
</tr>
<tr>
<td>B</td>
<td>Moderate Infiltration Rate</td>
<td>0.15 to 0.30 inches/hour</td>
</tr>
<tr>
<td>C</td>
<td>Slow Infiltration Rate</td>
<td>0.05 to 0.15 inches/hour</td>
</tr>
<tr>
<td>D</td>
<td>High Runoff Potential</td>
<td>0 to 0.05 inches/hour</td>
</tr>
</tbody>
</table>


13. Precipitation Excess
Determination of precipitation excess typically is embedded in hydrology software program, but is a straightforward step that can be assumed to be handled correctly with reputable software. The total rainfall excess must be determined and reported, in addition to instantaneous peak discharge. As a rule of thumb for General Storm PMP, rainfall excess less than 70% of total storm volume for 72-hour precipitation depth greater than 25 inches, or less than 60% of 72-hour storm volume for total precipitation depth less than 25 inches, will require justification. Loss parameters and precipitation increment size and distribution can have significant effect on rainfall excess.

14. Transform Methodology
The most common transform methodology is some sort of synthetic unit hydrograph procedure. SCS is fairly common, but may not be the best choice for PMP of extreme storms. SCS parameters are interrelated, and any deviation from the methodology (e.g. Initial-Constant loss rates rather than Curve Numbers) must be justified. The USBR Flood Hydrology Manual methodology is also commonly used. USBR is developed for the West, and has three regional unit hydrograph lag relationships that apply within New Mexico: “Great Plains,” “Rocky
Mountains,” and “Southwest Desert, Great Basin, and Colorado Plateau.” Additionally, the Manual contains information for urban basins. It is important to select the correct relationship for the watershed being evaluated. Other unit hydrograph procedures include Clark’s and Snyder’s unit hydrographs. If these are used, parameters must be provided and justified. User-specified unit hydrographs or other relationships derived from gaging records are possible, but submittals to OSE using these methods have been rare. SCS, Clark’s and Snyder’s unit hydrographs are available in HEC HMS, and parameters must be provided and justified but unit hydrographs need not be provided. If USBR methodology or other user-specified unit hydrographs are used, unit hydrograph ordinates must be provided. Kinematic Wave methodology is sometimes used, and is probably most suitable where the watershed can be conveniently be described as rectangular plane surfaces draining into lateral channels. Other distributed-model methodologies may exist or emerge, and should probably be discussed with OSE before submittal.

15. Application of Transform Methodology for Each Subbasin
For computer-based analysis, this is primarily a matter of properly configuring subbasin models and hydrologic parameters within the program.

16. Evaluation of Base Flow
In New Mexico, stream base flow is usually minimal or non-existent except in response to storm events. A possible exception might be snowmelt in mountainous regions. The USBR Flood Hydrology Manual discusses modeling base flow and snowmelt. If base flow in the stream will contribute significantly to the hydrograph, it should be considered, and base flow modeling assumptions documented. It may be desirable to model a token base flow if the resulting flood hydrograph will be analyzed in a program such as HEC-2 or HEC HMS for downstream water surface profiles under unsteady-flow conditions.

17. Hydrograph Combining and Routing to Determine IDF
Combining and routing is generally done by the computer model. Model input and output must be carefully scrutinized to make sure that the model is performing as intended.

18. Reservoir Routing
Stage-storage information used in routing must be provided; the Rules and Regulations require this to be in elevation intervals of 1 foot. Outlet and spillway capacity rating curve or table must be developed and provided. Relying on older, previously generated rating curves without independently verifying their appropriateness is not acceptable. Spillway capacity is most frequently based on the Weir Equation, \( Q = CL(H)^{1.5} \), Where \( Q \) is discharge, \( L \) is weir length perpendicular to flow, \( H \) is head on the weir typically taken as reservoir elevation minus weir elevation, and \( C \) is a discharge coefficient for the weir. The weir equation is only appropriate if flow passes through critical depth over the weir and supercritical flow will be present a sufficient distance downstream from the weir that backwater effects will not constrain flow over the weir. If supercritical flow is not assured, then a backwater analysis such as HEC-2 or HEC-RAS is needed to validate spillway capacity. Also if a significant channel exists between the weir and the reservoir, a backwater analysis is needed to confirm that the reservoir stage remains below the dam crest at the anticipated spillway capacity. Care must be exercised in selecting the coefficient \( C \), as it is not constant with respect to flow depth and is sensitive to geometry of the
spillway crest and entrance. Textbook values for typical broad-crested and ogee weirs may not be appropriate. The most common error is to select too high of a coefficient, for example, 3.0 or 3.1 for an open-cut spillway for which 2.6 or 2.7 may be more appropriate.

19. **Review of Results for Reasonableness**

It is tempting to assume that if the computer program gives an answer and doesn’t crash that this is the correct answer. In reality, the computer is not especially intelligent and will do exactly what you tell it to, whether this makes any sense or not. This is not just a matter of “garbage-in, garbage-out.” Sometimes, parameters that are in the ballpark when taken individually can compound to skew results in one direction or another. Also, sometimes the program will perform functions not intended by the analyst, such as inappropriate reduction of precipitation for storm area, if you do not tell it exactly what you want and understand the significance of program defaults. Therefore, a review of intermediate steps and final results for reasonableness is important. Calibration of the hydrologic model for PMP is difficult since storms approaching this magnitude are rare. Calibrating against lesser storms such as the 100-year or smaller events may not be appropriate for PMP. Reasonableness of results compared to past experience with similar input parameters may be the best tool available. It is important not only to ensure that the spillway design flood is not underestimated for reasons of public safety, but also that it is not overestimated for reasons of economics. Often, the predicted flood is significantly less probable than the precipitation, which in the case of PMP already has an essentially indefinable but extremely low probability. In some cases, particularly for rehabilitation projects, this can have a substantial impact on project costs.

20. **Adjustment of Model Parameters**

Based on review of results for reasonableness, it may be appropriate to adjust parameters and recalculate. This will obviously be necessary if the selected spillway turns out not to be adequate for the computed flood. Sensitivity analysis with respect to critical parameters is sometimes useful in forming an opinion with regard to the appropriateness of the result.

21. **Hydrologic Analysis Report**

Assuming the hydrologic analysis has included the required steps previously discussed, it is important that the methods and parameters used, the results obtained, and supporting justification be documented in a coherent report. This will allow OSE staff to verify that regulatory requirements for hydrology have been satisfied and evaluate whether the proposed design adequately addresses the required design storm. A secondary, but equally important purpose is to provide documentation of methods and assumptions to assist future engineering consultants and OSE staff in understanding the basis for design and assessing adequacy and safety of the structure. Personnel can turn over rapidly, analysis methods change over time, and the structure will almost certainly outlast both the designers and their methods. The hydrology report will serve as a guidance document to help future engineers understand the analysis. As a general principle, the information submitted must be adequate to allow an independent analyst, possibly at some point in the future, to replicate the analysis with comparable results. The information must be transparent and independent of the software program used for computation. The following are some of the items required in the report and supporting documentation:
1. Identification of the hazard potential classification, and any assumptions used in determining this classification. If the classification is anything other than High, supporting documentation, potentially including breach analysis and flood studies, may be required.

2. Determination of appropriate design precipitation based on hazard potential classification and size of structure. Provide detailed analysis report if design precipitation is based on incremental damage assessment or site-specific PMP study, either of which must be discussed with OSE in advance.

3. Location map and topographic map of drainage area contributing to the dam and reservoir, with drainage boundary and total area indicated.

4. Map indicating subbasin boundaries with areas indicated, hydrograph combination points, channels for routing, etc. This may be superimposed on the topographic map described in 3. above if of suitable scale.

5. Table of relevant basin and channel characteristics to be used in the analysis as dictated by the selected analysis methodology, including flow path lengths, centroid distances, mean basin elevations, channel slope, roughness, and cross-section, etc.

6. Discussion of timing and routing parameter derivation including methods or equations used and their applicability to this particular project, example calculations, and summary tables of input data and computed parameters.

7. Narrative discussion of watershed model accompanied by schematic showing the interrelation of various components of the model.

8. Elevation-storage and elevation-discharge tables for reservoir, outlets and spillways. These should be in 1-foot increments unless the dam is very high, in which case the appropriate interval must be discussed in advance with OSE.

9. Worksheets for Local Storm and General Storm PMP derivation from HMR 49 or 55A as appropriate. For Low hazard potential dams, copies of tables from NOAA Atlas 14 website, indicating latitude and longitude of point precipitation, must be included.

10. Table of distributed precipitation increments, distribution curve and/or hyetograph illustrating graphically how precipitation is distributed, and narrative describing and justifying the methodology for distributing precipitation.

11. If spatial distribution is used, full documentation of methodology and assumptions by qualified meteorologist is required.

12. Discussion of loss methodology and documentation of derivation of parameters, tables of soil and land use areas and percentages for each subbasin, and justification of the appropriateness of the parameters and methodology in the context of the overall analysis.

13. Table or graph of precipitation excess for each increment for which excess exists, and identification of total precipitation excess in inches and percentage of rainfall.

14. Discussion of transform methodology used. Coefficients or parameters for common synthetic unit hydrograph procedures (e.g. SCS, Snyder, Clark). If other than a common synthetic unit hydrograph procedure is used, unit hydrograph ordinates must be provided.

15. Table or computer echo of input parameters, with parameters identified or notated for each subbasin, routing reach, or other element.

16. Discussion of base flow or snowmelt methodology or considerations.

17. Table of combining and routing results, supported by computer output. Results must be concurrent with model schematic discussed in 7. above.
18. Elevation-storage and elevation-discharge tables for the reservoir in 1-foot increments, and table of routed hydrograph ordinates with peak inflow to reservoir and routed peak outflow identified. Inflow and outflow hydrographs plotted on same figure of appropriate scale.

19. Discussion of reasonableness of results, including any calibration or comparison information available.

20. Discussion of any parameter adjustments or sensitivity analysis performed in order to validate or improve reasonableness of results.

**Special Case – Perimeter Dams:**

An increasing number of dams regulated by OSE are perimeter embankments with no contributing watershed outside of the reservoir, interior slopes, and embankment crest. These dams may include wastewater pond dams, industrial evaporation pond dams, municipal raw water storage dams, tailings dams, etc. Water or potentially mobile contents are pumped or discharged to the reservoir as part of a controlled process.

For these perimeter dams, hydrology typically is greatly simplified. The contributing area (reservoir surface, interior slopes, and crest) is determined, and the design precipitation depth is applied to this area to determine the volume contribution of the storm to the reservoir. Where the design storm is all or a percentage of the PMP, the General Storm 72-hour index precipitation should be used. Losses are neglected, and the full precipitation depth is treated as excess contributing to the reservoir. In most cases, storage for this volume of water is provided above the normal maximum water level, with additional freeboard above flood stage to satisfy the freeboard requirements of OSE Rules and Regulations. In some cases, a spillway may be designed to allow routing and discharge of some of the flood volume, thereby reducing embankment height above normal maximum water level.

In addition to water from extreme precipitation events, perimeter embankments are susceptible to misoperation, where discharge into the reservoir continues past the design maximum reservoir level and eventually overtops the embankment, resulting in failure. For this reason, perimeter embankments must be provided with an overflow section with capacity equal to or greater than the discharge capacity into the reservoir, so that misoperation or failure of reservoir controls does not lead to embankment failure.

**References:**


The State Engineer has released proposed amendments to Rules and Regulations Governing Dam Design, Construction and Dam Safety. The proposed amendments were developed to address changes to Section 72-5-32 NMSA effective on June 19, 2009 and to address improvements to the standards of dam design, construction and operation practice in New Mexico.


The proposed regulations are available at the Office of the State Engineer in Santa Fe, Albuquerque, Las Cruces, Roswell, Deming, Aztec, and Cimarron. The proposed regulations are also posted on the Office of the State Engineer web site and may be accessed at www.ose.state.nm.us/water_info_dam_safety_rules.html. Click on the link under Proposed Rules and Regulations. To request that a copy of the rules and regulations be sent to you in the mail or by email, please contact Judy Leyba at 505-827-6111 or email judy.leyba@state.nm.us.

A public hearing will be held on the above described proposed and amended regulations at the State Capitol, Santa Fe, New Mexico, on October 29, 2010 beginning at 10:00 a.m. Any person who is or may be affected by these proposed rules and regulations may appear and testify. If you are an individual with a disability who is in need of special assistance or accommodation to attend or participate in the hearing, please contact Judy Leyba at (505) 827-6122. The Office of the State Engineer requests ten days advance notice to provide any special accommodation.

Written comments on the proposed regulations may be submitted to the Office of the State Engineer in Santa Fe or to any of the district offices. Written comments on the proposed rules and regulations may also be mailed to:

Office of the State Engineer
Dam Safety Bureau
Attention: Elaine Pacheco
P.O. Box 25102
Santa Fe, NM 87504

Please submit your written comments to the Office of the State Engineer no later than October 15, 2010. After October 15, 2010, written and oral comments must be submitted at the hearing in Santa Fe on October 29, 2010.
BEFORE THE NEW MEXICO STATE ENGINEER

IN THE MATTER OF THE PROPOSED )
AMENDMENT OF RULES GOVERNING )
DAM DESIGN, CONSTRUCTION AND )
DAM SAFETY )

FINDINGS OF FACT, ORDER
AND NOTICE OF PROPOSED RULEMAKING

COMES NOW John R. D’Antonio, Jr., P.E., State Engineer of the State of New Mexico, pursuant to NMSA 1978, Section 72-2-8(D), and makes the following FINDINGS OF FACT:

1. In accordance with NMSA 1978, Sections 72 2 8, 72 2 12 and 72 2 17, the State Engineer is authorized to adopt regulations, appoint hearing examiners, and conduct hearings on matters that are properly before him. A designated hearing examiner shall have such power as may be delegated by the State Engineer to regulate all proceedings before him, and to perform acts and take all necessary or proper measures for the efficient and orderly conduct of such proceedings.

2. The existing Rules and Regulations Governing Dam Design, Construction and Dam Safety do not adequately reflect and address:

   a. The 2009 amendment to NMSA 1978, Section 72-5-32, which changed the definition of dams that are under the jurisdiction of the State Engineer;

   b. Current state of the practice of the Office of the State Engineer concerning dam design, construction and dam safety; and
c. Industry standards relating to dam design, construction and dam safety.

3. It is necessary and appropriate to provide clear standards and regulations for the design, construction and safety of dams under the State Engineer's jurisdiction. Therefore, the existing rules should be amended so that consistent and detailed rules will be in place.

4. The proposed amendments have been reviewed by counsel for the State Engineer.

5. A detailed synopsis of the substantive proposed amendments is attached as Exhibit 1 to this Order and a list of references supporting the proposed amendments is attached as Exhibit 2.

6. A public hearing should be held on the proposed amendments to existing rules 19.27.12 NMAC (Dam Design, Construction and Dam Safety). Accordingly, the proposed amendments should be made publicly available, and a resume of the proposed amendments should be published together with notice of the public hearing pursuant to NMSA 1978, Section 72-2-8(D).

WHEREFORE, the State Engineer hereby ORDERS:

A. The proposed amended rules shall be filed for public inspection in the Office of the State Engineer in each District field office on or before August 23, 2010, and notice of the proposed rulemaking and public hearing shall be mailed to each person included in the file of interested persons in the Office of the State Engineer.

B. A resume of the substantive proposed amendments shall be published together with notice of public hearing in a minimum of five newspapers of general circulation once a week for two consecutive weeks, and notice shall also be published in the New Mexico Register. Publication shall be completed by October 8, 2010.
C. A public hearing on the proposed amendments shall be held in Santa Fe, New Mexico beginning at 10:00 a.m. on October 29, 2010.

Witness my hand and seal this 20th day of August, 2010.

[Signature]

John R. D’Antonio, Jr., P.E.
State Engineer of New Mexico
EXHIBIT 1

SYNOPSIS OF SUBSTANTIVE PROPOSED AMENDMENTS TO 19.25.12 NMAC
Dam Design, Construction and Dam Safety Rules and Regulations

Following is a synopsis of the sections of the substantive proposed amendments to rules and regulations governing dam design, construction and dam safety. Proposed procedural amendments are not included in this synopsis.

19.25.12.7 DEFINITIONS: The following definitions were added or amended.

19.25.12.7.A(2)
"Aesthetic fill: Cosmetic fill added to the downstream slope of a dam that is not required to address the safe design. Aesthetic fill shall not be considered when determining the properties of the dam for the purposes of evaluating the jurisdictional status and shall not be used to support the safe design."

19.25.12.7.D(1)(a)
"Jurisdictional dam" definition revised to conform to requirements of Section 72-5-32, NMSA 2009, as amended. See Exhibit 2, Reference 4.

19.25.12.7.D(1)(b)
"Non-jurisdictional dam" definition revised to conform to requirements of Section 72-5-32, NMSA 2009, as amended. Exemption for stock dams and erosion control dams as non-jurisdictional is no longer required. See Exhibit 2, Reference 4.

19.25.12.7.D(2)
"Dam crest" definition revised to recognize the crest is the entire uppermost surface and not a single location. The lowest elevation reference is moved to the dam height definition.

19.25.12.7.D(4)
"Dam height: The vertical distance from the lowest point on the downstream toe to the lowest point on the dam crest."

19.25.12.7.E(1)
"Earthquake: A sudden motion or trembling of the earth caused by the abrupt release of accumulated stress along a fault."

19.25.12.7.E(1)(a)
"Operating basis earthquake: The earthquake that can reasonably be expected to occur within the service life of the dam or appurtenant structures." See Exhibit 2, Reference 6.

19.25.12.7.E(1)(b)
"Maximum credible earthquake: The greatest earthquake that can reasonably be expected to be generated by a specific source on the basis of seismological and geological evidence." See Exhibit 2, Reference 6.
19.25.12.7.E(2)
"Evacuation map:  A map prepared in collaboration with local emergency managers defining the area to be evacuated from a dam failure."

19.25.12.7.F(1)
"Fetch" definition amended to the more specific distance between the dam and farthest reservoir shore rather than the general distance across a body of water.

19.25.12.7.G
"Geotextile:  Any fabric or textile (natural or synthetic) used as an engineering material in conjunction with soil, foundations or rock. Geotextiles provide the following uses: drainage, filtration, separation of materials, reinforcement, moisture barriers and erosion protection." See Exhibit 2, Reference 8.

19.25.12.7.I(1)
"Incremental impacts:  Under a given flood, earthquake or other conditions, the difference in impacts that would occur due to failure or misoperation of the dam and appurtenant structures compared to those that would have occurred without failure or misoperation of the dam and appurtenant structures." See Exhibit 2.

19.25.12.7.N(3)
"North American vertical datum" definition corrected to reference the national geodetic vertical datum 1929 rather than the North American vertical datum 1927.

19.25.12.7.R
"Residual freeboard:  The vertical distance between the high water line and the lowest point on the dam crest."

19.25.12.7.S(5)
"Sunny day failure:  Dam failure with the reservoir at the normal operating level."

19.25.12.8  FEE SCHEDULE:

19.25.12.8.B
Fee for alter, repair or rehabilitation of a dam is added to the fee schedule.

Schedule of fees for all copies is replaced with a statement that fees will be charged to offset the cost of the service and consistent with state engineer policy adopted pursuant to the NM Inspection of Public Records Act.

19.25.12.9  SIZE CLASSIFICATION:
19.25.12.9.A
"Small" classification is revised to conform to requirements of Section 72-5-32, NMSA 2009, as amended.

19.25.12.11 DESIGN OF A DAM:

19.25.12.11
Introduction amendment adds an option to require a quality management plan if the supporting documentation does not meet acceptable engineering standards as determined by the state engineer.

19.25.12.11.C(1)(a)-(g)
Hazard potential classification amendments reorganize and describe in greater detail the information that must be included in the dam breach and flood routing analysis. See Exhibit 2, Reference 7.

19.25.12.11.C(2)(b)
Hydrologic analysis amendment requires a description of land treatment for the drainage area.

19.25.12.11.C(4)
Incremental damage assessment amendments clarify that the assessment is a process used when spillways cannot be designed to comply with the spillway design flood listed in 19.25.12.11.C(3). A detailed description of the process to assess incremental impacts is provided in the amendment. See Exhibit 2, Reference 2.

19.25.12.11.C(5)
Spillway capacity amendment deletes the option of performing an erosion study of the embankment to justify overtopping of a new dam due to inadequate spillway capacity.

19.25.12.11.C(6)(e)
Energy dissipation for spillway discharge amendment states: "The design shall address energy dissipation to control erosion of the natural channel due to spillway discharge reasonably expected to occur during the life of the dam."

19.25.12.11.C(6)(g)
Training dikes amendment deletes the reference to compaction to "at least 70% relative density if Proctor testing is not appropriate."

19.25.12.11.C(8)(l)
Minimizing seepage along conduits amendment adds the following statement: "Seepage collars are not an acceptable design standard for controlling seepage." See Exhibit 2, Reference 5.

19.25.12.11.C(11)
Seepage and internal drainage amendment requires the evaluation of seepage and internal drainage for dams with aesthetic fill on the downstream slope and removes the option of requesting a waiver for reservoirs with synthetic liners on that basis alone.
19.25.12.11.C(11)(d)
Seepage and internal drainage amendments replace the requirement for a specific device depending on flow rate to a more general requirement that the measuring device must be appropriate for the rate of flow. A requirement for an upstream catchment for the seepage collection device is also added.

19.25.12.11.C(12)
Stability analysis amendment requires the evaluation of stability for dams with aesthetic fill on the downstream slope and requires the stability of the reservoir rim to be evaluated if the slopes are steeper than 3 horizontal to 1 vertical.

19.25.12.11.C(12)(c)-(d)
Stability analysis amendment increases the factor of safety for rapid drawdown and end of construction loading conditions from 1.2 to 1.3. See Exhibit 2, Reference 9.

19.25.12.11.C(13)
Seismic design and analysis amendment adds the requirement of a seismic analysis for appurtenant structures. See Exhibit 2, Reference 6.

19.25.12.11.C(13)(a)
Seismological investigation amendment provides the criteria for the operating basis earthquake to be used in the seismological investigation study. See Exhibit 2, Reference 6.

19.25.12.11.C(13)(a)(i)
Seismological investigation amendment states: "Dams classified as high hazard potential other than flood control structures shall be designed for the maximum credible earthquake or for a 1% probability of exceedance in 50 years (approximately 5000-year return frequency)." See Exhibit 2, Reference 6.

19.25.12.11.C(13)(c)(i)
Pseudostatic analysis amendment deletes the reference to compaction of "at least 70% relative density if Proctor testing is not appropriate".

19.25.12.11.C(13)(c)(ii)
Pseudostatic analysis amendment states that a pseudostatic analysis is acceptable if the peak ground acceleration is 0.35g or less.

19.25.12.11.C(17)
Geotextile design amendment requires the geotextile design computations to be provided and clarifies the installation requirements for the geotextile.

19.25.12.11.C(19)
Utilities design amendment requires the evaluation of utilities in the spillway and seepage limits of the dam.
19.25.12.11.D(2)
Scale and size amendment allows drawings to range in size from 22 inches to 24 inches by 34 inches to 36 inches.

19.25.12.11.D(12)
Permanent bench mark amendment deletes the option of providing the location of the permanent bench mark based on the New Mexico state plane coordinate system.

19.25.12.11.E
Specifications amendments clarify that a specification package is required to be submitted for each project and that reference to standard specifications is not acceptable; however, inclusion of appropriate specifications from model specifications is appropriate. The amendment also requires the specifications to address frequency of testing and frequency of inspection.

19.25.12.11.E(4)
General conditions of the specifications amendment add the requirement that statements recognizing the authority of the state engineer to perform inspections during construction and acknowledging that the construction drawings and specifications cannot be changed without prior written approval from the state engineer be included in the specification package.

19.25.12.11.H
Instrumentation plan amendment adds the requirement that details of the instrumentation must be included in the construction drawings and that specifications must be consistent with the instrumentation plan. See Exhibit 2, Reference 1.

19.25.12.11.H(3)
Calibration amendment adds the requirement of including calibration and maintenance schedules, and instructions in the instrumentation plan. See Exhibit 2, Reference 1.

19.25.12.11.H(5)
Data reduction amendment adds the requirement of including data reduction and interpretation instructions in the instrumentation plan. See Exhibit 2, Reference 1.

19.25.12.12 CERTIFICATIONS:

19.25.12.12
Certifications introduction amendment adds the requirement for a certification from the local emergency management official.

19.25.12.12.D
Local and state emergency management official’s certificate amendments revise the certification requirements to include a certification from the local emergency management official.

19.25.12.13 PERMIT CONDITIONS:
Engineer supervising construction amendments add the requirements that the monthly construction report be signed and sealed by the engineer supervising construction and the monthly construction report includes a summary of construction activities and captioned and dated construction photographs.

Construction completion amendment requires the construction completion report to include signed certifications from the engineer and a certification for the state engineer.

Record mylar drawings amendments require the drawings to contain signed certifications from the owner and the engineer supervising construction and a certificate for the state engineer. The design engineer may also be required to sign a certification depending on the changes.

Operation condition amendment specifies a list of operation conditions that shall be included in the permit.

19.25.12.17 OPERATION AND MAINTENANCE MANUAL:

The amendment to the introduction first deletes the requirement that a professional engineer prepare the entire operation and maintenance manual and instead specifies that a professional engineer is only needed to prepare the complex technical aspects of the operation and maintenance manual if deemed appropriate by the state engineer. Second, the amendment clarifies that the state engineer may order storage restrictions if the operation and maintenance procedures are not followed.

General information amendment adds the requirement of including in the operation and maintenance manual information on access to the dam and the history of construction, repairs and performance. See Exhibit 2, Reference 1.

Operation amendment adds the requirement of including the following information in the operation and maintenance manual: discharge information specific for the outlet conduit and spillway; an elevation, area and storage curve and table to the dam crest; and elevation of the high water line. See Exhibit 2, Reference 1.

Operator safety amendment adds the requirement of including the following information in the operation and maintenance manual: confined space entry and permits; fall protection; lockout/tag out; and other applicable safety requirements.
19.25.12.17.C (2)-(7)
Instrumentation amendment revises this section to conform to the requirements of the instrumentation plan specified in 19.25.12.11.H. Under the amendment, the following additional information must be included in the operation and maintenance manual: detailed description of installation; calibration schedule and instructions; reading instructions; data reduction and interpretation; notification procedures; and schedule for reporting data with interpretations. See Exhibit 2, Reference 1.

19.25.12.17.H
Appendices amendment adds the requirement of including the following information in the appendices of the operation and maintenance manual: captioned and dated photographs; key sheets from the record construction drawings; instrumentation construction drawings; instrumentation rating tables and calibration details; monitoring and inspection forms; and copies of any relevant procedures.

19.25.12.18   EMERGENCY ACTION PLAN:

19.25.12.18
The introduction amendment adds the requirement of including in the emergency action plan a signed certification from the local emergency official and requires the dam owner to coordinate with emergency management officials to establish the evacuation limits.

19.25.12.18(D)
Preparedness amendment deletes the requirement for a professional engineer to prepare this element of the emergency action plan.

19.25.12.18(E)
Evacuation map amendment adds the requirement of including an evacuation map in the emergency action plan. The amendment specifies that the evacuation map is required to extend to a point where the consequences of dam failure no longer pose a threat to life and evacuation or restricting access is no longer required. See Exhibit 2, Reference 3.

19.25.12.18(E)(1)-(4)
Evacuation map amendment adds the requirement of including the following information in the evacuation map: distance downstream from the dam; arrival time of the leading edge of the flood wave; peak flow depth, incremental rise or water surface elevation in feet; and peak velocity in feet per second. See Exhibit 2, Reference 3.

19.25.12.18(F)
Inundation map amendment deletes the requirement that every dam breach and flood routing analysis report for preparing an emergency action plan be prepared to the same level as required for a design effort. The amendment specifies that the use of a simplified dam breach and flood routing analysis is acceptable if the consequences of failure justify a simplified process and the state engineer concurs. The amendment also specifies that the effects of flooding from dam failure must be routed until the flood no longer poses a threat to life and evacuation or restricting access are no longer required. See Exhibit 2, Reference 3.
19.25.12.18(F)(1)-(4)  
Inundation map amendment adds the requirement of including the following information in the inundation map: distance downstream from the dam; arrival time of the leading edge of the flood wave; peak flow depth, incremental rise or water surface elevation in feet; and peak velocity in feet per second. See Exhibit 2, Reference 3.

19.25.12.19  CHANGES TO AN EXISTING DAM:

19.25.12.19.A  
Proposed changes to an existing dam amendment adds the requirement that dam owners adding aesthetic fill to an existing dam obtain approval from the state engineer prior to undertaking any actions.

19.25.12.19.A(1)  
Application amendment waives plan review fees for only the first review of plans to alter, repair or rehabilitate a dam.

Removal or breach of a dam amendment adds the requirement that a breach be sized to pass the peak discharge without attenuation of the flood through the reservoir.

19.25.12.19.F  
Proof of completion of works amendment clarifies that the requirement for a proof of completion of works form for changes to an existing dam will be made on a case by case basis by the state engineer.

19.25.12.20  CHANGES TO AN EXISTING NON-JURISDICTIONAL DAM:

19.25.12.20  
The introduction amendment clarifies that a non-jurisdictional dam will no longer become jurisdictional if the purpose changes, but that a non-jurisdictional dam can become jurisdictional when the ownership changes from federal to non-federal.

19.25.12.21  EXISTING DAMS:

19.25.12.21.A  
The introduction amendment adds the following statement: "Failure to comply with state engineer directives or these regulations may result in an order to reduce storage or to take corrective action."

Hazard classification change amendment deletes the following statement: "If the dam owner fails to address a deficiency, the state engineer may revoke the license to operate the dam and order the dam breached in accordance with Subsection B or C of 19.25.12.19 NMAC."
19.25.12.21.E
Operation and maintenance manual requirement amendment deletes compliance deadlines because the amendment will be promulgated on or after the deadlines and the deleted deadlines are no longer relevant. Existing owners of dams classified as high or significant hazard potential will be out of compliance if they have not complied with the requirements of 19.25.12.17 NMAC for an operation and maintenance manual.

19.25.12.21.F
Emergency action plan requirement amendment deletes compliance deadlines for all but significant hazard potential flood control dams and owners of 5 or more dams because the amendment will be promulgated on or after the deadlines and the deleted deadlines are no longer relevant.
EXHIBIT 2

REFERENCES FOR SELECT AMENDMENTS TO 19.25.12 NMAC
Dam Design, Construction and Dam Safety


4. Section 72-5-32 NMSA, 2009


TITLE 19  NATURAL RESOURCES AND WILDLIFE
CHAPTER 25  ADMINISTRATION AND USE OF WATER - GENERAL PROVISIONS
PART 12  DAM DESIGN, CONSTRUCTION AND DAM SAFETY

19.25.12.1 ISSUING AGENCY: New Mexico Office of the State Engineer

[19.25.12.1 NMAC - N, 3/31/2005]

19.25.12.2 SCOPE: These regulations apply to the design and construction of all jurisdictional dams in New Mexico and are intended to facilitate the continued safe operation and maintenance of all non-federal jurisdictional dams. These regulations govern the review and acceptance of plans for construction, alteration, modification, repair, enlargement and removal of a jurisdictional dam. These regulations ensure the continued safe operation, maintenance, site security and emergency preparedness for existing non-federal jurisdictional dams. These regulations do not authorize the appropriation or use of water pursuant to 19.26 NMAC and 19.27 NMAC.


19.25.12.3 STATUTORY AUTHORITY: Section 72-5-32 NMSA requires any person, association or corporation, public or private, the state or the United States that is intending to construct a jurisdictional dam to submit detailed plans to the state engineer. Sections 72-5-9 and 72-5-10 NMSA establish the state engineer’s authority over the construction of works and issuing certificates of construction. Sections 72-5-8 and 72-5-14 NMSA require construction to be completed in a time limit set by the state engineer and procedures for requesting an extension of time. Sections 72-5-11, 72-5-12 and 72-5-13 NMSA gives the state engineer jurisdiction over unsafe works, penalties for failure to comply with state engineer orders and priority of liens. Section 72-2-6 NMSA gives the state engineer the authority to assess fees. Section 72-2-8 NMSA gives the state engineer authority to adopt regulations and codes to implement and enforce any provision of any law administered by him. Section 72-8-1 NMSA gives the state engineer the authority to enter upon private property for the performance of his duties. Nothing in these rules shall be construed so as to limit the state engineer's authority to take lawful alternative or additional actions relating to the design, construction and safety of dams.

[19.25.12.3 NMAC - N, 3/31/2005]

19.25.12.4 DURATION: Permanent.


19.25.12.5 EFFECTIVE DATE: March 31, 2005 unless a later date is cited at the end of a section.

[19.25.12.5 NMAC - N, 3/31/2005]

19.25.12.6 OBJECTIVE: To establish minimum design requirements, minimum submittal requirements and dam site owner responsibilities that shall be addressed to the state engineer’s satisfaction in order to ensure a dam is designed, constructed, operated, maintained and secured in a safe manner.

[19.25.12.6 NMAC - N, 3/31/2005]

19.25.12.7 DEFINITIONS: Unless defined below or in a specific section of these regulations, all other words used herein shall be given their customary and accepted meaning.

   A. Terms starting with the letter ‘A’ are defined as follows:
      [A.] (1) Abutment: That part of the valley side against which the dam is constructed. The left and right abutments of dams are defined with the observer viewing the dam looking in the downstream direction.
      (2) Aesthetic fill: Cosmetic fill added to the downstream slope of a dam that is not required to address the safe design. Aesthetic fill shall not be considered when determining the properties of the dam for the purposes of evaluating the jurisdictional status and shall not be used to support the safe design.
      [B.] (3) Alteration, modification, repair, rehabilitation or enlargement of an existing dam: To change from the state engineer accepted construction drawings and specifications or current condition.
      [C.] (4) Appurtenant structure: Auxiliary features of a dam such as outlets, spillways, access structures, tunnels and related housing at a dam.
      [D.] (5) American society for testing and materials (ASTM): An accepted standard for testing the properties of materials. ASTM: Standards promulgated by ASTM international for testing the properties of materials. Methods cited in these regulations include laboratory compaction characteristics of soils.
B. Terms starting with the letter ‘B’ are defined as follows:

[\textbf{E.}] Breach: An opening through a dam or spillway that is capable of draining a portion of the reservoir or the entire reservoir. A controlled breach is a constructed opening. An uncontrolled breach is an unintentional discharge from the reservoir.

C. Terms starting with the letter ‘C’ are defined as follows:

[\textbf{F.}] (1) Consequences of failure: Potential loss of life or property damage downstream of a dam caused by waters released at the dam or by waters released by partial or complete failure of dam; includes effects of landslides upstream of the dam on property located around the reservoir.

[\textbf{G.}] (2) Crest width: The thickness or width of a dam at the crest level (excluding corbels or parapets). In general, the term thickness is used for gravity and arch dams and width is used for other dams.

D. Terms starting with the letter ‘D’ are defined as follows:

[\textbf{H.}] (1) Dam: A man-made barrier constructed across a watercourse or off-channel for the purpose of storage, control or diversion of water.

[\textbf{F.}] (2) Jurisdictional dam: [A dam that is more than 10 feet in height measured from the lowest point on the downstream toe to the dam crest or impounds more than 10 acre-feet of water as measured from the lowest point on the downstream toe to the spillway crest. Dams constructed under the supervision of the U.S. army corps of engineers before May 19, 2004, become jurisdictional when such supervision by the U.S. army corps of engineers is terminated.] A dam 25 feet or greater in height, which impounds more than 15 acre-feet of water or a dam that impounds 50 acre-feet or more of water and is 6 feet or greater in height. For purposes of these regulations, reference to a dam means a jurisdictional dam unless otherwise noted. See figure of jurisdictional dam size.

Non-jurisdictional dam: [Any dam less than or equal to 10 feet in height and having storage less than or equal to 10 acre-feet of water.] Any dam not meeting the height and storage requirements of a jurisdictional dam. The state engineer does not regulate the design, construction and operation of a non-jurisdictional dam unless the dam is unsafe and there is a threat to life or property, as determined by the state engineer. Waters impounded by a non-jurisdictional dam may not be exempt from water right permit requirements; therefore a separate state engineer water right permit for the water impounded in the reservoir created by a non-jurisdictional dam may be required. Non-jurisdictional dams shall meet the requirements of 19.26.2.15 NMAC unless otherwise exempt. The structures listed below are considered non-jurisdictional dams:

[\textbf{a.}] Stock dam: A stock dam constructed prior to May 19, 2004 with a storage capacity of 10 acre-feet or less regardless of the height of the dam.

[\textbf{b.}] Erosion control dam: A dam for the sole purpose of erosion control constructed on a naturally dry watercourse as determined by the state engineer, with a storage capacity of 10 acre-feet or less as measured from the lowest point on the downstream toe to the spillway crest and the reservoir drains in 96 hours unless a quicker drain time is required by court decree.]
Levee or diversion dike: A structure where water flows parallel to the length of the levee or diversion dike as determined by the state engineer.

Roadway embankment: A structure across a watercourse designed for the sole purpose of supporting a roadbed or other means of conveyance for transportation as determined by the state engineer; where the area upstream has not been enlarged to increase flood storage; and where the embankment is provided with an uncontrolled conduit of sufficient capacity to satisfy requirements of the appropriate state or local transportation authority. If no transportation authority has jurisdiction over the structure, the current drainage design criteria of the New Mexico department of transportation shall apply.

Dam crest: The uppermost surface of a dam, usually a road or walkway excluding any parapet wall, railing, etc.

Dam failure: The breakdown of a dam, characterized by the uncontrolled release of impounded water. [There are varying degrees of failure.]

Dam height: The vertical distance from the lowest point on the downstream toe to the lowest point on the dam crest.

Dam incident: An event at a dam that interrupts normal procedures and performance, affects the safety of the dam or results in a potential loss of life or damage to property.

Earthquake: A sudden motion or trembling of the earth caused by the abrupt release of accumulated stress along a fault.

Operating basis earthquake: The earthquake that can reasonably be expected to occur within the service life of the dam or appurtenant structures.

Maximum credible earthquake: The greatest earthquake that can reasonably be expected to be generated by a specific source on the basis of seismological and geological evidence.

Evacuation map: A map prepared in collaboration with local emergency managers defining the area to be evacuated from a dam failure.

Fetch: The straight-line distance across a body of water between the dam and farthest reservoir shore subject to wind forces. The fetch is one of the factors used to calculate wave heights in a reservoir.

Freeboard: The vertical distance between the spillway crest and the lowest point of the dam crest not including camber.

Functional exercise: A meeting in a conference room environment involving the dam owner and state and local emergency personnel with responsibilities in the emergency action plan. The exercise takes place in a stress-induced environment with time constraints and involves simulation of a dam failure and other specific events. The exercise is designed to evaluate both the internal capabilities and responses of the dam owner and the workability of the information in the emergency action plan used by emergency management officials.

Geotextile: Any fabric or textile (natural or synthetic) used as an engineering material in conjunction with soil, foundations or rock. Geotextiles provide the following uses: drainage, filtration, separation of materials, reinforcement, moisture barriers and erosion protection.

High water line: The highest water level elevation in the reservoir as determined from routing the spillway design flood or inflow design flood.

Incremental impacts: Under a given flood, earthquake or other conditions, the difference in impacts that would occur due to failure or misoperation of the dam and appurtenant structures compared to those that would have occurred without failure or misoperation of the dam and appurtenant structures.

Inflow design flood: The flood flow above which the incremental increase in downstream water surface elevation due to failure of a dam is no longer considered to present an unacceptable additional downstream threat. The upper limit of the inflow design flood is the flood resulting from the probable maximum precipitation and the lower limit is the flood resulting from the 100 year precipitation.]
Length of dam: The length measured along the dam axis at the dam crest. This also includes the spillway, powerplant, navigation lock, fish pass, etc., where these form part of the length of the dam. If detached from the dam these structures shall not be included.

Loss of life: The likely number of human fatalities that would result from a dam failure flood event. No allowances for evacuation or other emergency actions by the population shall be considered.

Naturally dry watercourse: A watercourse or portion thereof, which under normal conditions is dry, which flows only in direct response to precipitation and whose channel is at all times above the groundwater table.

Normal operating level: The water level elevation corresponding to the maximum storage level that excludes any flood control or surcharge storage.

North American vertical datum 1988 (NAVD 88): The current vertical control datum in use in North America established from nine space geodetic stations. This basis of establishing elevation provides a precise surface, whereas the North American vertical datum 1927 (NAVD27) whereas the national geodetic vertical datum 1929 (NGVD 29) is elevation established from mean sea level.

One-hundred year flood: A flood that has 1 chance in 100 of being equaled or exceeded during any year.

Owner: The individual, association or corporation, public or private, the state or the United States, owning the land upon which a dam is constructed; having a contractual right to construct, operate or maintain a dam; or the beneficiary of an easement to construct, operate or maintain a dam.

Probable: Likely to occur, reasonably expected, realistic.

Probable maximum precipitation: Theoretically, the greatest depth of precipitation for a given duration that is physically possible over a given size storm area at a particular location during a certain time of year.

Spillway: A structure over or through which excess flow is discharged from a reservoir. If the rate of flow is controlled by mechanical means such as gates, it is considered a controlled spillway. If the geometry of the spillway is the only control, it is considered an uncontrolled spillway. For purposes of these regulations, an uncontrolled outlet conduit that is used to drain the reservoir is not considered a spillway.

Spillway crest: The lowest level at which water can flow over or through the spillway.

Spillway design flood: The required flood that a spillway must pass without failure of the dam.

Residual freeboard: The vertical distance between the high water line and the lowest point on the dam crest.

Storage: For purposes of determining whether a dam is jurisdictional, the storage is the volume of water impounded by the dam above the lowest elevation of the downstream toe to the elevation of the spillway crest. For dams with no spillway, storage is measured to the dam crest. Definitions of specific types of storage in reservoirs are:

Dead storage is the storage volume of a reservoir that lies below the invert of the lowest outlet and therefore, cannot readily be withdrawn from the reservoir.

Flood surcharge storage is the storage volume between the maximum operating level and the maximum water level during the spillway design flood.

Live storage is the storage volume of a reservoir that is available for use and lies above the invert of the lowest outlet.

Reservoir storage capacity is the sum of the dead and live storage of the reservoir.

Maximum storage is the sum of the reservoir storage capacity and flood surcharge storage.

Sunny day failure: Dam failure with the reservoir at the normal operating level.
19.25.12.1 **Tabletop exercise:** A meeting in a conference room environment involving the dam owner and state and local emergency personnel with responsibilities in the emergency action plan. The format is a discussion of an emergency event, response procedures to resolve concerns regarding coordination and responsibilities.

19.25.12.2 **Toe:** The contact line between the outer shell of the dam and the natural ground surface.

**U. Terms starting with the letter ‘U’ [Reserved]**

**V. Terms starting with the letter ‘V’ [Reserved]**

**W. Terms starting with the letter ‘W’ are defined as follows:**

**[GG.] Wave runup:** Vertical height above the water level to which water from a specific wave will run up the face of a structure or embankment.

**X. Terms starting with the letter ‘X’ [Reserved]**

**Y. Terms starting with the letter ‘Y’ [Reserved]**

**Z. Terms starting with the letter ‘Z’ [Reserved]**

**19.25.12.8 FEE SCHEDULE:** The state engineer assesses fees for filing forms, reviewing plans and specifications for dams and appurtenant structures and construction inspections.

A. For filing an application for permit to construct and operate a dam the fees shall be $25.

B. For filing an application to alter, repair or rehabilitate a dam the fee shall be $25.

C. For each review of design plans, construction drawings and specifications for a dam the fee shall be $2 per $1000 or fraction thereof of the estimated construction cost. For determination of fees, inclusion of contingencies, taxes and other permit fees is not required. Assessment of multiple review fees for the same application is at the sole discretion of the state engineer.

D. For issuing an extension of time for construction of a dam the fee shall be $50.

E. For inspecting construction of a dam the fee shall be $100/8-hour day and actual and necessary traveling expenses.

F. For filing a proof of completion of works for a dam the fee shall be $25.

G. For filing a change of ownership for a dam the fee shall be $5.

**[Gi.] H. For copies of dam safety records up to 11 inches by 17 inches the fee shall be $0.20 per copy.] The state engineer shall charge reasonable fees for copy and reproduction to offset the cost of the service, consistent with the state engineer’s current policy adopted pursuant to the New Mexico Inspection of Public Records Act, NMSA 1978 Section 14-2 et seq.

[Gi.] I. For copies of dam safety records greater than 11 inches by 17 inches the fee shall be $3.00 per copy.]

**19.25.12.9 SIZE CLASSIFICATION:** A dam shall be less than or equal to the maximum height and storage to qualify for the size classification.

A. Small: A small dam is greater than 10 feet but less than or equal to 40 feet in height, or greater than 10 acre-feet but less than or equal to 1000 acre-feet of storage. A small dam is 25 feet or greater but less than or equal to 40 feet in height, or 50 acre-feet or greater but less than or equal to 1000 acre-feet of storage.

B. Intermediate: An intermediate dam is greater than 40 feet but less than or equal to 100 feet in height, or greater than 1000 acre-feet but less than or equal to 50,000 acre-feet of storage.

C. Large: A large dam is greater than 100 feet in height[,] or greater than 50,000 acre-feet of storage.

**19.25.12.10 HAZARD POTENTIAL CLASSIFICATION:** The hazard potential classification is a rating for a dam based on the potential consequences of failure. The rating is based on loss of life, damage to property and environmental damage that is likely to occur in the event of dam failure. No allowances for evacuation or other emergency actions by the population shall be considered. The hazard potential classification is not a reflection of the condition of the dam.

A. Low hazard potential: Dams assigned the low hazard potential classification are those dams where failure or misoperation results in no probable loss of life and low economic and/or environmental losses. Losses are principally limited to the dam owner’s property.
B. Significant hazard potential: Dams assigned the significant hazard potential classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in populated areas with significant infrastructure.

C. High hazard potential: Dams assigned the high hazard potential classification are those dams where failure or misoperation will probably cause loss of human life.

19.25.12.11 DESIGN OF A DAM: Any person, association or corporation, public or private, the state, or the United States that is intending to construct a dam shall submit an application to construct and operate a dam and supporting documentation acceptable to the state engineer. This section primarily addresses the design and construction of embankment dams. Other types of dams shall conform to sound engineering principles and current state of the practice. Because each site, design and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. If the supporting documentation for the design of a dam does not meet acceptable engineering standards and does not conform to these regulations, as determined by the state engineer, a quality management plan or third party review may be required by the state engineer. Construction shall not begin until the state engineer has accepted the supporting documentation and approved the application with [construction and operation] permit conditions. The application and supporting documentation shall include[ ] the information described below.

A. Application: An application form shall be completed with original signature of the dam owner and accompanied with a filing fee in accordance with Subsection A of 19.25.12.8 NMAC. The form will be the only information available to the public before the project is approved for construction. All other supporting documentation is considered draft until accepted by the state engineer. A plan review fee in accordance with Subsection B of 19.25.12.8 NMAC shall accompany the submittal of the design report, construction drawings and specifications. A detailed estimate of the construction cost for the proposed dam and appurtenant structures shall be submitted in support of the plan review fee.

B. Water right: A water right is required for water impounded by the dam. If the dam owner has a permit for the diversion of water, documentation addressing the necessity for storage, diversion periods and release conditions for the reservoir may be required. This requirement is waived for flood control dams that do not detain water longer than 96 hours in accordance with Subparagraph (b) of Paragraph (7) of Subsection C of 19.25.12.11 NMAC or provide documentation that a waiver by the state engineer has been granted. Flood control dams that do not drain within 96 hours require a water right for water permanently stored beyond the 96-hour drain time requirement and for associated losses due to evaporation and other potential depletions to the system unless a waiver in accordance with 19.25.12.11 NMAC is obtained.

C. Design report: A design report, which includes information to evaluate the safe design of the dam and appurtenant structures, shall be submitted in a form acceptable to the state engineer. The design report shall also be submitted in an electronic format acceptable to the state engineer. The design report may be submitted as a single report or as individual reports documenting the information described below. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare or supervise the preparation of the design report. The design report shall also be submitted in an electronic format acceptable to the state engineer. The design report shall conform to sound engineering principles and current state of the practice. The application and supporting documentation shall include[ ] the information described below.

1. Hazard potential classification. A hazard potential classification shall be based on the dam failure condition that results in the greatest potential for loss of life and property damage. If the state engineer concurs, the classification may be based on the judgment and recommendation of the professional engineer. For all other cases, a
low or significant hazard potential classification shall be supported by a dam breach and flood routing analysis, which includes calculations and data that supports the predicted dam failure flood. This analysis shall also address the potential for foreseeable future development. Evaluation of the effects of flooding from dam failure shall extend at least to the location downstream where the classification can be properly identified. The dam breach and flood routing analysis shall include, but not be limited to:

(a) [dam failure inundation maps;] description of the dam breach and flood routing methodology;

(b) map of the water surface profiles;

c) cross sections drawn to scale showing water surface elevation at critical sections where structures are impacted and showing discharge in cubic feet per second, average velocity in feet per second, flood wave travel times, rate of rise and structures located in the flooded sections;

d) a tabulation and justification of [assumed] parameters used in the analysis;

e) a sensitivity analysis of the [assumed] parameters used in the analysis;

(f) references to all computer models, data and supporting justification used in the analysis; and

g) appropriate data sheets and computer program output computations from computerized analysis shall be provided.

(2) Hydrologic analysis. The hydrologic analysis shall include a discussion of methodology used to calculate the spillway design flood for determining the available flood storage and spillway capacity. Consideration of how the dam will perform under these hypothetical flood conditions shall be evaluated. The hydrologic analysis shall include, but not be limited to:

(a) a topographic map of the drainage area above the dam with the drainage area and sub-basins delineated and presented on a map of appropriate scale and size;

(b) a description of the topography, soils and vegetative cover and land treatment of the drainage area;

(c) a discussion of the depth, duration and distribution of the spillway design storm;

(d) a tabulation, discussion and justification of all hydrologic parameters and methodology used to calculate runoff from rainfall;

(e) a discussion of the peak inflow, volume of runoff and maximum reservoir water level elevation for the inflow hydrograph;

(f) a plot of the reservoir inflow and outflow hydrographs extended until flow is negligible and plotted on the same figure of appropriate size and scale;

(g) a table showing the reservoir area (in acres) and storage capacity (in acre-feet) for each foot of elevation above the bottom of the reservoir to the dam crest; the table shall be determined from the reservoir topography map: indicate the amount of dead storage, elevation of the invert of the outlet and elevation of the crest of each spillway; all elevations shall be based on North American vertical datum 1988 or more recent adjustment; and

(h) appropriate data sheets and computer program output computations from computerized analysis shall be provided.

(3) Spillway design flood. The spillway design flood is the flood that a spillway must be capable of conveying without dam failure. For perimeter embankment dams with no spillway and no external drainage area, the dam must be capable of impounding the spillway design flood without dam failure. A spillway design flood less than these requirements is acceptable to the state engineer if an incremental damage analysis is presented to justify the inflow design flood in accordance with Paragraph (4) of Subsection C of 19.25.12.11 NMAC. The spillway design flood is based on size classification and hazard potential classification of the dam as [follows] described below.
(a) Dams classified as low hazard potential, regardless of size, shall have spillways designed to pass a flood resulting from a 100-year precipitation event expressed as a percentage of the probable maximum precipitation.

(b) Dams classified as small and intermediate, with a significant hazard potential rating shall have spillways designed to pass a flood resulting from 50 percent of the probable maximum precipitation.

(c) Dams classified as large, with a significant hazard potential rating shall have spillways designed to pass a flood resulting from 75 percent of the probable maximum precipitation.

(d) Dams classified as high hazard potential, regardless of size, shall have spillways designed to pass a flood resulting from the probable maximum precipitation.

(4) Incremental damage assessment. [Where spillways are not in compliance with Paragraph (3) of Subsection C of 19.25.12.11 NMAC an incremental damage assessment shall justify the inflow design flood used to size the spillway. The assessment shall evaluate the consequences of dam failure. The assessment shall compare the impact of with failure and without failure conditions on downstream water levels and existing and known future development.] Where spillways cannot be designed to comply with Paragraph (3) of Subsection C of 19.25.12.11 NMAC an incremental damage assessment shall justify the spillway design flood used to size the spillway. The spillway design flood from an incremental damage assessment is the flood above which the incremental increase in downstream water surface elevation due to failure of a dam is no longer considered to present an unacceptable additional downstream threat when compared to the same flood without dam failure. The lower limit is the flood resulting from the 100-year precipitation. The assessment shall compare the incremental impacts on downstream areas including existing and foreseeable future development. The assessment shall include a dam breach and flood routing analysis in accordance with Subparagraphs (a) through (g) of Paragraph (1) of Subsection C of 19.25.12.11 NMAC for the failure and non-failure conditions. Methods for assessing the damage between failure and non-failure conditions shall be fully documented.

(5) Spillway capacity. The spillway capacity shall be adequate to pass the spillway design flood in accordance with Paragraph (3) of Subsection C of 19.25.12.11 NMAC or accepted inflow design flood in accordance with Paragraph (4) of Subsection C of 19.25.12.11 NMAC without failure of the dam. [If design calculations show that overtopping will occur, an erosion study of the embankment documenting that the dam will not breach is required.] If the outlet works are gated, the design discharge of the outlet works shall not be considered when routing the spillway design flood through the reservoir and spillway. The water level shall be at the normal operating level at the beginning of the spillway design storm. A spillway rating curve and table showing elevation in one-foot increments versus maximum discharge capacity shall be prepared. The rating curve and table shall include data from the crest of the spillway to the dam crest. The parameters used to calculate the spillway capacity shall be justified and appropriate data sheets and computer program output computations from computerized analysis shall be provided. Elevations shall be based on North American vertical datum 1988 or more recent adjustment.

(6) Spillway design. Spillways shall be evaluated for erosion potential during normal operation and the design flood event. Damage to a spillway during the design flood event is acceptable; however, a breach of the spillway is unacceptable. The spillway design shall address the [following] minimum requirements described below.

(a) The material required for spillway lining depends on the spillway location, frequency of discharge and velocity of discharge to adequately address erosion and breach potential. The design shall provide adequate justification for the material selected.

(b) The design shall provide aeration of the nappe for cavitation control where control weirs are used at the spillway crest.

(c) The spillway must discharge away from the toe of the dam and abutment slopes.

(d) The design shall address the potential for the accumulation of debris that may block the spillway [shall be addressed].

(e) [Energy dissipation to control erosion of the natural channel due to spillway discharge shall be addressed.] The design shall address energy dissipation to control erosion of the natural channel due to spillway discharge reasonably expected to occur during the life of the dam.

(f) Channel lining shall be placed on a suitably prepared, stable subgrade. All edges and joints in channel lining material must be designed to prevent undermining and erosion. Concrete channel lining must be provided with adequate jointing to permit thermal expansion and contraction and adequate reinforcing to control thermal cracking. Adequate water stops are required at joints in the spillway lining. Concrete lining shall be
adequately anchored against displacement and uplift and shall be provided with adequate subdrainage to relieve hydrostatic pressure and prevent frost heave.

(g) Where training dikes are used to divert the water away from the dam, the dike shall be designed with a compaction to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557, or at least 70% relative density if Proctor testing is not appropriate. Erosion protection for the dike shall be addressed in accordance with Paragraph (16) of Subsection C of 19.25.12.11 NMAC.

(7) Outlet works capacity. Dams shall be designed with a low level outlet to drain the entire contents above the elevation of the downstream toe of the dam. If environmental consequences prevent draining of the reservoir, the state engineer will grant a waiver if written justification is provided to the satisfaction of the state engineer. The outlet shall be sized to provide adequate capacity to satisfy water rights of downstream priority users. A stage discharge curve and table showing elevation in one-foot increments versus discharge capacity shall be prepared. The rating curve and table shall be from the invert of the outlet to the dam crest. The parameters used to calculate the outlet works capacity shall be justified and appropriate data sheets and computer program output computations from computerized analysis shall be provided. Elevations shall be based on North American vertical datum 1988 or more recent adjustment. The outlet works capacity shall meet the following minimum requirements described below.

(a) Outlets for water storage [reservoirs] dams shall drain the reservoir in 45 days with supporting calculations provided.

(b) Outlets for flood control dams shall drain the reservoir in 96 hours unless a waiver is granted by the state engineer. The 96-hour time frame begins once the reservoir storage drops to the emergency spillway crest or reaches its peak during the 100-year, 24-hour event. Documentation supporting the waiver shall include the time to drain more frequent events.

(8) Outlet works design. The outlet works design includes the intake structure, conduit and terminal structure. The outlet works design shall meet the following minimum requirements described below.

(a) Minimum conduit diameter is 18 inches unless a waiver is granted by the state engineer. Documentation supporting a waiver shall include identification of methods to inspect the interior of the conduit.

(b) Metal conduits used in dams that are classified as significant hazard potential where the sole purpose of the dam is flood control, or in dams classified as low hazard potential, shall have adequate strength after corrosion for a minimum of 200 years, based on corrosivity testing of onsite soils. Cathodic or other protection of metal conduits is permissible and may be considered in this analysis. Metal conduits are not acceptable for dams classified as high hazard potential or dams classified as significant hazard potential with permanent water storage except as interior forms for cast-in-place concrete conduits.

(c) Outlet conduits for storage reservoirs shall be gated at the upstream end unless a waiver is granted by the state engineer. Where gates are located other than at the upstream end of the conduit, a guard gate or bulkhead shall be provided at the upstream end to allow draining of the conduit for inspection, maintenance and repair.

(d) Outlet conduits shall be adequately vented and shall include all supporting calculations. Where the outlet conduit ties directly to a downstream pipe, a by-pass valve shall be provided.

(e) Outlet controls and equipment shall be properly designed to be secure from damage due to vandalism, weather, ice, floating debris, wave action, embankment settlement and other reasonably foreseeable causes. The outlet control operators shall remain accessible during outlet works and spillway releases.

(f) Outlets for flood control structures shall be ungated. Where a gate is required to satisfy downstream release restrictions, a waiver from the state engineer is required. The written request for waiver shall include a plan for timely release of the floodwater.

(g) Outlet works intake structures shall be provided with trash racks or grates to prevent clogging with debris. Grate opening [size] area or bar spacing shall be adequate to satisfy applicable public safety requirements, if appropriate. Total [size] area of grate openings must be at least three times the cross-sectional area of the outlet conduit.

(h) The design of the outlet works terminal structure shall address energy dissipation to prevent erosion and shall include supporting calculations.

(i) Outlet conduits shall be designed for full embankment loading and for hydrostatic pressure equal to the maximum reservoir head, acting separately and in combination, with an adequate factor of safety for the
conduit material. If future increases in embankment height or reservoir head are foreseeable, allowance shall be made in the design.

(j) The conduit together with all joints and fittings shall be watertight at the design pressure and shall be pressure tested prior to backfilling. Conduits shall be designed for all reasonably foreseeable adverse conditions including corrosion, abrasion, cavitation, embankment settlement and spreading, thermal effects and seismic loading. The ability of the conduit to withstand deflection and separation at the joints shall be addressed in the design of the outlet conduit.

(k) Outlet works shall be supported by stable, well-consolidated foundation materials. Where the conduit is placed in embankment fill or native overburden materials, settlement analysis shall be performed.

(l) Minimizing seepage along conduits shall be addressed including the methods for ensuring compaction of backfill around and beneath the conduit. Seepage collars are not an acceptable design standard for controlling seepage.

(m) All supporting documentation and calculations for the outlet works design shall be provided. The outlet works design shall include all foreseeable loading conditions, including but not limited to ice loading, debris buildup, wave action and embankment settlement. Structural design calculations for the intake structure, conduit and outlet structure shall be submitted.

9) Geological assessment. A geological assessment of the dam and reservoir site is required for all dams classified as high or significant hazard potential. The geological assessment may be included in the geotechnical investigation or seismic study, or may be submitted as a separate document. The geological assessment shall address regional geologic setting; local and site geology; geologic suitability of the dam foundation; slide potential of the reservoir rim and abutment areas; and seismic history and potential.

10) Geotechnical investigation. A geotechnical investigation shall assess site conditions and support the design. A professional engineer licensed in the state of New Mexico qualified to provide geotechnical expertise in the design and construction of dams shall prepare, stamp and sign the geotechnical investigation, which may be submitted as a separate report. The scope of the geotechnical investigation is dependent on the size classification, hazard potential classification, anticipated materials and construction methods, site geology and seismicity, anticipated soil strata and other site-specific conditions. The geotechnical investigation shall include a field investigation and laboratory testing. Results of field and laboratory testing shall be presented in a report, including recommended parameters to be used in design and construction of the dam and appurtenant structures. The field investigation and laboratory testing shall include but not be limited to the following:

(a) test borings in the footprint of the embankment, spillway excavations and appurtenant structures extending to bedrock or to a depth equal to at least the height of the dam; where appropriate, borings may include coring of bedrock materials to determine the quality and character of the rock;

(b) standard penetration tests or other field-testing to assess soil character and consistency;

(c) “undisturbed” sampling for further tests such as insitu density, shear strength and compressibility;

(d) supplemental test pits, if deemed necessary, to obtain bulk and undisturbed samples, assess soil layering and measure bedrock orientation;

(e) measurement of water level in drill holes;

(f) field permeability testing, if feasible;

(g) logs of test borings and test pits, location map and profile along dam axis with soil information shown;

(h) testing to determine the relevant properties of the material to be used in construction, including but not limited to shear strength, permeability, compressibility and filter characteristics; the testing method shall conform to accepted industry standards and be appropriate for the material being tested;

(i) evaluation of liquefaction potential and dynamic shear strength testing if deformation analysis is required; and

(j) identification of the location of the borrow material to be used during construction.

11) Seepage and internal drainage. The effects of seepage and potential for internal erosion shall be evaluated. For dams with aesthetic fill on the downstream slope, the effects of seepage shall be evaluated with and without the aesthetic fill. A seepage analysis shall be performed to address the performance of the embankment under steady-state conditions for dams classified as high or significant hazard potential. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the seepage analysis. A waiver may be requested in writing for flood control dams [or reservoirs with synthetic liners] that drain in 96 hours.
seepage analysis and internal drainage design shall include [but not be limited to the followings] the minimum requirements described below.

(a) Flow nets of appropriate size and scale shall be prepared. The effects of anisotropy with respect to permeability shall be addressed. Ratios of horizontal to vertical permeability of less than 4 for constructed embankments and less than 9 for native deposits shall be supported by field and laboratory permeability tests. Appropriate data sheets and computer program output computations from computerized analysis shall be provided.

(b) The design shall address the effects of anticipated seepage beneath, around and through the dam. Seepage shall not exit on the dam face and excessive exit seepage gradients are unacceptable. All filter, transition and drainage zones within earth dams shall have a thickness adequate to address constructability and enhance seismic stability with a minimum thickness of 3 feet for each zone.

(c) Collector pipes and conduits for internal drains shall be made of non-corrodible material capable of withstanding the anticipated loads. If possible, pipes shall be located where they can be exposed for repair or replacement without threatening the stability of the dam. Collector pipes for drains shall be enveloped in a free-draining medium meeting filter criteria for adjacent embankment or foundation zones. Where surging or hydraulic gradient reversal is likely, perforation size must be less than the diameter at which 15 percent of the surrounding medium is finer. Where surging or hydraulic gradient reversal are unlikely, the perforation size must be less than the diameter at which 85 percent of the surrounding medium is finer.

(d) Drain pipes shall be sized to provide a flow depth no more than ¼ of the pipe diameter when carrying the anticipated discharge. Drain pipes shall be at least 6 inches in diameter unless the availability of technology for inspection and maintenance can be demonstrated. Individual pipes shall discharge to a gallery, well, manhole, or to daylight such that the flow of each pipe can be monitored and measured. Manifold connections, tees and wyes are not permitted. A seepage measuring device must be appropriate for the rate of anticipated flow. The measuring device must include an upstream catchment to detect any sediment in the seepage. Where pipes from internal drains are discharged to daylight, a rodent screen shall be provided.

(12) Stability analysis. Cross-sectional design for dams shall be supported by slope stability analysis. For dams with aesthetic fill on the downstream slope, the stability of the downstream slope shall be evaluated with and without the aesthetic fill. Dams classified as low hazard potential with upstream slopes no steeper than 3 horizontal to 1 vertical, downstream slopes no steeper than 2 horizontal to 1 vertical and which are 25 feet or less in height will not require slope stability analysis. Stability analysis of the reservoir rim is required where slopes are steeper than 3 horizontal to 1 vertical. The analysis model shall adequately represent the geometry and zoning, shear strength parameters, material unit weights, pore pressure and seepage conditions, external loading and other relevant factors of the critical cross section or sections. Manual computations in the analysis will be accepted if judged to be sufficiently rigorous. Where appropriate, the analysis shall consider noncircular or block and wedge type failure surfaces as well as circular failures. All parameters and assumptions used in the analysis shall be summarized in a table and justified in the geotechnical investigation. A scale drawing, utilizing the same scale for vertical and horizontal dimensions, shall be provided for each cross-sectional model used in the analysis, with the critical failure surface(s) identified. Appropriate data sheets and computer program output computations from computerized analysis shall be provided. Dams shall be designed to provide the following minimum factors of safety from the stability analysis:

(a) 1.5 for steady state long-term stability;
(b) 1.5 for operational drawdown conditions;
(c) \[4-2\] 1.3 for rapid drawdown conditions; and
(d) \[4-2\] 1.3 for end of construction.

(13) Seismic design and analysis. Dams and appurtenant structures classified as high or significant hazard potential shall be analyzed for seismic stability. Seismic analysis for water storage dams shall be based on full reservoir under steady state seepage conditions. Flood control dams with ungated outlets that satisfy Subparagraph (b) of Paragraph (7) of Subsection C of 19.25.12.11 NMAC without waiver shall be designed for earthquake loads under empty reservoir conditions and need not consider steady-state seepage. Dams sited on active faults shall obtain a waiver from the state engineer. To obtain a waiver the analysis shall show that the location of the dam is unavoidable and the dam must be designed to withstand anticipated fault movement without compromising its integrity. Appropriate data sheets and computer program output computations from computerized
analysis shall be provided. The seismic analysis shall meet the [following] minimum requirements [\(\star\)] described below.

(a) A seismological investigation for the dam area and reservoir area shall be performed. This study may be part of the geological or geotechnical report for the structure, or may be a separate effort. The study shall determine and justify the appropriate seismic parameters to be used for design. The dam and appurtenant structures shall be capable of withstanding the operating basis earthquake without damage. The operating basis earthquake has a 50% probability of exceedance during the service life of the dam or appurtenant structures. In no case shall the service life be less than 100 years. The dam and appurtenant structures critical to the safety of the dam shall be capable of withstanding the design earthquake without failure. The seismic parameters shall be based on the [following] design earthquake [\(\star\)] requirements described below.

(i) Dams classified as high hazard potential other than flood control structures shall be designed for the maximum credible earthquake or for [an earthquake with a 5000-year return frequency] a 1% probability of exceedance in 50 years (approximately 5000-year return frequency).

(ii) Dams classified as significant hazard potential or high hazard potential dams whose sole purpose is for flood control shall be designed for a 2% [chance of occurrence] probability of exceedance in 50 years (approximately 2500-year return frequency).

(b) An analysis of materials in the foundation, reservoir area and proposed embankment shall be completed to determine the potential for liquefaction, earthquake-induced sliding, or other seismic sensitivity, which may be accomplished as part of the geotechnical investigation.

(c) Pseudostatic analysis will be acceptable for the following cases:

(i) the embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557 [or at least 70% relative density if Proctor testing is not appropriate]; no materials prone to liquefaction are present in the foundation and peak [bedrock] ground acceleration is 0.20g or less; or

(ii) the embankment is to be mechanically compacted to at least 95% of the maximum standard Proctor density, ASTM D 698, or at least 90% of the maximum modified Proctor density, ASTM D 1557; potentially submerged portions of the embankment except for internal drain elements are constructed of clayey material; the dam is constructed on clayey soil or bedrock foundation and peak [bedrock] ground acceleration is 0.35g or less; and

(iii) all safety factor requirements in accordance with Subparagraphs (a) through (d) of Paragraph (12) of Subsection C of 19.25.12.11 NMAC are met;

(iv) minimum freeboard requirements in accordance with Subparagraphs (a) through (e) of Paragraph (15) of Subsection C of 19.25.12.11 NMAC are met; and

(v) the pseudostatic coefficient selected for analysis must be at least 50% of the predicted peak [bedrock] ground acceleration, but not less than 0.05g and the factor of safety under pseudostatic analysis shall be 1.1 or greater. In determining the factor of safety for pseudostatic analysis, a search for the critical failure surface shall be made.

(d) For dams not satisfying the requirements for pseudostatic analysis, a deformation analysis is required. The resulting embankment must be capable of withstanding the design earthquake without breaching and with at least 3 feet of freeboard remaining after deformation. The analysis shall also assess the potential for internal erosion as a result of cracking during deformation.

(e) The seismic assessment shall also address the stability of appurtenant structures to the dam during the design earthquake as appropriate, unless failure of an appurtenance due to earthquake does not represent an immediate threat to the dam, in which case the operating basis earthquake may be used.

(14) Dam geometry. The dam geometry shall be supported by the stability and seismic analysis and [meeting the following minimum requirements] shall meet the minimum requirements described below.

(a) The crest width shall be at least equal to the dam height in feet divided by 5 plus 8 feet, with the minimum permissible crest width being 10 feet and the maximum required crest width being 24 feet.

(b) Roads located on the crest shall have appropriate surfacing to provide a stable base that resists rutting and provides adequate friction for safety in wet conditions.

(c) The crest design shall provide a minimum of 2 feet of cover or the depth of frost penetration; whichever is greater, above clay cores to prevent cracking of the core due to desiccation or frost penetration.
(d) Turnarounds [should] shall be provided on dead-end service roads on dam crests, located in such a manner that backing maneuvers longer than 300 feet are eliminated.

(e) The crest shall be provided with adequate cross slope to prevent ponding.

(f) The slope or slopes to which crest drainage is directed must be provided with adequate erosion protection to accept the crest drainage.

(g) The crest longitudinal profile shall be provided with adequate camber to maintain the profile after embankment settlement. Camber [should] shall be based on a settlement analysis and shall be at least 2 percent of the total embankment height, with a minimum of 1 foot at the highest point of the dam. The tops of internal core zones shall also be provided with camber in a similar manner to the crest of the dam.

(h) In the event that safety berms, street curbs, or other longitudinal features which block, control, or concentrate drainage are required on the dam crest, the design shall provide for collection and conveyance of accumulated water to discharge away from the embankment without erosion.

(15) Freeboard. Dams shall be provided with adequate freeboard. Wave runup shall be determined taking into consideration wind speed, reservoir fetch, embankment slope and roughness of the slope surface.

Freeboard shall satisfy the [following conditions] minimum requirements described below.

(a) Anticipated wave runup resulting from a 100 mph wind with reservoir level at the spillway crest will not overtop the dam.

(b) Anticipated wave runup resulting from a 50 mph wind with maximum reservoir level from routed spillway design flood will not overtop the dam.

(c) Clay core cover and capillary rise requirements in accordance with Subparagraph (c) of Paragraph (14) of Subsection C of 19.25.12.11 NMAC are satisfied.

(d) A minimum of 3 feet of freeboard remains after seismic deformation.

(e) In any case, at least 4 feet of freeboard shall be provided. The minimum of 4 feet of freeboard may be waived for perimeter embankment dams with no spillway and no external drainage area, provided a written request is made to the state engineer accompanied with supporting justification.

(16) Erosion protection. Erosion protection shall be addressed to protect the dam and appurtenant structures from erosion that can threaten the safety of the structure. [At a minimum, the following areas of erosion shall be addressed:] Erosion protection shall address the minimum requirements described below.

(a) Wave erosion. The upstream slope shall be protected from wave erosion. The material selected and area of coverage shall be appropriate for the protection required with justification provided. Flood control dams in compliance with Subparagraph (b) of Paragraph (7) of Subsection C of 19.25.12.11 NMAC without waiver are exempt from wave protection.

(b) Surface erosion. The slope, crest, abutment and groins, toe areas and any other constructed areas associated with the dam and appurtenant structures shall be protected from [surface wind erosion and erosion from concentrated and sheet flows. The material selected and area of coverage shall be appropriate for the protection required with justification provided.

(17) Geotextile design. Geotextiles are an acceptable material for use in dam design only if the geotextile is placed so that it does not jeopardize the dam or appurtenant structures during repair or failure of the geotextile. The geotextile [material] shall be used in accordance with the manufacturer’s recommendations and intended use for the product. [Installation shall be by certified personnel and the completed installation certified by installer or manufacturer, if required by the manufacturer.] Geotextile design computations shall be provided. Where a geotextile is used for fluid containment the installation shall be performed by certified personnel and the completed installation shall be certified by a qualified independent entity.

(18) Structural design. The structural design information for all appurtenant structures, addressing water, earth, ice and any other applicable load shall be provided. Reinforced concrete design including assumptions for loads and limiting stresses and sample calculations shall be provided. Appropriate data sheets and computer program output computations from computerized analysis shall be provided.

(19) Utilities design. Utility placement or relocation shall be addressed as applicable. Utilities located in the vicinity of the proposed embankment footprint and spillway footprint and seepage limits must be relocated and trenches backfilled and compacted with suitable material to the satisfaction of the state engineer. If utilities are allowed to remain, they will be required to satisfy applicable provisions for outlet conduits in accordance with Paragraph (8) of Subsection C of 19.25.12.11 NMAC.
Miscellaneous design. Because each design is unique, all design elements not specifically addressed in these regulations shall be documented and justified with sample calculations and appropriate data sheets and computer program output computations from computerized analysis shall be included in the design report.

D. Construction drawings: Construction drawings shall be submitted in a form acceptable to the state engineer. The final construction drawings shall also be submitted in an electronic format acceptable to the state engineer. A professional engineer licensed in the state of New Mexico qualified in dam design and construction shall prepare the construction drawings. Illegible, mutilated, careless or otherwise poorly prepared drawings are not acceptable for filing with the state engineer. Plan drawings and maps prepared with the aid of a computer require the submittal of the digital data files in tagged image file format or other format acceptable to the state engineer. The preparation of construction drawings is described below and shall include the following items. The construction drawings shall contain the information described below and any other additional information determined necessary by the state engineer to evaluate if the construction drawings are consistent with the design.

(1) Quality. Construction drawings and maps shall be made from actual field or photogrammetric surveys of an accuracy acceptable to the state engineer. Construction drawings and maps shall be prepared with permanent black ink on mylar. All original signatures, dates and acknowledgments appearing on the sheet(s) shall be in permanent ink. Plan Construction drawings and maps shall always be rolled, never folded, for transmittal.

(2) Scale and size. Sheets shall range in size from twenty-two (22) to twenty-four (24) inches by thirty-four (34) to thirty-six (36) inches with one (1) inch margins on all sides. The scale(s) used on the drawings may vary according to requirements and space available to show all necessary data in detail clearly in feet and decimals and to be clearly legible when the drawings are reduced to eleven (11) inches by seventeen (17) inches. Detailed dimensions of appurtenant structures shall be given in feet and inches. All sheets shall have bar scales in order to allow scaling of reduced drawings.

(3) Sheet numbers. Each sheet shall be numbered sequentially with the first sheet being sheet number one in conjunction with the total numbered sheets (example Sheet 1 of 5). The sheet number on the last sheet shall equal the total number of sheets.

(4) Engineer’s seal and signature. Each sheet shall have the responsible engineer’s seal and signature. Seals and signatures shall be presented in accordance with 16.39.3 NMAC.

(5) Orientation and date. The direction of north and the basis of bearings shall be shown on all maps. The date that field surveys are made or the date of the aerial photography used shall be shown on the maps.

(6) Title sheet. The first sheet of a set of plans is the title sheet. The title sheet shall only contain sufficient information to summarize the scope of the project, the title of the project and signed certifications from the dam owner, engineer and state engineer in accordance with Subsections A, B and E of 19.25.12 NMAC. The title sheet shall summarize the properties of the dam and shall include the following information, as appropriate:

(a) name of the dam (same as shown on the application);
(b) type of dam (material);
(c) hazard potential classification;
(d) maximum height above the downstream toe in feet;
(e) maximum length in feet;
(f) crest width in feet;
(g) slope of the upstream face (horizontal to 1 vertical);
(h) slope of the downstream face (horizontal to 1 vertical);
(i) elevation of the dam crest in feet;
(j) elevation of spillway crest in feet;
(k) length of the conduit in feet;
(l) invert elevation of the upstream end of the conduit in feet;
(m) invert elevation of the downstream end of the conduit in feet;
(n) freeboard in feet;
(o) residual freeboard in feet;
(p) maximum spillway discharge capacity in cubic feet per second;
(q) type of outlet conduit (give size and material);
(r) maximum outlet conduit discharge capacity in cubic feet per second; and
(p) (5) location of the outlet works intake structure (using latitude and longitude [or to the New Mexico state plane coordinate system] in decimal degrees).

(6) Vicinity map. A vicinity map of sufficient scale and size to locate the pertinent area shall be shown on the title sheet or second sheet of the drawings.

(7) Site topography. A detailed topography of the dam site including sufficient area upstream and downstream and at the abutments shall be provided. Elevations shall be based on North American vertical datum 1988 or more recent adjustment.

(8) Design details. Detailed information of the various construction features including plan view, elevations, cross-sections at the maximum section and along the outlet works, profile along and section through the centerline of the dam showing the foundation materials, construction features and cross-sections and a profile of the emergency spillway with dimensions and construction details shall be provided. Any other information necessary for the state engineer to determine the feasibility and safety of the dam shall be [required] provided.

(10) Reservoir area, capacity and high water line traverse. The topography of any proposed reservoir site shall be determined to industry standards and a contour map with a contour interval of 1 foot shall be prepared. Elevations of the contours shall be tied to the North American vertical datum of 1988 or more recent adjustment. [The high water line at the elevation of the dam crest will be highlighted on the contour map.] The elevation of the high water line will be highlighted on the contour map. A curve [or] and table of elevation versus area and storage capacity for the reservoir shall be prepared from the contour map. The curve [or] and table shall be from the bottom of the reservoir to the dam crest. Area shall be provided in acres and storage capacity in acre-feet.

 connaît. Point of outlet. A location of the outlet works shall be referenced using latitude and longitude [or to the New Mexico state plane coordinate system.]

(11) Permanent bench mark. A permanent bench mark shall be established above the high water line at a location unlikely to settle or be disturbed. The North American vertical datum of 1988 or more recent adjustment [and latitude and longitude or the New Mexico state plane coordinate system] for the bench mark elevation and the latitude and longitude in decimal degrees for the bench mark location shall be provided. A detail of construction of the permanent bench mark shall be provided.

E. Specifications: [Specifications] A specification package shall be prepared for each project describing work to be done and materials to be used to supplement construction drawings. [Specifications must be clear and concise and include detailed methods of construction, qualities and sizes of materials, unit amounts to be used and methods of testing and quality control, construction supervision and inspection.] Specifications shall be submitted in a form acceptable to the state engineer. The specifications shall also be submitted in an electronic format acceptable to the state engineer. Reference to standard specifications is not acceptable. Inclusion of appropriate specification sections derived from model specifications is acceptable. Specifications must be clear and concise. Specifications shall include detailed methods of construction, qualities and sizes of materials, unit amounts to be used, methods and frequency of testing and quality control, construction supervision and frequency of inspection. Specifications shall be prepared by a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams. The specifications shall [meet the following requirements:] contain the information described below and any other additional information determined necessary by the state engineer to evaluate if the construction methods are consistent with the design and construction drawings.

(1) The front cover of the specifications shall show the name of the dam (identical to the application) and the county in which the dam is located. The first page behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located, [signed certifications for the engineer and state engineer in accordance with Subsections B and E of 19.25.12.12 NMAC and a statement recognizing the authority of the state engineer. An approved model statement recognizing the authority of the state engineer is provided below. Changes to the model statement require prior approval of the state engineer. “All construction shall be performed in strict accordance with the accepted plans and specifications. Representatives of the state engineer shall have full authority to perform inspections during construction and shall have full power to act pursuant to the law and in accordance with Title 19, Chapter 25, Part 12, Dam Design, Construction and Dam Safety of the New Mexico Administrative Code if plans and specifications are not followed.”] a signed certification from the engineer and a certification for the state engineer in accordance with Subsections B and E of 19.25.12.12 NMAC.

(2) The specifications shall [be indexed] include a table of contents.

(3) The specifications shall be bound and submitted on [a good grade of white] 8 1/2-inch by 11-inch white paper.
The general conditions shall include statements that the construction drawings and specifications cannot be significantly changed without the prior written approval of the state engineer. The general conditions shall include a statement that the construction drawings and specifications cannot be changed without the prior written approval of the state engineer and must recognize the authority of the state engineer to perform inspections during construction. An approved model statement is provided below. Changes to the model statement require prior approval of the state engineer. All construction shall be performed in strict accordance with the accepted construction drawings and specifications. Changes to the accepted construction drawings or specifications require prior written approval of the state engineer. Representatives of the state engineer shall have full authority to perform inspections during construction and shall have full power to act pursuant to the law and in accordance with Title 19, Chapter 25, Part 12, Dam Design, Construction and Dam Safety of the New Mexico Administrative Code if construction drawings and specifications are not followed.

F. Boundary, easement or right of way plat of survey: A plat of survey shall be submitted in a form acceptable to the state engineer. A professional surveyor licensed in the state of New Mexico shall prepare a plat of survey showing the dam owner’s property boundaries or easement [and/or] right of way granted by the land owner. The plat of survey shall be prepared in conformance with the requirements as set forth in the Minimum Standards for Surveying in New Mexico, 12.8.2 NMAC. The plat of survey shall clearly state to whom an easement is granted and what rights are conveyed with the easement. The plat of survey shall show the footprint of the dam and appurtenant structures and the high water line in the reservoir. The plat of survey shall be [submitted with the construction drawings and] recorded with the county clerk of the county or counties in which the survey is located. A certificate signed by the surveyor in accordance with Subsection C of 19.25.12.12 NMAC shall appear on the plat of survey. A certified copy of the recorded plat of survey bearing the recorded page and endorsement of the county clerk shall be submitted to the state engineer for filing [upon completion of construction]. Adequate property ownership, easement or right of way shall be required for the following conditions:

1. to access the dam and outlet controls during normal and flood events;
2. to prevent development encroachment into the reservoir area defined by normal operation and the spillway design flood that adversely affects the performance of the dam;
3. to prevent development in the approach, control and discharge section of the spillway that may restrict flow through the spillway;
4. to return outlet works and spillway discharge to the natural drainage and allow the outlet works to discharge freely; and
5. to perform maintenance on the dam, appurtenant structures and surrounding areas to ensure the safe performance of the dam.

G. Dam site security: Dams classified as high or significant hazard potential shall address security at dams to prevent unauthorized operation or access. If in the opinion of the state engineer, the failure of the dam will result in catastrophic consequences, a security and risk management program for the dam will be required. Elements of a security and risk management program are:

1. threat, vulnerability and risk assessments;
2. physical security plans; and
3. integration of security operational procedures.

H. Instrumentation plan: An instrumentation plan shall be submitted in a form acceptable to the state engineer. An instrumentation plan providing the ability to monitor and evaluate the performance of a dam is required for dams classified as high or significant hazard potential. Instrumentation details must be included on the construction drawings and specifications must be consistent with the instrumentation plan. The instrumentation plan may be submitted as a separate report or as part of the [operation and maintenance manual] design report. Minimum requirements of the instrumentation plan shall include:

1. general description of instrumentation;
2. reading schedule;
3. identification of critical readings;
4. specifies for each installation including:
   a. detailed description of installations;
   b. purpose of the instrumentation;
   c. reading and maintenance schedule instructions; and
5. special instrumentation or monitoring requirements.

1. description and purpose;
(2) detailed description of installations;
(3) calibration and maintenance schedule and instructions;
(4) reading schedule and instructions;
(5) data reduction and interpretation instructions; and
(6) identification of critical readings.

I. Operation and maintenance manual: An operation and maintenance manual is required for dams classified as high or significant hazard potential. The operation and maintenance manual identifies activity necessary to address the continued safe operation, maintenance and overall performance of the dam. Any restrictions imposed by the design shall be addressed in the operation and maintenance manual. The operation and maintenance manual shall conform to the requirements set forth in 19.25.12.17 NMAC.

J. Emergency action plan: An emergency action plan is required for dams classified as high or significant hazard potential. The emergency action plan identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The emergency action plan shall conform to the requirements set forth in 19.25.12.18 NMAC.

19.25.12.12 CERTIFICATIONS: Signed certifications by the dam owner, engineer, surveyor, [state office of emergency management] local and state emergency management officials and the state engineer are required by these regulations on specific documents. Approved model certifications for the dam owner, engineer, surveyor, [state office of emergency management] local and state emergency management officials and state engineer are provided below. Changes to the model certifications require prior approval of the state engineer.

A. DAM OWNER’S CERTIFICATE: A certificate followed by the dated signature of the dam owner and notary public acknowledgment is required on the title sheet of the construction drawings and first page behind the front cover of the operation and maintenance manual and emergency action plan. The following model certification is considered to be an example of the minimum that the dam owner shall certify. If the dam owner is a corporation, political subdivision or other governmental entity a model certificate is also provided.

[ state of ________________ )
____________________ [ ss. ]
county of ________________ ]

I, (dam owner’s name) , being first duly sworn, upon my oath, state that I have read and examined the accompanying __________________ (construction drawings consisting of ____ sheets, operation and maintenance manual, or emergency action plan) and know the contents and representations therein for __________________ dam and all that is shown herein is done with my free consent and in accordance with my wishes and state that the same are true and correct to the best of my knowledge and belief.

_____________________________
Dam owner signature                   Date

Subscribed and sworn to before me this _____ day of __________________ , 20__. 

_____________________________
Notary public

My commission expires ____________ (SEAL)

If a claimant is a corporation, political subdivision or other governmental entity the following shall be used:

[ state of ________________ )
____________________ [ ss. ]
county of ________________ ]

I, (representative’s name) , being first duly sworn, upon my oath, state [ than ] that I am the ________________ (officer) of the __________________________, a __________ [ corporation ] (corporation or political subdivision) duly organized under the laws of the state of ________________, that the accompanying
(construction drawings consisting of ____ sheets, operation and maintenance manual, or emergency action plan) for ____________ dam were made under authority of the board of directors of said [corporation] (corporation or political subdivision) and that, in their behalf, I have read and examined the statements and representations and all that is shown herein is done with their free consent and in accordance with their wishes and state that the same are true and correct to the best of my knowledge and belief.

____________________________________
Representative signature, title           Date

Subscribed and sworn to before me this _____ day of __________________ , 20__.

_______________________________
Notary public

My commission expires ____________ (SEAL)

B. **ENGINEER’S CERTIFICATE:** A certificate followed by the dated signature, license number and seal of the engineer responsible for preparing the [design] report, construction drawings, specifications, operation and maintenance manual and engineering elements of the emergency action plan is required. The certificate shall be placed on the title sheet of the construction drawings and first page behind the front cover of the [design] report, specifications, operation and maintenance manual and emergency action plan. The following model certification is considered to be an example of the minimum that the engineer [should] must certify to:

[state of ________________________ )

_______________________________
county of  ______________________

I, ______ (engineer’s name)________, hereby certify that I am a professional engineer licensed in the state of New Mexico, qualified in ________________ (civil, geotechnical, etc.) engineering; that the accompanying ________________ ([design] report, construction drawings consisting of ____ sheets, specifications, ________________ elements of the operation and maintenance manual, or ________________ elements of the emergency action plan) for ____________ dam was prepared by me or under my supervision; that the accompanying ________________ ([design] report, construction drawings consisting of ____ sheets, specifications, ________________ elements of the operation and maintenance manual, or ________________ elements of the emergency action plan) is in compliance with the Dam Design, Construction and Dam Safety Regulations (19.25.12 NMAC) and that the same are true and correct to the best of my knowledge and belief. I further certify that this survey is not a land division or subdivision as defined in the New Mexico Subdivision Act and that this instrument is a (boundary, easement, or right of way) plat of survey of ________________ dam.

(Engineer’s signature) __________, License number ____________,                           (SEAL)

Engineer’s name

Date [submitted]: ________________

C. **SURVEYOR’S CERTIFICATE:** The professional surveyor licensed in the state of New Mexico preparing the plat of survey showing property boundaries, acquired easements or rights-of-way shall include a certificate on the plat of survey as modeled in Paragraph (2) of Subsection J of 12.8.2.9 NMAC, the Minimum Standards for Surveying in New Mexico. The following model certificate is considered to be an example of the minimum that the surveyor [should] must certify to:

I, ______ (surveyor’s name)________, New Mexico professional surveyor no. (surveyor’s license number), do hereby certify that this (boundary, easement, or right of way) plat of survey and the actual survey on the ground upon which it is based were performed by me or under my direct supervision; that I am responsible for this survey; that this survey meets the Minimum Standards for Surveying in New Mexico; and that it is true and correct to the best of my knowledge and belief. I further certify that this survey is not a land division or subdivision as defined in the New Mexico Subdivision Act and that this instrument is a (boundary, easement, or right of way) plat of survey of ________________ dam.
D. **STATE OFFICE OF EMERGENCY MANAGEMENT**: A certificate form for the state office of emergency management acceptance shall be placed on the first page behind the front cover of the emergency action plan. This certificate is to be signed by state office of emergency management after all necessary corrections or additions, if any, have been made.

state of ______________________ )

county of _____________________ )

**LOCAL AND STATE EMERGENCY MANAGEMENT OFFICIAL’S CERTIFICATE**: Certificate forms for the local and state officials responsible for emergency management shall be placed at the front of the emergency action plan and immediately after the engineering’s certificate. The local official’s certificate shall be placed in front of the state official’s certificate.

I hereby certify that the accompanying emergency action plan for _____________ dam has been duly examined by me and accepted for filing on the _____ day of _____________, 20__.

[State office of emergency management]

(Official’s signature) ____________

(Print official’s name) ______________________

(Print name of local or state emergency management entity)

E. **STATE ENGINEER’S CERTIFICATE**: A certificate form for the state engineer acceptance shall be placed on the title sheet of the construction drawings and first page behind the front cover of the [design] report, specifications, operation and maintenance manual and immediately after the state official responsible for emergency management in the emergency action plan. This certificate is to be signed by the state engineer or his representative after all necessary corrections or additions, if any, have been made.

[state of ______________________ ]

county of ______________________ )

I hereby certify that the accompanying _____________ ([design] report, construction drawings, specifications, operation and maintenance manual or emergency action plan) for _____________ dam and appurtenant structures has been duly examined by me and accepted for filing on the _____ day of _____________, 20__.

____________________________________

State engineer


**19.25.12.13 CONSTRUCTION AND OPERATION PERMIT CONDITIONS**: After reviewing the required documentation, the state engineer will notify the dam owner if any deficiencies are found with the submittal to construct and operate a dam. The dam owner will be given an opportunity to correct any deficiencies noted in the review process. Once all deficiencies have been addressed the state engineer will approve the application for permit to construct and operate a dam with conditions under which construction and operation shall occur. Failure to comply with conditions of the approved permit may result in the state engineer issuing an order to redesign, reconstruct or restrict operation of the dam and reservoir until conditions are met. Construction must be completed within two years of approving the application unless an extension of time for the construction is requested and approved by the state engineer. [The conditions of construction and operation shall include, but not be limited to the]
The permit conditions are described below and may include additional conditions determined necessary by the state engineer to ensure the dam is constructed and operated in a safe condition.

A. **Engineer supervising construction:** Prior to initiation of construction, the dam owner shall designate a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams to supervise construction. If the state engineer finds the engineer acceptable, an order is issued approving the engineer and setting forth conditions under which the engineer will supervise construction. [Conditions shall include, but shall not be limited to:] Construction supervision conditions are described below.

1. The engineer supervising construction shall submit monthly progress reports [including summary of test results, problems encountered and their solutions] that are signed and sealed. The report shall include:
   - (a) summary of construction activities;
   - (b) summary of test results;
   - (c) captioned and dated construction photographs; and
   - (d) a discussion of problems encountered and their solutions.

2. Construction shall be in accordance with accepted drawings and specifications. State engineer approval of any modifications to the accepted drawings or specifications is required prior to undertaking the modifications. Requests for changes or modifications by the engineer supervising construction shall be submitted in writing, supported with appropriate documentation.

3. The engineer supervising construction shall provide the state engineer a minimum of 72 hours notice to perform inspections as specified in the conditions of construction.

4. Upon completion of construction, the engineer supervising construction shall submit to the state engineer the following items:
   - (a) a completion report, which shall include descriptions of problems and their solutions;
   - (b) a summary of materials test data and labeled and dated construction photographs;
   - (c) record mylar construction drawings including signed certifications on the title sheet; and
   - (d) a certificate that the dam was constructed in accordance with the accepted drawings and specifications and is in satisfactory condition. An approved model certificate for the engineer supervising construction is shown below. Changes to the language in the certification require prior approval by the state engineer.

Upon completion of construction, the engineer supervising construction shall submit to the state engineer the items described below.

- (a) A construction completion report, which shall include a signed certification from the engineer supervising construction and a certification for the state engineer in accordance with Subsections B and E of 19.25.12.12 NMAC. The construction completion report shall also include:
  - (i) description of construction activities including problems and their solutions;
  - (ii) a summary of materials test data; and
  - (iii) captioned and dated construction photographs.

- (b) Record mylar construction drawings including a signed certification on the title sheet from the dam owner and a certification for the state engineer in accordance with Subsections A and E of 19.25.12.12 NMAC. The record mylar drawings shall also contain a signed certificate from the engineer supervising construction that the dam was constructed in accordance with the record drawings and specifications and is in satisfactory condition. If design changes are made during construction, the design engineer may also be required to sign a certification in accordance with Subsection B of 19.25.12.12 NMAC. An approved model certificate for the engineer supervising construction is shown below. Changes to the language in the certification require prior approval by the state engineer.

[State of ____________________________)

County of _____________________________)

I, ____________________________, (engineer’s name) state that I am a qualified professional engineer licensed in the state of New Mexico, that I have inspected the __________________________ dam and appurtenant structures and find them to be completed in accordance with the record construction drawings and specifications and are now in a satisfactory condition for acceptance.]
I, (engineer’s name), state that I am a qualified professional engineer licensed in the state of New Mexico, that I have supervised the (construction, repair, rehabilitation) of _______ dam and appurtenant structures and find them to be completed in accordance with the record construction drawings and specifications and are now in a satisfactory condition for acceptance.

(Engineer’s signature) ______________________ License number __________, (SEAL)
Engineer’s name

Date [submitted]: ______________

B. State engineer’s authority during construction: The state engineer may perform inspections at any time during construction of the dam and appurtenant structures. Inspections will vary with each project, based on the complexity of the design. Inspection of specific construction items are standard construction conditions in the permit and require the engineer supervising construction to provide the state engineer with a minimum of 72 hours advanced notice. If the state engineer receives a minimum of 72 hours advanced notice, a delay of construction to schedule a state engineer inspection is not required. State engineer inspection fees are charged in accordance with Subsection [D] E of 19.25.12.8 NMAC. Fees for inspection of construction by the state engineer not paid on demand shall become a lien on any land or other property of the dam owner and may be recovered by the state engineer.

C. Completion of construction: Upon completion of construction, a proof of completion of works form for the dam shall be submitted in accordance with 19.25.12.14 NMAC. Owners of dams classified as high or significant hazard potential shall submit to the [state engineer an updated operation and maintenance manual in accordance with 19.25.12.17 NMAC and an updated emergency action plan] state engineer any required updates to the operation and maintenance manual in accordance with 19.25.12.17 NMAC and any required updates to the emergency action plan in accordance with 19.25.12.18 NMAC incorporating any modifications made during construction. Upon the satisfactory completion of all conditions in the permit, pending the issuance of a certificate of completion of works form for the dam, use of the reservoir shall require written permission from the state engineer. Use of the dam and reservoir are restricted until the state engineer accepts the updated operation and maintenance manual and emergency action plan, if required.

D. Extension of time for construction: The state engineer will grant an extension of time for completing construction upon proper showing by the dam owner of due diligence or reasonable cause for delay and accompanied with a fee in accordance with Subsection [D] E of 19.25.12.8 NMAC. An affidavit by a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall be filed with the state engineer providing evidence that the design of the dam meets or exceeds the design requirements in accordance with 19.25.12.11 NMAC. An extension of time may be granted for a period not to exceed five (5) years. No extension of time shall be granted which in combination extend the time allowed by the permit beyond ten (10) years from the initial date of approval of the application, unless the state engineer in his discretion expressly waives this limitation pursuant to NMSA 1978, Section 72-5-14. Failure to request an extension of time shall result in cancellation of the permit by the state engineer.

E. Operation conditions: Operation conditions will be identified in the permit to construct and operate a dam. Operation conditions are described below:

1. The owner shall comply with the office of the state engineer rules and regulations for dams;
2. Changes to the easements require prior approval from the state engineer;
3. Changes, alterations, or modifications to the dam or sediment removal or dredging not outlined in the operation and maintenance manual requires state engineer approval prior to making the change;
4. The dam owner shall provide access to the state engineer for periodic dam safety inspections;
5. The dam owner must comply with all state engineer safety orders issued for the dam;
6. Owners of dams classified as low and significant hazard potential shall have the hazard classification periodically evaluated by a professional engineer licensed in New Mexico if downstream development occurs to ensure the dam design is not deficient;
7. Operation of the dam must be in compliance with the approved operation and maintenance manual and emergency action plan;
8. The dam owner shall operate the dam in compliance with any specific condition, requirement, or limitation established by the design engineer or otherwise applicable to the dam.
Failure by the dam owner to comply with operation conditions may result in revocation of the permit or license to operate and an order to breach the dam in accordance with Subsection B or C of 19.25.12.19 NMAC.

19.25.12.14  **PROOF OF COMPLETION OF WORKS:** Upon completion of all construction conditions a proof of completion of works for the dam shall be filed on a form provided by the state engineer with appropriate fees in accordance with Subsection [E] of 19.25.12.8 NMAC. The proof of completion of works for the dam shall be filed with original signature of the dam owner and engineer supervising construction. The proof of completion of works form shall be provided to the state engineer as a separate submittal.

19.25.12.15  **CERTIFICATE OF CONSTRUCTION OF A DAM:** Upon receipt of the proof of completion of works form, the state engineer will determine if all construction conditions of the permit were met. Upon a determination by the state engineer that all construction conditions have been complied with, the state engineer shall issue a certificate of construction. The certificate of construction shall address the general properties of the dam and appurtenant structures. The dam owner shall record the certificate of construction with the county clerk of the county within which the works are located.

19.25.12.16  **LICENSE TO OPERATE A DAM:** Upon issuance of a certificate of construction the state engineer shall issue a license to operate a dam. The license to operate a dam shall address operation conditions and dams shall be operated in accordance with the operation conditions. In addition, dams classified as high and significant hazard potential shall operate in accordance with the operation and maintenance manual and emergency action plan prepared in accordance with Sections 17 and 18 of 19.25.12 NMAC. Failure to comply with the conditions of the license to operate a dam may result in a state engineer order that limits operation, requires specific action by the owner and if necessary the license to operate a dam may be revoked by the state engineer. If a license to operate a dam is revoked the state engineer may order the dam breached in accordance with Subsections B or C of 19.25.12.19 NMAC.

19.25.12.17  **OPERATION AND MAINTENANCE MANUAL:** Owners of dams classified as high or significant hazard potential shall prepare, maintain and adhere to an operation and maintenance manual that addresses the continued safe operation, maintenance and performance of the dam. Because each site, design and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare the operation and maintenance manual. The front cover shall show the name of the dam (identical to the application), the county in which the dam is located and type of report. The first page behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located and signed certifications for the dam owner, engineer if required and the state engineer in accordance with Subsections A, B and E of 19.25.12.12 NMAC. If deemed appropriate, the state engineer may require the owner to obtain the services of a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams to prepare complex technical aspects of the operation and maintenance manual. The operation and maintenance manual shall be submitted in a form acceptable to the state engineer. The operation and maintenance manual shall also be submitted in an electronic format acceptable to the state engineer. The front cover shall identify the document as an operation and maintenance manual and shall show the name of the dam, the county in which the dam is located and the dam owner. The first page behind the front cover shall show the name of the dam, the county in which the dam is located, signed certifications from the dam owner, engineer if required and a certification for the state engineer in accordance with Subsections A, B and E of 19.25.12.12 NMAC. Operation or maintenance of the dam in violation of the procedures presented in the accepted operation and maintenance manual that affect the safety of the dam will result in an order being issued requiring the dam owner to address the problem. The state engineer may also issue an order restricting storage in order to improve the unsafe condition. Failure to comply with orders issued by the state engineer may result in the license to operate the dam being revoked and the dam being ordered breached in accordance with
Subsection B or C of 19.25.12 NMAC. [Generally, the] The operation and maintenance manual shall [address the following, with modification depending on the specific dam application] contain the information described below, if relevant to the project, and any other additional information determined necessary by the state engineer to evaluate if the dam will be operated and maintained in a safe condition.

[A. Project Information: General information on the project including the purpose, location, history, responsibilities and description and properties of the dam and appurtenant structures shall be required.]

A. General information: Information on the project shall include but not be limited to the following:

1. location and access;
2. purpose and description;
3. table of properties; and
4. history of construction, repairs and performance.

B. Operation: Operation instructions, frequency of operation and operator safety for the project shall include but not be limited to the following:

1. Reservoir:
   a. water right storage allocations;
   b. [spillway design flood water level] elevation, area and storage curve and table to the dam crest;
   c. [emergency reservoir evacuation procedures and maximum discharge rate; and] elevation of the high water line;
   d. discharge rating table for the outlet conduit;
   e. discharge rating table for the spillway;
   f. emergency reservoir evacuation procedures; and
   [g] first filling criteria and monitoring requirements.
2. Outlet works:
   a. first operation;
   b. seasonal startup;
   c. seasonal shutdown;
   d. installation and removal of bulkhead;
   e. operation procedures for specific equipment; and
   f. electrical systems and controls.
3. Operator safety:
   a. confined space entry and permits;
   b. fall protection;
   c. lockout/tag out; and
   d. other applicable safety requirements.

C. Instrumentation: [The following elements for monitoring instrumentation shall be addressed]

1. general description
2. purpose
3. critical readings
4. reading and maintenance procedures; and
5. reading schedule.] Instrumentation for the project shall include but not be limited to the following:

1. description and purpose;
2. detailed description of installation;
3. calibration and maintenance schedule and instructions;
4. reading schedule and instructions;
5. data reduction and interpretation;
6. identification of critical readings and notification procedures; and
7. schedule for reporting data with interpretations to the state engineer.

D. Security: Projects that include security measures shall describe the security measures along with instructions for monitoring, maintaining and inspection.

[D. Maintenance: Maintenance requirements and [schedule] frequency shall be included.
E. Inspection: Inspection requirements, [schedule] frequency and recommended checklist shall be included.
F. Updates and revisions: An update and revision procedure shall be included.
19.25.12.18 EMERGENCY ACTION PLAN: Owners of dams classified as high or significant hazard potential shall prepare, maintain and exercise an emergency action plan for immediate action in the event of a potential dam failure. The emergency action plan shall follow the format provided by the state engineer or a format that has prior approval of the state engineer. Because each site and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. The emergency action plan shall follow the format provided by the state engineer or a format that has prior approval of the state engineer. The emergency action plan shall also be submitted in an electronic format acceptable to the state engineer. The front cover shall identify the document as an emergency action plan and shall show the name of the dam (identical to the application), the county in which the dam is located and [type of report] the dam owner. The pages immediately behind the front cover shall show the name of the dam (identical to the dam name on the application), the county in which the dam is located and signed certifications for the dam owner, engineer, local and state office of officials responsible for emergency management and state engineer in accordance with Subsections A, B, D and E of 19.25.12.12 NMAC. The pages immediately behind the front cover shall show the name of the dam, the county in which the dam is located, signed certifications from the dam owner, engineer, local and state officials responsible for emergency management and a certification for the state engineer in accordance with Subsections A, B, D and E of 19.25.12.12 NMAC. The dam owner shall coordinate with the local emergency management office in preparing the emergency action plan. The coordination is required to ensure that there is an agreement on the evacuation limits and responsibilities. The dam owner shall submit a copy to the local and state [office of] officials responsible for emergency management for acceptance prior to submittal to the state engineer. The dam owner shall review the emergency action plan annually, update as necessary and furnish a copy of updates to [the state engineer, state office of emergency management and] all official copyholders. The dam owner shall exercise the emergency action plan to verify those involved in its implementation know their roles and responsibilities. [It is recommended the] The dam owner shall conduct a functional exercise of the emergency action plan every 5 years with a table top exercise conducted 2 to 3 years before the functional exercise. The exercise may result in updates to ensure the emergency action plan maintains operational readiness, timeliness and responsiveness. Failure to act in accordance with the accepted emergency action plan that affects [the safety of the dam] public safety will result in an order being issued requiring the dam owner to address the problem. Failure to comply with orders issued by the state engineer may result in the license to operate the dam being revoked and the dam being ordered breached in accordance with Subsection B or C of 19.25.12.19 NMAC. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare engineering [elements of] information for the emergency action plan as specified below. An emergency action plan shall [contain the following minimum elements:] contain the information described below and any other additional information determined necessary by the state engineer or emergency management official to evaluate the planned response to an emergency situation by the dam owner.

A. Notification flowchart: A notification flowchart showing who is to be notified, by whom and in what priority.

B. Emergency detection, evaluation and classification: Procedures for reliably and timely identifying an emergency situation to ensure that an appropriate course of action is implemented. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare this element.

C. Responsibilities: A list designating responsibilities for the emergency action plan related tasks including, but not limited to developing, maintaining, exercising, implementing, warning, evacuation and termination of the emergency.

D. Preparedness: A list of materials, equipment and manpower available to moderate or alleviate the effects of a dam failure or spillway release. [A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare this element.]

E. Evacuation map: An evacuation map delineating the areas that will be evacuated as a result of dam failure. The evacuation map shall extend to a point where the consequences of dam failure does not pose a threat to life and evacuation or restricting access is not required. If available, shape files from geographic information system software of the evacuation map shall be submitted. Evacuation maps shall include the following information at critical locations downstream as required by the local official responsible for emergency management:

1. distance downstream from the dam;
2. arrival time of the leading edge of the flood wave;
3. peak flow depth, incremental rise or water surface elevation in feet; and
4. peak velocity in feet per second.

F. Inundation map: An inundation map delineating the areas that will be flooded as a result of dam failure. [The dam breach analysis shall be prepared in accordance with Subparagraphs (a) through (g) of Paragraph (1) of Subsection C of 19.25.12.11 NMAC for the failure with the water level at the reservoir storage capacity and at the maximum water level during the spillway design flood event. If a dam is located upstream, failure scenarios with the upstream dam shall also be evaluated. Flood control dams that have not experienced a fill to the spillway crest shall prepare a failure scenario with the water level at the spillway crest. Flood inundation maps shall also be prepared for the maximum release without failure of the dam. Evaluation of the effects of flooding from dam failure shall extend at least to the location downstream where the flood no longer poses a threat to life or property.] The inundation map shall be supported by a dam breach and flood routing analysis report. The dam breach and flood routing analysis shall evaluate the sunny day failure, failure at the high water line and any additional event deemed appropriate by the dam owner. If appropriate considering the consequences of dam failure, a simplified dam breach and flood routing analysis may be used with approval from the state engineer. If a dam is located downstream, failure scenarios with the downstream dam shall also be evaluated. Evaluation of the effects of flooding from dam failure shall extend at least to the location downstream where the consequences of dam failure does not pose a threat to life and evacuation or restricting access is not required. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare this element. If available, shape files from geographic information system software of the inundation map shall be submitted. Inundation maps shall include the following information at critical locations downstream:

1. distance downstream from the dam;
2. arrival time of the leading edge of the flood wave;
3. peak flow depth, incremental rise and water surface elevation in feet; and
4. peak velocity in feet per second.

G. Appendices: All information that supports and supplements the material used in the development and maintenance of the emergency action plan. The dam breach and flood routing analysis report shall be submitted as a separate document.


19.25.12.19 CHANGES TO AN EXISTING DAM: A dam owner proposing to reconstruct, enlarge, modify, restore reservoir capacity, repair, remove or breach an existing dam must make application to and receive approval from the state engineer prior to undertaking any such action. The current condition of the dam, the type of repair or modification and the proposed means to achieve the repair or modification shall dictate the detail of the information provided to the state engineer in order to obtain approval. Because each site, design change and operating practice is unique, waivers of specific requirements in this section will be considered on a case-by-case basis. Request for waiver shall be in writing accompanied with documentation justifying the request. If the request is not justified to the satisfaction of the state engineer the request will be denied. Existing dams present the same hazards to life and
Proposed changes to an existing dam: For dam owners proposing to reconstruct, enlarge, modify, restore reservoir capacity, [or] repair or add aesthetic fill to an existing dam, the following supporting documentation information described below is required prior to undertaking any such action:

1. An [amended] application [if properties of] to alter, repair or rehabilitate the dam and appurtenant structures [change]. Fees for filing the [amended] application and for reviewing drawings and specifications shall be in accordance with Subsections [A] B and [B] C of 19.25.12.8 NMAC. [Fees] Review fees identified in Subsection C of 19.25.12.8 NMAC are waived for the first review if the state engineer requires the change to address a dam safety deficiency.

2. Documentation of sufficient water rights if changes in storage or release requirements are proposed in accordance with the requirements of Subsection B of 19.25.12.11 NMAC.

3. A design report addressing the proposed change in accordance with the requirements of Subsection C of 19.25.12.11 NMAC. Owners of dams classified as high or significant hazard potential shall submit a design report addressing whether the existing condition of the dam is in compliance with the design requirements listed in Subsection C of 19.25.12.11 NMAC. Where the existing condition of the dam is not in compliance with the design requirements of Subsection C of 19.25.12.11 NMAC, the design report shall propose changes to address compliance with the design requirements of Subsection C of 19.25.12.11 NMAC or request a waiver that the deficiency is not critical to the safety of the dam and provide adequate justification for the waiver.

4. Construction drawings and specifications addressing the proposed change in accordance with the requirements of Subsections D and E of 19.25.12.11 NMAC.

5. A plat of survey showing the dam owner’s property boundaries, easement, or right of way. The plat of survey shall be in accordance with the requirements of Subsection F of 19.25.12.11 NMAC.

6. For dams classified as high or significant hazard potential, a dam site security assessment in accordance with the requirements of Subsection G of 19.25.12.11 NMAC.

7. For dams classified as high or significant hazard potential, an instrumentation plan in accordance with the requirements of Subsection H of 19.25.12.11 NMAC.

8. For dams classified as high or significant hazard potential, an updated operation and maintenance manual and emergency action plan in accordance with the requirements of Sections 17 and 18 of 19.25.12 NMAC.

B. Removal or breach of dams classified as high or significant hazard potential: Dam owners intending to breach or remove a dam classified as high or significant hazard potential shall submit a plan to the state engineer for approval prior to breaching or removing the dam. The plan shall evaluate the potential effects of the dam removal or breach on life, property and the environment downstream. A professional engineer licensed in the state of New Mexico qualified in the design and construction of dams shall prepare the plan. The state engineer will revoke the license to operate a dam upon completion of all construction conditions. The plan shall meet the following conditions described below:

1. The reservoir shall be emptied in a controlled manner, which will not endanger lives or damage property downstream.
(2) The dam or breach area shall be excavated down to the level of natural ground and the breach shall be of sufficient width to safely pass the 100-year, 24-hour flood peak discharge without attenuation of the flood through the reservoir.

(3) The side slopes of the breach shall be excavated to a stable angle.

(4) The breach shall be armored as necessary to prevent erosion of the breach area.

(5) The plan shall address the control of sediment previously deposited in the reservoir.

(6) Drawings and specifications shall be prepared in accordance with the appropriate requirements listed in Subsections D and E of 19.25.12.11 NMAC and shall include a title sheet with required certifications and signatures, the location, dimensions and lowest elevation of the breach and any other detail to sufficiently describe the proposal.

(7) Designation of the professional engineer licensed in the state of New Mexico qualified in the design and construction of dams that will supervise construction of the breach or dam removal. Submittal of the professional engineer’s qualifications for state engineer approval is required.

C. Removal or breach of dams classified as low hazard potential: Owners of dams classified as low hazard potential shall submit a written notice to the state engineer of intent to breach the dam. The state engineer will revoke the license to operate a dam upon completion of all construction conditions. The breach notice shall meet the following minimum requirements described below.

(1) The bottom width elevation of the breach shall be to original ground.

(2) The bottom width of the breach shall be a minimum of one-half the height of the dam but not less than 10 feet.

(3) The side slopes shall not be steeper than one horizontal to one vertical.

(4) The excavated material shall not be placed in the streambed.

D. Closure of a tailings facility: A closure plan must be prepared to address the closure of a tailings facility. State engineer approval is required before any modification occurs to a jurisdictional tailings dam. A professional engineer licensed in the state of New Mexico qualified in the design and construction of tailings dams shall prepare the closure plan, which shall include a design report, drawings and specifications prepared in accordance with the appropriate requirements listed in Subsections C, D and E of 19.25.12.11 NMAC. The state engineer will revoke the license to operate a dam upon completion of all construction conditions. The plan shall address the following issues:

(1) long-term stability under static and dynamic conditions;

(2) control of surface runoff to avoid erosion;

(3) plan for long term monitoring, if appropriate; and

(4) identification of an engineer licensed in the state of New Mexico qualified in tailings dam design and construction to supervise implementation of the closure plan; submittal of the engineer’s qualifications for state engineer approval is required.

E. Construction and operating conditions: After reviewing the required documentation, the state engineer will notify the dam owner if any deficiencies are found with the submittal. The dam owner will be given an opportunity to correct any deficiencies noted in the review process. Once all deficiencies have been addressed the state engineer will approve the amended application or proposed change with conditions under which construction and operation shall occur. Action by the state engineer will be in accordance with 19.25.12.13 NMAC, appropriately modified to address the proposed changes.

F. Proof of completion of works, certificate of construction and license to operate: The requirement for a proof of completion of works form for the dam, certificate of construction and license to operate a dam for changes to a dam will be made on a case by case basis by the state engineer. The proof of completion of works form for the dam, certificate of construction and license to operate a dam, if required, shall be in accordance with the Sections 14, 15 and 16 of 19.25.12 NMAC, appropriately modified to address the proposed changes. If the dam is breached, the state engineer will cancel the permit and revoke the license to operate a dam.


19.25.12.20 CHANGES TO AN EXISTING NON-JURISDICTIONAL DAM: A dam owner proposing to reconstruct, enlarge, or modify a non-jurisdictional dam, resulting in a jurisdictional dam after construction is completed, shall comply with 19.25.12.11 NMAC before construction begins. If the ownership changes, resulting in a jurisdictional dam, or if ownership changes, resulting in a jurisdictional
19.25.12.21 EXISTING DAMS: The state engineer may inspect existing dams to verify dams are operated and maintained in a safe manner. Access to the dam site shall be made available to the state engineer upon request. If a critical dam safety problem is observed by the state engineer or reported to the state engineer, an order may be issued requiring the dam owner to address the problem. If a dam incident occurs at a dam, the dam owners shall report the incident to the state engineer within 72 hours. If a major repair is required at an existing dam, the plan to repair the dam shall be in accordance with 19.25.12.19 NMAC. Minor repairs not identified as maintenance activity in accordance with 19.25.12.17 NMAC require state engineer approval. Failure to comply with state engineer directives or these regulations may result in an order to reduce storage or to take corrective action. Failure to comply with orders issued by the state engineer may result in the license to operate a dam being revoked and the dam ordered breached in accordance with Subsection B or C of 19.25.12.19 NMAC. Owners of existing dams shall comply with the following requirements described below.

A. Owners acquiring property with a dam shall promptly notify the state engineer of the change in ownership. Recognition of the responsibility and liability associated with dam ownership is required along with fees for filing the change in ownership form for a dam in accordance with Subsection [F] G of 19.25.12.8 NMAC.

B. Owners of dams classified as low or significant hazard potential shall evaluate the hazard classification if downstream development occurs. The dam owner shall submit the results of the hazard potential evaluation prepared in accordance with Paragraph (1) of Subsection C of 19.25.12.11 NMAC to the state engineer for approval and a plan for addressing design deficiencies. If the hazard potential classification changes due to downstream development, the state engineer shall give the dam owner a time limit to address deficiencies. Deficiencies shall be addressed in accordance with [Paragraphs (3), (12) and (13) of] Subsection C of 19.25.12.11 NMAC and Sections 17 and 18 of 19.25.12 NMAC. [If the dam owner fails to address a deficiency, the state engineer may revoke the license to operate the dam and order the dam breached in accordance with Subsection B or C of 19.25.12.19 NMAC.]

C. Dams classified as high or significant hazard potential shall be inspected on an interval no greater than 5 years by a professional engineer licensed in the state of New Mexico qualified in the design and construction of dams. The owner is responsible for securing the services of the professional engineer. The professional engineer shall provide a signed and sealed report to the state engineer describing the findings of the inspection and recommendations for corrective action or changes to the operating procedures. Routine inspection by the state engineer as described in 19.25.12.21 NMAC satisfies this requirement.

D. Owners of dams classified as high or significant hazard potential in an unsafe condition may receive an order from the state engineer to address the deficiency pursuant to NMSA 1978, Section 72-5-11 (1979). The state engineer may also issue an order to an owner of a non-jurisdictional dam if the dam is unsafe and a threat to life or property, as determined by the state engineer. Owners shall comply with orders issued by the state engineer pursuant to NMSA 1978, Section 72-5-12 (1979).

E. Owners of dams classified as high or significant hazard potential shall comply with 19.25.12.17 NMAC requiring an operation and maintenance manual. Upon compliance with 19.25.12.17 NMAC the state engineer will issue a license to operate the dam. [Dams classified as high hazard potential shall comply by December 31, 2008. Dams classified as significant hazard potential shall comply by December 31, 2010.]

F. Owners of dams classified as high or significant hazard potential shall comply with 19.25.12.18 NMAC requiring an emergency action plan. [Dams classified as high hazard potential shall comply by December 31, 2008 unless the dam is for flood control purposes with no permanent storage, then compliance by December 31, 2010 is required. Dams classified as significant hazard potential shall comply by December 31, 2010 unless the dam is for flood control purposes with no permanent storage, then compliance by December 31, 2012 is required.]

Dams classified as significant hazard potential for flood control purposes with no permanent storage shall comply by December 31, 2012. Owners of 5 or more dams classified as high or significant hazard potential may propose a schedule for compliance with the emergency action plan requirement. [The schedule must be submitted by the owner to the state engineer by December 31, 2005 and is subject to review and approval or modification by the state engineer. The schedule must propose compliance dates for each dam. The first dam must be in compliance by December 31, 2008 and at least an additional dam must be in compliance each year thereafter. All dams must be in
compliance by December 31, 2015. Upon failure to meet an approved compliance schedule all dams will revert to compliance dates shown above. The schedule must propose compliance dates for each dam and all dams must be in compliance by December 31, 2015. The compliance schedule is subject to review and approval or modification by the state engineer.

G. Dam owners that transfer the entire water right out of the reservoir shall have their license to operate a dam revoked and [may] will receive from the state engineer an order to breach the dam in accordance with Subsection B or C of 19.25.12.19 NMAC.

H. Dam owners that fail to obtain state engineer approval prior to construction of a dam shall comply with all conditions imposed by the state engineer within a time limit established by the state engineer or the state engineer may order the dam breached in accordance with Subsection B or C of 19.25.12.19 NMAC.

19.25.12.22 SEVERABILITY: If any portion of this part is found to be invalid, the remaining portion of this part shall remain in force and not be affected.

History of 19.25.12 NMAC: [RESERVED]
Hydrologic analysis requirements for dams are cited in the Rules and Regulations Governing Dam Design, Construction and Dam Safety, which were filed with the New Mexico State Record Center as Title 19, Chapter 25, Part 12 of the New Mexico Administrative Code (19.25.12 NMAC). Hydrologic analysis shall be performed in accordance with Subsection C of 19.25.12.11 NMAC. The design life of a dam is much longer than the record retention period of most engineering firms and memories of most design engineers. It is important that the analysis stand on its own in a manner that is comprehensible to future engineers who may be involved with the structure. Therefore, the Office of the State Engineer (OSE) requires that the hydrologic analysis be fully documented and supported independent of computer programs or other computational methodology used in the analysis.

Most dams are constructed on a watercourse or have a contributing drainage area upstream from the dam. Intense rainfall creates inflow to the reservoir of the dam, which is routed through the reservoir and allowed to pass the dam through a spillway or multiple spillways. Earlier dams typically were provided with spillways that were sized to pass the largest observed floods. These dams frequently overtopped and failed, and roughly half of all known dam failures have been the result of flood overtopping. During the 20th Century, methods were developed to better evaluate infrequent or extreme flood events, and provide adequate spillway capacity to safely pass these floods. Hydrologic analysis is one of the most important aspects in the design of a safe dam, and will be closely reviewed by the New Mexico Office of the State Engineer (OSE) Dam Safety Bureau.

Presented below is an outline of the typical steps for completing a hydrologic analysis satisfying the requirements outlined in Subsection C of 19.25.12.11 NMAC. In order to facilitate review by the OSE Dam Safety Bureau the hydrologic analysis report must be organized in an easy to follow layout and format. Submittals that are not consistent with this document and the requirements outlined in Subsection C of 19.25.12.11 NMAC will cause a delay in the review by the OSE Dam Safety Bureau and may be returned to the owner with no review provided. Inadequate hydrology submittals may also require review fees to be resubmitted prior to subsequent review by the OSE Dam Safety Bureau.

The following steps are typically required in completing hydrologic analysis for dams for submittal to New Mexico Office of the State Engineer:

1. Determine hazard potential classification for the dam location.
2. Determine appropriate design storm requirements for location.
3. Determine geographic location, limits and area of watershed contributing to dam and reservoir.
4. Divide watershed into subbasins as appropriate, and determine subbasin areas, channel locations for routing, etc.
5. Determine basin or subbasin geometry such as longest flow path for each basin or subbasin, channel slope and cross section, highest and lowest points, basin centroid(s), mean basin elevation, etc. as required for methodology to be used.
6. Determine appropriate timing and routing parameters for the elements in the watershed model.
7. Determine reservoir characteristics including stage-storage and stage-discharge relationships.
8. Develop total watershed model by arranging subbasins, routing reaches, etc. in the proper sequence with appropriate parameters.
9. Derive the precipitation to be used for design.
10. Develop incremental precipitation from depth-duration relationship and arrange increments to create an appropriate temporal distribution of precipitation.
11. Develop spatial distribution of precipitation if appropriate.
12. Determine loss parameters or functions and apply to incremental precipitation.
13. Deduct losses from precipitation increments to estimate precipitation excess.
14. Select an appropriate transform methodology for converting excess rainfall to runoff.
15. Apply the transform methodology to each subbasin using incremental precipitation excess.
16. Add stream base flow, etc., to obtain flood hydrograph for each subbasin.
17. Combine and/or route subbasin hydrographs to determine the inflow design flood.
18. Route flood through reservoir and spillway to obtain estimates of reservoir peak stage, peak outflow, peak storage, flood duration, etc.
19. Review results for reasonableness, comparing to known floods or otherwise calibrating if possible.
20. Adjust model parameters, spillway characteristics, etc. as necessary and appropriate and repeat process.
21. Prepare hydrologic analysis report for OSE review and for the permanent record.

Discussion:

The steps taken in the analysis, along with assumptions made and parameters used, must be fully documented. Documentation requirements are discussed in the final section of this paper. Discussion of each of the steps for performing hydrologic analysis is as follows:

1. **Hazard Potential Classification**
Hazard Potential Classification is a function of dam location and downstream conditions, and is not a measure of the integrity of the dam or the adequacy of the design. High hazard potential classification applies if loss of life is probable if the dam fails catastrophically. This is usually fairly obvious, based on downstream development conditions. In some cases, breach and flood wave analysis is needed to establish hazard potential classification. If site is not High hazard potential, in most cases it will be Significant, due to substantial risk to property or assets (highways, barns, irrigation ditches, etc.) or potential for significant environmental consequences. Low hazard potential is typically limited to remote, small structures such as ranch ponds for cattle watering and limited irrigation. Flood control dams typically are High or Significant hazard potential, because the need to control flooding suggests life and/or assets being protected downstream. Evaluations for Low or Significant hazard potential dams must consider the potential for future downstream development.
2. Design Precipitation Requirements
Generally, high hazard potential dams require consideration of Probable Maximum Precipitation (PMP). Significant hazard potential dams require consideration of 50% PMP if 100 feet or less in height and having 50,000 acre-feet or less storage, or 75% PMP if greater than 100 feet in height or having over 50,000 acre-feet of storage. For significant hazard potential dams, percentages are applied to precipitation prior to hydrologic analysis. Low hazard potential dams require consideration of 100-year storm, expressed as a percentage of PMP. Therefore, most dams will require evaluation of PMP. In some cases, waiver of evaluation of PMP will be entertained for low hazard potential dams with no realistic possibility for future hazard potential change.

In addition to precipitation requirements for spillway design, flood control dams must be able to drain from spillway crest or 100-year, 24-hour peak reservoir level within 96 hours. This implies determination of 100-year, 24-hour precipitation in most cases. For high and significant hazard potential flood control dams conforming to local flood control authority or NRCS requirements for 100-year, 24-hour flood routing, OSE will defer to these requirements for determination of compliance with the 96-hour rule.

3. Watershed Location, Limits, and Area
Watershed location, limits and area have traditionally been obtained from 7-1/2 minute USGS quad maps by tracing the divide, and then determining the area by planimeter or other measurement. For smaller drainages, a site topo map is sometimes used. Recent analyses frequently use ArcView or other GIS software in conjunction with DEM or DTM. Determination of precipitation will require geographic location (latitude and longitude) of the approximate basin centroid or a georeferenced perimeter at an appropriate scale. Methodology used must be described and supported as appropriate. Drainage area for existing dams must be independently verified rather than relying on area indicated on drawings or in design report, particularly for older dams. Precipitation depths may require adjustment based on watershed area. Average elevation of the watershed is needed for determination of Local Storm PMP.

4. Subdivision of Watershed
Logical subdivision can be made where topography or surface features and development are dissimilar. SCS methodology would suggest maximum subbasin size of about 20 square miles. USBR – Cudworth recommends 500 square miles maximum area per subbasin. Subbasin areas should be reasonably similar – for example, don’t combine 20 square mile and 0.5 square mile subbasins in the same model if you can help it. Avoid dividing into unnecessary subbasins, as this complicates the model and usually does not improve results. Particularly, avoid overdividing small basins, such as dividing 5 square miles into 20 subbasins. Subbasins should generally correspond with logical junction points and routing reaches.

5. Basin and Subbasin Geometry
Specific information required will depend on methodology used for timing parameters and runoff transform. Typical requirements might include length of longest watercourse, length to a point opposite the basin centroid, watercourse slope, average basin slope, estimated length of overland flow, length, slope, and cross-section of channel reaches, etc.
6. **Timing and Routing Parameters**

Typical parameters may include time of concentration, lag time, time-to-peak, time of travel, kinematic wave travel time, channel geometry and roughness, etc. depending on requirements of the transform methodology and channel routing used. To add to confusion, a parameter may be defined in different ways for different methodologies, even if the name is the same. The parameter(s) used must be appropriate for and compatible with transform methodology as defined within that methodology. Also, assumptions or limitations for the timing parameters must be consistent with the watershed being studied. These may include basin size or watershed length, channel condition (natural vs. improved or hardened), degree of development, etc. Method of determining timing and routing parameters must be indicated and justified as appropriate for location and transform methodology, with sample derivation and references.

7. **Reservoir Characteristics**

This may be developed as elevation-area or elevation-storage, depending on modeling requirements or input parameters for the method used. However, OSE Rules and Regulations require reservoir characteristics to be reported as elevation-storage table in one-foot intervals. Water storage reservoirs generally are assumed to be full to the point of uncontrolled discharge, e.g. spillway crest. Flood control dams with uncontrolled outlets and no permanent storage generally are assumed to be empty at the start of the modeling period.

8. **Watershed Model**

The basin and subbasin geometry and characteristics, routing reaches and parameters, reservoir characteristics, etc. are assembled to create the watershed model for the dam. It is useful to create a schematic or flow chart for the watershed model, particularly if software being used does not provide a graphical or schematic representation. A schematic or graphical representation of the model and tables of relevant model parameters will be required in the report submitted to OSE.

9. **Precipitation Derivation**

PMP east of the Continental Divide is derived using methodology of HMR 55A, PMP west of the Continental Divide is derived using HMR 49. Both HMR documents provide for 1) a Local Storm (thunderstorm), with 6 hours total duration, and 2) a General Storm, with 72 hours duration. Neither HMR includes procedures or allowances for durations less than the complete storm, such as a 1-hour thunderstorm or a 24-hour general storm. If a shorter duration is used, justification must be provided.

Concerning durations less than the complete storm, FEMA as quoted in City of Albuquerque Development Process Manual states, “FEMA’s position regarding the duration of rainfall is that the storm must extend for a period long enough to include all rainfall excess when the volume of the runoff hydrograph is an important consideration. This includes conditions when detention storage is involved, when sediment processes are a significant factor, and when combining and routing subbasin hydrographs to obtain watershed runoff. When the peak flow is the primary concern, and it is established that the use of a longer duration storm would not increase the peak flow, shorter duration storms are acceptable.” This would suggest that using the most intense 24 hours of the General Storm would only be appropriate if it can be shown that no excess
precipitation will occur outside of this period, or if it can be shown that the peak flow is not sensitive to storm volume if peak flow is the primary concern.

Both HMR documents require obtaining index precipitation from maps, and then adjusting precipitation depths for area, elevation, and orographic effects specific to the watershed being studied. The index precipitation depths are plotted against duration to develop a smooth depth-duration passing through the origin. Area adjustments typically are based on the total contributing area above the dam or other point of interest, rather than on individual subbasin areas. Since precipitation depth for PMP is adjusted for storm area during the derivation, no additional reductions should typically be taken during the hydrologic analysis.

The 1984 reprint of HMR 49 contains an Errata sheet following the title page. The entry for page 154 on this Errata sheet changes the basis for local storm elevation adjustments from the lowest elevation in the drainage to the mean elevation. This generally will result in greater reductions in precipitation depth for cases where the elevation adjustment applies. This change is not well documented anywhere else in the literature. Electronic versions of HMR 49 not containing this correction may still be available online.

Both Local and General Storm should be evaluated, unless clear evidence and justification can be provided showing that one storm or the other obviously controls. For example, in the Eastern portion of the New Mexico HMR 55A area, the 1- and 6-hour ordinates for the General Storm frequently are greater than the 1- and 6-hour ordinates of the Local Storm. Conversely, in certain locations of HMR 49 where the orographic component of General Storm precipitation is low, total storm volume for the General Storm can be less than the Local Storm. In most other cases, it is not sufficient to simply compare precipitation depths, since routing effects may result in greater spillway discharge from the General Storm, even though the Local Storm precipitation depths are greater at 1 and 6 hours.

Alternatives to HMR 49 and HMR 55A include site-specific analysis for PMP and Incremental Damage Assessment, either of which should be discussed first with OSE. In the future, an Extreme Precipitation Analysis Tool may be available for portions of the state, to provide an updated estimate of extreme precipitation.

Precipitation for frequency-based events, such as the 100-year storm, is obtained from NOAA Atlas 14, available online. Precipitation is obtained by latitude and longitude, and is point precipitation. The precipitation values from Atlas 14 are considered appropriate for storm areas of 10 square miles or less, and the full precipitation depth should be used for watersheds less than 10 square miles. For larger areas, an approved procedure for reducing precipitation based on area may be applied. The online documentation for Atlas 14 does not provide areal reduction factors specific to Atlas 14, but instead references three possible sources:


These methods will allow reductions for areas less than 10 square miles; however, Atlas 14 seems to recommend using the point precipitation values for 10 square miles or less. If areal reductions are made for drainage areas less than 10 square miles, justification must be provided. Areal reductions for frequency storms should be based on the total watershed contributing to the point of interest, and not on individual subbasin areas. For watersheds with total area exceeding the limits of the reduction method (400 square miles for NOAA Atlas 2/U.S. weather Bureau Technical Paper 40) the services of a qualified meteorologist may be necessary to determine appropriate reductions of point precipitation.

10. Precipitation Increments and Distribution

Precipitation increment size should generally correspond to the computational time step used, although this is not mandatory for many computer programs including HEC-HMS. Increments are obtained from the depth-duration curve by subdividing the curve by increment length and successively subtracting curve ordinates. For small, fast basins in particular it is important to use a sufficiently small increment size and computational time step to avoid under-prediction of peak runoff.

Once the increments have been determined, they must be arranged in an appropriate distribution. One of the most common arrangements sometimes called “center-peeking” or “balanced” distribution, places the largest increment at the center of the storm duration. The second largest increment is placed directly in front of the first, the third largest placed behind the first, and the procedure is continued with successively smaller increments until the distribution is filled. A similar distribution, favored by Bureau of Reclamation for 72-hour general storm PMP, can be termed “late-peeking.” This distribution places the largest increment at the 2/3 point of the storm, then places the second and third largest increment successively in front of the largest increment, then the fourth largest increment immediately behind the largest increment, then continuing the sequence with two increments in front, one behind until the distribution is filled and all increments are used. Either the center-peeking or late peaking distribution will be acceptable for 72-hour General Storm PMP.

Both HMR 49 and HMR 55A refer to two recommended distributions for the 6-hour Local Storm. One is obtained from HMR 5, and the other from the USACE EM1110-2-1411. The distributions are similar, with the USACE EM1110-2-1411 distribution peaking later in the storm. HMR 49 states, “In application, the choice of either of these distributions is left to the user since one may prove to be more critical in a specific case than the other.” This suggests that both methods should be evaluated and the more critical distribution should be used. In practice, the USACE EM1110-2-1411 appears to provide the higher peak discharge in the majority of cases. While not specifically discussed in either HMR 49 or HMR 55A, a center-peeking distribution of local storm PMP has been used in the past and is acceptable to OSE. In any case,
the distribution used must be justified as being appropriate for the specific drainage area being evaluated.

The center-peaking and late-peaking distributions described above are frequently approximated in HEC-HMS or HEC-1 using the Frequency Storm definition for precipitation. Using the Frequency Storm to distribute PMP can cause unintended consequences if one is not careful, and probably should be avoided by infrequent users. The Frequency Storm requires input of precipitation depths for durations corresponding to the frequency series of 5 min, 15 min, 1 hour, 2 hours, 3 hours, 6 hours, 24 hours, 48 hours, etc. The frequency series does not include a 72-hour duration, and so will not emulate the full General Storm PMP. The General Storm index values from HMR 55A do not include values for 5 min, 15 min, 2 hour, 3 hour, or 48 hour durations, and the index values from HMR 49 do not include 5 min, 15 min, 1, 2, or 3 hour values, requiring values to be interpolated or read from curve plots, introducing a possible source of error. The Frequency Storm method can result in unintended reductions of precipitation due to inappropriate use of Storm Area and Probability inputs in HEC-HMS and HEC-1. It is probably best to discuss with OSE before using the Frequency Storm to distribute PMP.

In cases where 100-year precipitation is required (primarily for low-hazard potential dams) the preferred distribution is a center-peaking distribution based on the frequency series from NOAA Atlas 14. The Frequency Storm functions in HEC-HMS, HEC-1, and possibly other programs, are suitable and are intended for this type of storm. Since the precipitation from Atlas 14 is point precipitation, reductions for storm area may be taken as appropriate. The common SCS Type II distribution used for most of the US east of New Mexico will not be appropriate in New Mexico in most cases. The Type IIA distributions used by NRCS in New Mexico may be appropriate, but it is recommended that their use be discussed with OSE prior to using these distributions.

The following distribution methods, which have all been used in submittals to OSE, are not generally appropriate:

- Using the depth-duration curve as the distribution.
- Straight-line distribution of equal increments throughout the storm or during peak periods of the storm.
- Using SCS Type II or NRCS Type II-a distribution for PMP.
- Compressing SCS or NRCS distributions for durations less than 24 hours
- Using a Huff distribution.

11. Spatial Distribution of Precipitation
Spatial distribution of precipitation intensity within a basin through use of isohyetal storm patterns is typically done only for relatively large basins. This method is not common in submittals to OSE, and the services of a qualified meteorologist is required if this method is used. The method is illustrated in HMR 52, which contains information for applying this method east of the 105th meridian, comprising roughly the eastern third of New Mexico.

The more typical submittal applies precipitation uniformly across the basin, with reductions in precipitation depth for larger areas as appropriate. The reductions in these cases are applied during the derivation of precipitation using HMR 49 or HMR 55A. When the isohyetal method
of spatial distribution is used, the full index precipitation is used without reduction, since reduction is effected by application of the isohyetal pattern.

12. Loss Function Parameters
Not all of the precipitation that falls is available to generate runoff. The primary losses to precipitation are interception, evaporation, retention, and infiltration. The first three of these are grouped, along with part of the infiltration loss, and termed “initial losses.” For large, infrequent events such as the PMP, initial losses are relatively low compared to infiltration losses, and are assumed to have occurred due to antecedent rainfall prior to the start of the PMP. Therefore, initial losses are commonly neglected in evaluating PMP. Common loss characterizations include SCS curve numbers, initial/constant loss rates, exponential losses, and Green-Ampt method. Other methods are available as well. SCS curve numbers are typically used with SCS hydrograph methodology, and are not recommended for other hydrograph methods. Initial/Constant loss rate methodology is used with USBR and other unit hydrograph methods. Green-Ampt and exponential methods have not been frequently used in submittals to OSE. Parameters must be justified, both in terms of appropriateness for basin conditions (soil and vegetative cover or land use) and appropriateness with the selected transform methodology. For PMP, loss rates frequently are lower than those used with typical return frequency storms such as the 100-year event. Constant loss rates in excess of 0.5 inches/hour will require adequate supporting justification. Typical loss rates for the four SCS soil groups are as follows:

<table>
<thead>
<tr>
<th>SCS Soil Group</th>
<th>Descriptive Characteristic</th>
<th>Ultimate Infiltration Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Low Runoff Potential</td>
<td>0.3 to 0.5 inches/hour</td>
</tr>
<tr>
<td>B</td>
<td>Moderate Infiltration Rate</td>
<td>0.15 to 0.30 inches/hour</td>
</tr>
<tr>
<td>C</td>
<td>Slow Infiltration Rate</td>
<td>0.05 to 0.15 inches/hour</td>
</tr>
<tr>
<td>D</td>
<td>High Runoff Potential</td>
<td>0 to 0.05 inches/hour</td>
</tr>
</tbody>
</table>


13. Precipitation Excess
Determination of precipitation excess typically is embedded in hydrology software program, but is a straightforward step that can be assumed to be handled correctly with reputable software. The total rainfall excess must be determined and reported, in addition to instantaneous peak discharge. As a rule of thumb for General Storm PMP, rainfall excess less than 70% of total storm volume for 72-hour precipitation depth greater than 25 inches, or less than 60% of 72-hour storm volume for total precipitation depth less than 25 inches, will require justification. Loss parameters and precipitation increment size and distribution can have significant effect on rainfall excess.

14. Transform Methodology
The most common transform methodology is some sort of synthetic unit hydrograph procedure. SCS is fairly common, but may not be the best choice for PMP of extreme storms. SCS parameters are interrelated, and any deviation from the methodology (e.g. Initial-Constant loss rates rather than Curve Numbers) must be justified. The USBR *Flood Hydrology Manual* methodology is also commonly used. USBR is developed for the West, and has three regional unit hydrograph lag relationships that apply within New Mexico: “Great Plains,” “Rocky
Mountains,” and “Southwest Desert, Great Basin, and Colorado Plateau.” Additionally, the Manual contains information for urban basins. It is important to select the correct relationship for the watershed being evaluated. Other unit hydrograph procedures include Clark’s and Snyder’s unit hydrographs. If these are used, parameters must be provided and justified. User-specified unit hydrographs or other relationships derived from gaging records are possible, but submittals to OSE using these methods have been rare. SCS, Clark’s and Snyder’s unit hydrographs are available in HEC HMS, and parameters must be provided and justified but unit hydrographs need not be provided. IF USBR methodology or other user-specified unit hydrographs are used, unit hydrograph ordinates must be provided. Kinematic Wave methodology is sometimes used, and is probably most suitable where the watershed can be conveniently be described as rectangular plane surfaces draining into lateral channels. Other distributed-model methodologies may exist or emerge, and should probably be discussed with OSE before submittal.

15. Application of Transform Methodology for Each Subbasin
For computer-based analysis, this is primarily a matter of properly configuring subbasin models and hydrologic parameters within the program.

16. Evaluation of Base Flow
In New Mexico, stream base flow is usually minimal or non-existent except in response to storm events. A possible exception might be snowmelt in mountainous regions. The USBR Flood Hydrology Manual discusses modeling base flow and snowmelt. If base flow in the stream will contribute significantly to the hydrograph, it should be considered, and base flow modeling assumptions documented. It may be desirable to model a token base flow if the resulting flood hydrograph will be analyzed in a program such as HEC-2 or HEC HMS for downstream water surface profiles under unsteady-flow conditions.

17. Hydrograph Combining and Routing to Determine IDF
Combining and routing is generally done by the computer model. Model input and output must be carefully scrutinized to make sure that the model is performing as intended

18. Reservoir Routing
Stage-storage information used in routing must be provided; the Rules and Regulations require this to be in elevation intervals of 1 foot. Outlet and spillway capacity rating curve or table must be developed and provided. Relying on older, previously generated rating curves without independently verifying their appropriateness is not acceptable. Spillway capacity is most frequently based on the Weir Equation, \( Q = CL(H)^{1.5} \), Where \( Q \) is discharge, \( L \) is weir length perpendicular to flow, \( H \) is head on the weir typically taken as reservoir elevation minus weir elevation, and \( C \) is a discharge coefficient for the weir. The weir equation is only appropriate if flow passes through critical depth over the weir and supercritical flow will be present a sufficient distance downstream from the weir that backwater effects will not constrain flow over the weir. If supercritical flow is not assured, then a backwater analysis such as HEC-2 or HEC-RAS is needed to validate spillway capacity. Also if a significant channel exists between the weir and the reservoir, a backwater analysis is needed to confirm that the reservoir stage remains below the dam crest at the anticipated spillway capacity. Care must be exercised in selecting the coefficient \( C \), as it is not constant with respect to flow depth and is sensitive to geometry of the
spillway crest and entrance. Textbook values for typical broad-crested and ogee weirs may not be appropriate. The most common error is to select too high of a coefficient, for example, 3.0 or 3.1 for an open-cut spillway for which 2.6 or 2.7 may be more appropriate.

19. **Review of Results for Reasonableness**

It is tempting to assume that if the computer program gives an answer and doesn’t crash that this is the correct answer. In reality, the computer is not especially intelligent and will do exactly what you tell it to, whether this makes any sense or not. This is not just a matter of “garbage-in, garbage-out.” Sometimes, parameters that are in the ballpark when taken individually can compound to skew results in one direction or another. Also, sometimes the program will perform functions not intended by the analyst, such as inappropriate reduction of precipitation for storm area, if you do not tell it exactly what you want and understand the significance of program defaults. Therefore, a review of intermediate steps and final results for reasonableness is important. Calibration of the hydrologic model for PMP is difficult since storms approaching this magnitude are rare. Calibrating against lesser storms such as the 100-year or smaller events may not be appropriate for PMP. Reasonableness of results compared to past experience with similar input parameters may be the best tool available. It is important not only to ensure that the spillway design flood is not underestimated for reasons of public safety, but also that it is not overestimated for reasons of economics. Often, the predicted flood is significantly less probable than the precipitation, which in the case of PMP already has an essentially indefinable but extremely low probability. In some cases, particularly for rehabilitation projects, this can have a substantial impact on project costs.

20. **Adjustment of Model Parameters**

Based on review of results for reasonableness, it may be appropriate to adjust parameters and recalculate. This will obviously be necessary if the selected spillway turns out not to be adequate for the computed flood. Sensitivity analysis with respect to critical parameters is sometimes useful in forming an opinion with regard to the appropriateness of the result.

21. **Hydrologic Analysis Report**

Assuming the hydrologic analysis has included the required steps previously discussed, it is important that the methods and parameters used, the results obtained, and supporting justification be documented in a coherent report. This will allow OSE staff to verify that regulatory requirements for hydrology have been satisfied and evaluate whether the proposed design adequately addresses the required design storm. A secondary, but equally important purpose is to provide documentation of methods and assumptions to assist future engineering consultants and OSE staff in understanding the basis for design and assessing adequacy and safety of the structure. Personnel can turn over rapidly, analysis methods change over time, and the structure will almost certainly outlast both the designers and their methods. The hydrology report will serve as a guidance document to help future engineers understand the analysis. As a general principle, the information submitted must be adequate to allow an independent analyst, possibly at some point in the future, to replicate the analysis with comparable results. The information must be transparent and independent of the software program used for computation. The following are some of the items required in the report and supporting documentation:
1. Identification of the hazard potential classification, and any assumptions used in determining this classification. If the classification is anything other than High, supporting documentation, potentially including breach analysis and flood studies, may be required.

2. Determination of appropriate design precipitation based on hazard potential classification and size of structure. Provide detailed analysis report if design precipitation is based on incremental damage assessment or site-specific PMP study, either of which must be discussed with OSE in advance.

3. Location map and topographic map of drainage area contributing to the dam and reservoir, with drainage boundary and total area indicated.

4. Map indicating subbasin boundaries with areas indicated, hydrograph combination points, channels for routing, etc. This may be superimposed on the topographic map described in 3. above if of suitable scale.

5. Table of relevant basin and channel characteristics to be used in the analysis as dictated by the selected analysis methodology, including flow path lengths, centroid distances, mean basin elevations, channel slope, roughness, and cross-section, etc.

6. Discussion of timing and routing parameter derivation including methods or equations used and their applicability to this particular project, example calculations, and summary tables of input data and computed parameters.

7. Narrative discussion of watershed model accompanied by schematic showing the interrelation of various components of the model.

8. Elevation-storage and elevation-discharge tables for reservoir, outlets and spillways. These should be in 1-foot increments unless the dam is very high, in which case the appropriate interval must be discussed in advance with OSE.

9. Worksheets for Local Storm and General Storm PMP derivation from HMR 49 or 55A as appropriate. For Low hazard potential dams, copies of tables from NOAA Atlas 14 website, indicating latitude and longitude of point precipitation, must be included.

10. Table of distributed precipitation increments, distribution curve and/or hyetograph illustrating graphically how precipitation is distributed, and narrative describing and justifying the methodology for distributing precipitation.

11. If spatial distribution is used, full documentation of methodology and assumptions by qualified meteorologist is required.

12. Discussion of loss methodology and documentation of derivation of parameters, tables of soil and land use areas and percentages for each subbasin, and justification of the appropriateness of the parameters and methodology in the context of the overall analysis.

13. Table or graph of precipitation excess for each increment for which excess exists, and identification of total precipitation excess in inches and percentage of rainfall.

14. Discussion of transform methodology used. Coefficients or parameters for common synthetic unit hydrograph procedures (e.g. SCS, Snyder, Clark). If other than a common synthetic unit hydrograph procedure is used, unit hydrograph ordinates must be provided.

15. Table or computer echo of input parameters, with parameters identified or notated for each subbasin, routing reach, or other element.

16. Discussion of base flow or snowmelt methodology or considerations.

17. Table of combining and routing results, supported by computer output. Results must be concurrent with model schematic discussed in 7. above.
18. Elevation-storage and elevation-discharge tables for the reservoir in 1-foot increments, and table of routed hydrograph ordinates with peak inflow to reservoir and routed peak outflow identified. Inflow and outflow hydrographs plotted on same figure of appropriate scale.

19. Discussion of reasonableness of results, including any calibration or comparison information available.

20. Discussion of any parameter adjustments or sensitivity analysis performed in order to validate or improve reasonableness of results.

**Special Case – Perimeter Dams:**

An increasing number of dams regulated by OSE are perimeter embankments with no contributing watershed outside of the reservoir, interior slopes, and embankment crest. These dams may include wastewater pond dams, industrial evaporation pond dams, municipal raw water storage dams, tailings dams, etc. Water or potentially mobile contents are pumped or discharged to the reservoir as part of a controlled process.

For these perimeter dams, hydrology typically is greatly simplified. The contributing area (reservoir surface, interior slopes, and crest) is determined, and the design precipitation depth is applied to this area to determine the volume contribution of the storm to the reservoir. Where the design storm is all or a percentage of the PMP, the General Storm 72-hour index precipitation should be used. Losses are neglected, and the full precipitation depth is treated as excess contributing to the reservoir. In most cases, storage for this volume of water is provided above the normal maximum water level, with additional freeboard above flood stage to satisfy the freeboard requirements of OSE Rules and Regulations. In some cases, a spillway may be designed to allow routing and discharge of some of the flood volume, thereby reducing embankment height above normal maximum water level.

In addition to water from extreme precipitation events, perimeter embankments are susceptible to misoperation, where discharge into the reservoir continues past the design maximum reservoir level and eventually overtops the embankment, resulting in failure. For this reason, perimeter embankments must be provided with an overflow section with capacity equal to or greater than the discharge capacity into the reservoir, so that misoperation or failure of reservoir controls does not lead to embankment failure.

**References:**


