

**Forest Service Handbook
National Headquarters – Washington Office
Washington, DC**

**Forest Service Handbook 7509.11 – Dams Management Handbook
Zero Code**

Amendment: 7509.11-1993-1

Effective date: August 5, 1993

Duration: This amendment is effective until superseded or removed.

Superseded Directive: 1, August 8, 1990; Entire Handbook issued, December 1986

Approved by: F. Dale Robertson, Chief

Date approved:

Responsible Staff:

Explanation of changes: Following is an explanation of the changes throughout the directive by section.

Posting Instructions: Amendments are numbered consecutively by Handbook number and calendar year. Post document in numerical order of chapters (1109.12, sec. 4.32, ex. 01). Remove entire national text of the Handbook and replace with this amendment. DO NOT REMOVE SUPPLEMENTS OR INTERIM DIRECTIVES. Retain this transmittal as the first page of this document.

Revises and updates entire Handbook. Significant changes in direction are as follows:

05: Moves select definitions from FSM 7500. Modifies definitions to agree with Glossary of Terms for Dam Safety, prepared by the Interagency Committee for Dam Safety (ICODS), and Federal Emergency Management Agency (FEMA).

08: Updates reference list and adds names and addresses of agencies, associations, and groups publishing reference materials related to dams and dam safety.

10: Changes chapter title from Project Files to Records and Files.

40: Changes chapter title from Safety Evaluation/Hazard Potential to Safety Inspections and Hazard Assessments. Replaces the term "safety evaluation" with "safety inspection" throughout.

Guidance documents lack the force and effect of law, unless expressly authorized by statute or incorporated into a contract. USDA may not cite, use, or rely on any guidance that is not available through their guidance portal, except to establish historical facts.

42: Replaces the term "Hazard - Potential Evaluations "with" Hazard Assessment."

42.3: Adds hazard classification examples.

53: Adds direction on location of copies of emergency action plans.

54: Adds direction on testing emergency action plans.

62: Revises direction to exclude Regional dam or water resources engineer from serving on a dam failure investigation team in cases of potential or apparent conflict of interest.

70: Changes title from Dam Inventory to Management of Special Use and Other Non-Forest Service Projects. Previous direction contained in this chapter is moved to FSM 7514; moves direction from previous chapter 80 to chapter 70.

80: Changes title from Management of Special-Use and Other Non-Forest Service Projects to Planning and Design.

Completes previously reserved FSM 7520 and incorporates it into FSH 7509.11.

81: Provides guidance and definitions for four phases in the design schedule.

82: Provides guidance for planning and designing channel layout.

83: Provides guidance for assigning hazard classification.

This Handbook is now available electronically in the National Information Center in the same format as the paper copy. Henceforth, amendments to this Handbook will be issued to Forest Service units electronically on a document basis.

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This handbook provides methods and guidelines for administering the dams management program in accordance with established policy and responsibility in FSM 7500. It is intended for use by engineers and others involved in the dams management program at the Regional, Forest, and District levels. The handbook contains procedures and specific information for the management of existing dams, both Forest Service-owned and those authorized by a special-use document (permit, term permit, lease, easement). Procedures for the technical administration of special-use applications for new dams and water transmission structures are also included. The handbook also provides limited planning and design guidance specific to Forest Service needs. The remainder of planning and design guidance may be obtained from the sources listed in FSM 7524.

02 - Objective

(FSM 7502).

03 - Policy

Only personnel determined to be qualified as defined in FSM 7505 may participate in the preparation and review of operation and maintenance plans, inspection reports, emergency action plans, safety evaluations, and other pertinent dam safety activities.

04 - Responsibility

The Washington Office Dam Safety Officer, Regional Staff Officer for dams or water resources, or Forest Staff Officer for engineering activities, as applicable, shall provide the users of this handbook with general assistance in all aspects of water resources engineering and with specific guidance on individual water storage and transmission projects.

05 - Definitions

The following are definitions of some commonly used terms. They are in agreement with the Glossary of Terms for Dam Safety prepared by the Interagency Committee on Dam Safety (ICODS) Task Group on Glossary of Terms, Federal Emergency Management Agency, February 1988. For additional definitions, see the Glossary of Terms for Dam Safety, FSM 7505, and FSM 7523.01.

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 Trench (or Cutoff Trench). A foundation excavation later to be filled with impervious material to limit seepage beneath a dam.

Dam Base Width. The maximum width or thickness 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.

Dam Centerline. The longitudinal axis of the top of the dam located at the midpoint of the dam crest.

Dam Length. The length along the top of the dam. This also includes the spillway, powerplant, navigation lock, fish pass, and so forth where these form part of the length of the dam. If detached from the dam, these structures should not be included.

Dam Top Width (or Top Thickness). The width or thickness of a dam at the top of the dam (excluding corbels or parapets), measured normal to the dam centerline. In general, the term "thickness" is used for gravity and arch dams, and the term "width" is used for other dams.

Design Reservoir Elevation. The maximum water storage elevation (FSM 7505).

Drainage Area. The surface area of a watershed that contributes runoff into a reservoir (or to a particular point on a river or stream).

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.

Emergency Spillway Hydrograph. The hydrograph used as a basis for the hydraulic design of the emergency spillway.

Flood Pool. That part of the reservoir volume allotted to the temporary storage of floodwater. Its upper limit is the minimum elevation of the crest of the emergency spillway.

Flood Pool Hydrograph. The hydrograph used as a basis for proportioning the flood pool spillway system and determining the design reservoir elevation; for a flood control dam, it establishes the lowest crest elevation of the emergency spillway.

Freeboard Reservoir Elevation. The highest water surface elevation in the reservoir, determined by routing the freeboard hydrograph through the reservoir spillway system.

Maximum Spillway Design Discharge. The peak flow through the spillway system measured in cubic feet per second at the design reservoir elevation.

Normal Storage. The total storage space, measured in acre-feet, in a reservoir at the normal storage elevation (FSM 7505), excluding storage of flood waters above the normal full storage elevation.

Sediment Pool. That part of the reservoir volume allotted to the storage of sediment.

Sediment Pool Elevation. The elevation of the surface of the sediment pool at the dam.

Shell. The outer, usually relatively permeable, zone of an earth dam or earth-rock dam.

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 hydraulic design of the spillway is the only control, it is considered an uncontrolled spillway. Various adjectives, such as primary, principal, auxiliary, emergency, and service, are used to describe the uses and combination of spillway types employed by Federal and State agencies.

08 - References

The following lists Federal and State agencies, associations, groups, and individuals involved in publishing reference materials related to dams and dam safety. Contact these groups to learn of the latest developments in dams management.

Additional references are in FSM 7506. Refer to FSM 2700 for additional information on structures under special-use authorization.

Make available a sufficient collection of some of these and other appropriate references and keep them current in each engineering office so that they can be used for maintaining a safe Forest dams management program.

American Concrete Institute (ACI), P.O. Box 19150, Detroit, Michigan 48219, Telephone: (313) 532-2600.

American Society of Civil Engineers (ASCE), 345 E. 47th Street, New York, New York 10017, Telephone: (212) 705-7696.

Association of State Dam Safety Officials (ASDSO), P.O. Box 55270, Lexington, Kentucky 40555, Telephone: (606) 257-5146.

Bureau of Reclamation, U.S. Department of the Interior, Denver Federal Center, P.O. Box 25007, Denver, Colorado 80225-0007, Telephone: (303) 236-4200.

Federal Emergency Management Agency (FEMA), ENH Division, Washington, DC 20470, Telephone: (202) 646-2817.

Federal Energy Regulatory Commission (FERC), Room 1111, 810 First Street NE, Washington, DC 20426, Telephone: (202) 357-0734.

Geological Survey, U.S. Department of the Interior (USGS), 12201 Sunrise Valley Drive, Reston, Virginia 22092, Telephone: (703) 860-7000.

Mine Safety and Health Administration (MSHA), U.S. Department of Labor, 4015 Wilson Boulevard, Room 960, Arlington, Virginia 22203, Telephone: (703) 235-1590.

National Research Council (NRC), 2101 Constitution Avenue NW, Washington, DC, Telephone: (202) 334-2168.

Soil Conservation Service, U.S. Department of Agriculture, (SCS) Engineering Division, P.O. Box 2890, Washington, DC 20013, Telephone: (202) 720-4909.

Tennessee Valley Authority (TVA), Evans Building, 524 Union Avenue, Knoxville, Tennessee 37900, Telephone: (615) 632-8153.

U.S. Army Corps of Engineers, CECW-EG, 20 Massachusetts Avenue, NW, Washington, DC 20314-1000, Telephone: (202) 272-0207.

The following publications, which are listed alphabetically by originating organization, are a sample of what is available but do not constitute a complete listing.

1. Ad Hoc Interagency Committee on Dam Safety of the Federal Coordinating Council for Science, Engineering and Technology, Washington, D.C. 20500.

U.S. Federal Coordination Council for Science, Engineering, and Technology. 1979. Federal Guidelines for Dam Safety, Washington, DC, Government Printing Office. 39pp.

These guidelines outline good management practices for dam safety for all federal agencies responsible for the planning, design, construction, operation, or regulation of dams. They are not intended as standards for technology of dams. While the basic principles of the guidelines apply to all dams, reasonable judgements need to be made in their application commensurate with each dam's size, complexity, and hazards. The information in the guidelines is subject to change as the state of the science develops.

2. Bureau of Reclamation, U.S. Department of the Interior.

- a. Bureau of Reclamation, U.S. Department of the Interior, Water and Power Resources Service. 1980. Safety evaluation of existing dams (SEED) manual, Denver, Colorado. 152pp.

- b. Bureau of Reclamation, U.S. Department of the Interior, Materials Engineering Branch, Research and Laboratory Services Division. 1974. Earth manual. Denver, Colorado. First edition. 553pp.
 - c. Bureau of Reclamation, U.S. Department of the Interior. 1976. Design of gravity dams. Denver, Colorado. First edition. 553pp.
 - d. Bureau of Reclamation, U.S. Department of the Interior. 1977. Design of arch dams. Denver, Colorado. First edition. 882pp.
 - e. U.S. Department of the Interior, Government Printing Office. 1987. Design of small dams. Washington, DC. Third edition. 435pp.
 - f. Aisenbrey, A.J. Bureau of Reclamation, U.S. Department of the Interior. 1974. Design of small canal structures. Denver, Colorado. First edition. 435pp.
 - g. Bureau of Reclamation, U.S. Department of the Interior, Denver Federal Center. Downstream hazard classification guidelines. P.O. Box 25007, Denver, Colorado 80225, Telephone: (303) 236-5981. Current Edition.
 - h. Training aids for dam safety (TADS) (Available in Regional Offices).
- (1) "Identification of Visual Dam Safety Deficiencies." Booklet and video tape.
 - (2) "Inspection and Testing of Gates, Valves and Other Mechanical Systems." Booklet and video tape.
 - (3) "Inspection of Spillways and Outlet Works." Booklet and video tape.
 - (4) "Inspection of Concrete and Masonry Dams." Booklet and video tape.
 - (5) "Instrumentation for Embankment and Concrete Dams." Booklet and video tape.
 - (6) "Inspection of Embankment Dams." Booklet and video tape.
 - (7) "How to Develop and Implement an Emergency Action Plan." Booklet and video tape.
 - (8) "Inspection of the Foundation, Abutments, and Reservoir Rim." Booklet.
 - (9) "Documenting and Reporting Findings From a Dam Safety Inspection." Booklet.

- (10) "Preparing to Conduct a Dam Safety Inspection." Booklet.
- (11) "Evaluation of Facility Emergency Preparedness." Booklet.
- (12) "How to Organize an Operation and Maintenance Program." Booklet.
- (13) "Identification of Material Deficiencies." Booklet and video tape.
- (14) "Evaluation of Seepage Conditions." Booklet.
- (15) "How to Organize a Dam Safety Program." Booklet.
- (16) "Evaluation of Hydrologic Adequacy." Booklet.
- (17) "Evaluation of Concrete Dam Stability." Booklet.
- (18) "Evaluation of Embankment Dam Stability and Deformation." Booklet.

3. U.S. Army Corps of Engineers.

a. Engineering Manuals (EM):

- (1) EM 1110-2-1602. Hydraulic Design of Reservoir Outlet Structures. Current edition.
- (2) EM 1110-2-1603. Hydraulic Design of Spillways. Current edition.
- (3) EM 1110-2-1902. Stability of Earth & Rockfill Dams. Current edition.
- (4) EM 1110-2-1908. Instrumentation of Earth and Rockfill Dams. Current edition.
- (5) EM 1110-2-1911. Construction Control for Earth and Rockfill Dams. Current edition.
- (6) EM 1110-2-2200. Gravity Dam Design. Current edition.
- (7) EM 1110-2-2300. Earth and Rockfill Dams, General Design and Construction Considerations. Current edition.
- (8) EM 1110-2-1601. Hydraulic Design of Flood Control Channels. Current edition.

b. Engineering Reports (ER):

- (1) ER 1110-2-1450. Hydrologic Frequency Estimates. Current edition.
- (2) ER 1110-2-1806. Earthquake Design and Analysis for Corps of Engineers Dams. Current edition.
- c. Recommended Guidelines for Safety Inspection of Dams, National Program of Inspection of Dams, Vol. 1, Appendix D. Chief of Engineers, Washington, D.C., 1975.

4. Federal Emergency Management Agency (FEMA):

- a. Interagency Committee on Dam Safety, Subcommittee on Emergency Action Planning. 1985. Emergency Action Planning Guidelines for Dams. Federal Emergency Management Agency, Washington, D.C., 27pp.
- b. Colorado Division of Disaster Emergency Services. 1987. Dam Safety: An Owner's Guidance Manual. Federal Emergency Management Agency, Washington, D.C., 117pp.

Note: This reference contains a good list of references in the area of dams and dam safety.

5. Federal Highway Administration (FHWA).

- a. U.S. Dept. of Transportation, FHWA, co-sponsored by the Forest Service, USDA. 1987. Development of a Methodology for Estimating Embankment Damage Due to Flood Overtopping. U.S. Dept. of Transportation, FHWA, Turner-Fairbank Highway Research Center, McLean, VA 22101-2296.

6. U.S. Department of Agriculture (USDA), Forest Service.

- a. USDA, Forest Service. 1981. Operation and Maintenance Inspection for Dams, EM-7570-2. USDA, Forest Service, Engineering Staff, Washington, DC 20090-6090. 26pp.

Although this book is out of print and will not be reprinted, the information is still valid and any copies presently in circulation may be used.

- b. USDA, Forest Service, Region 4. Circa 1987. Dam Safety, an Owner's Responsibility. USDA, Forest Service Region 4, Federal Building, 324 25th Street, Ogden, Utah 84401. 8pp.

7. USDA, Forest Service and Soil Conservation Service.

- a. USDA, Forest Service and Soil Conservation Service. Guide for Safety Evaluation and Periodic Inspection of Existing Dams, EM-7570-1. 1980. USDA, Forest Service, Engineering Staff, Washington, DC. 135pp.

Although this book is out of print and will not be reprinted, the information is still valid and any copies presently in circulation may be used.

8. International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, California 90601, Telephone: (213) 699-0543.

- a. Uniform Building Code.

9. USDA, Soil Conservation Service.

- a. National Engineering Handbooks. Current Editions.
- b. USDA, Soil Conservation Service. Revised 1985. Earth Dams and Reservoirs, Technical Release No. 60, 210-VI. USDA, Soil Conservation Service, Washington, D.C.

10. Other Publications.

- a. Cedergren, H. 1989. Seepage, Drainage, and Flow Nets. Third edition. Wiley and Sons, New York, New York. 531pp.
- b. Casagrande, A. 1973. Embankment Dam Engineering. Wiley and Sons, New York, New York. 454pp.
- c. Sherard, Woodward, Gizidenski, and Clevenger. 1963. Earth and Earth-Rock Dams. Wiley and Sons, New York, New York. 421pp.
- d. California Department of Water Resources, Division of Safety of Dams. 1986. Guidelines for the Design and Construction of Small Embankment Dams. California Department of Water Resources, Division of Safety of Dams, Sacramento, California.