

Dam Safety Guidelines

Part II:

Project Planning and Approval of Dam Construction or Modification



WASHINGTON STATE
DEPARTMENT OF
E C O L O G Y

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DAM SAFETY GUIDELINES

PART II

PROJECT PLANNING AND APPROVAL OF DAM CONSTRUCTION OR MODIFICATION

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PROJECT PLANNING AND APPROVAL OF DAM CONSTRUCTION OR MODIFICATION

1. INTRODUCTION

The **Dam Safety Guidelines** are intended to provide dam owners, operators and design engineers with information on activities, procedures and requirements involved in the planning, design, construction, operation and maintenance of dams in the State of Washington. In particular, they provide guidance in meeting the requirements identified in the **Dam Safety Regulations**, Chapter 173-175 WAC. For convenience of the various expected users, the guidelines have been organized into four basic units entitled:

Part I - General Information and Owner Responsibilities

Part II - Project Planning and Approval of Dam Construction or Modification

Part III - An Owner's Guidance Manual

Part IV - Dam Design and Construction

Technical Notes have also been prepared to provide technical information on engineering design and analysis of various project elements. For clarity, all important definitions and terms pertinent to State of Washington dam safety activities are summarized in Appendix A of Part IV.

Part II of the guidelines provides information on the specific activities and actions that are involved in project planning and the plan review and construction permit process. An overview of the planning process is provided along with a list of permits and approvals that are normally involved. Submittal requirements for plan review are listed and flowcharts are included to more clearly delineate the steps in the administrative process. Obligations of dam owners during project construction are identified. Specific owner responsibilities for the development of procedures for operation, maintenance, and inspection are also included.

1.1 APPLICABILITY - JURISDICTIONAL THRESHOLD

The Dam Safety Regulations (Chapters 173-175 WAC) are applicable to dams which can impound a volume of 10 acre-feet or more of water as measured at the dam crest elevation. The 10 acre-foot threshold applies to dams which can impound water on either an intermittent or permanent basis. The water impounded can be of any quality or can contain any substance in combination with water to exist in a liquid or slurry state at the time of initial impoundment. Only water that can be stored above natural ground level or which could be released by a failure of the dam is considered in assessing the storage volume.

For a dam whose dam height is 6 feet or less and which meets the above conditions, the Dam Safety Office (DSO) may elect to exempt the dam from the regulations. Such a decision will be made on a case-by-case basis for those dams whose failure is not judged to pose a risk to life, and minimal property damage would be expected under current conditions of development.

1.2 CONSTRUCTION RELATED ACTIVITIES REQUIRING ACTION BY THE DSO

Construction related activities that require review and approval by the Dam Safety Office include:

- Construction of a new dam.
- Modification of an existing dam.
- Removal or abandonment of an existing dam.
- Construction change orders for project elements that could have an effect on public safety.

Construction related activities that require review and acceptance by the DSO include:

- Adoption of an Operation and Maintenance (O&M) Plan.
- Adoption of an Emergency Action Plan (EAP).

Construction related activities that require authorization from the DSO before proposed actions can proceed include:

- Startup of construction.
- Initial controlled filling of a reservoir following new dam construction.
- Resumption of normal reservoir operation following dam repair or modifications.

Construction related activities that require a notification to the DSO include:

- Advance notice of the startup of dam construction.
- Declaration by the project engineer of project completion in accordance with approved plans and specifications.

2. PLANNING OF DAM AND RESERVOIR PROJECTS

All dam and reservoir projects proceed through a similar sequence of activities during their development leading up to construction. The normal progression includes: initial investigations of potential site(s); identification of the major components of the project to fit the site(s); development of conceptual plans; examination of options and final selection of site and project configuration; detailed engineering investigations and preparation of design reports; preparation of preliminary and/or intermediate level construction plans; and preparation of final construction plans and specifications.

The following sections present a general overview of the various activities that are involved in the planning and design of a dam, up to development of conceptual plans. Once an application for a dam construction permit is submitted to the DSO, the project enters the plan review process. The steps involved in the plan review process are discussed in detail in Section 3, Plan Review.

2.1 PROJECT FEASIBILITY AND PLANNING

The initial step in project planning is the assessment and formulation of project purposes, needs, economics, potential environmental impacts, and operational requirements. Once established, preliminary or feasibility investigations are conducted to identify potential sites, define possible project configurations, and establish the type of project components that are best suited to available sites. Final site selection is based on an evaluation of this information. Figure 1 presents a general schematic outline of the planning process.

To accomplish these planning goals, a consulting engineering firm should be selected that has the necessary qualifications and experience to plan, design, and supervise the construction of the type and size of project being proposed. Specialists whose expertise may be needed for various elements of the project should become involved as early as possible to allow efficient coordination of all project elements.

Information about specific engineering activities normally required by the DSO during project design is contained in Section 3, Plan Review. This information may be useful to owners in outlining a scope of work for retaining consultant engineering services. The selection of the engineering consultant(s) is an important first step leading towards the successful construction of the project.

As a guide to consultant selection, dam owners are strongly encouraged to closely review the level of experience of prospective engineering consultants on projects of the type being proposed.

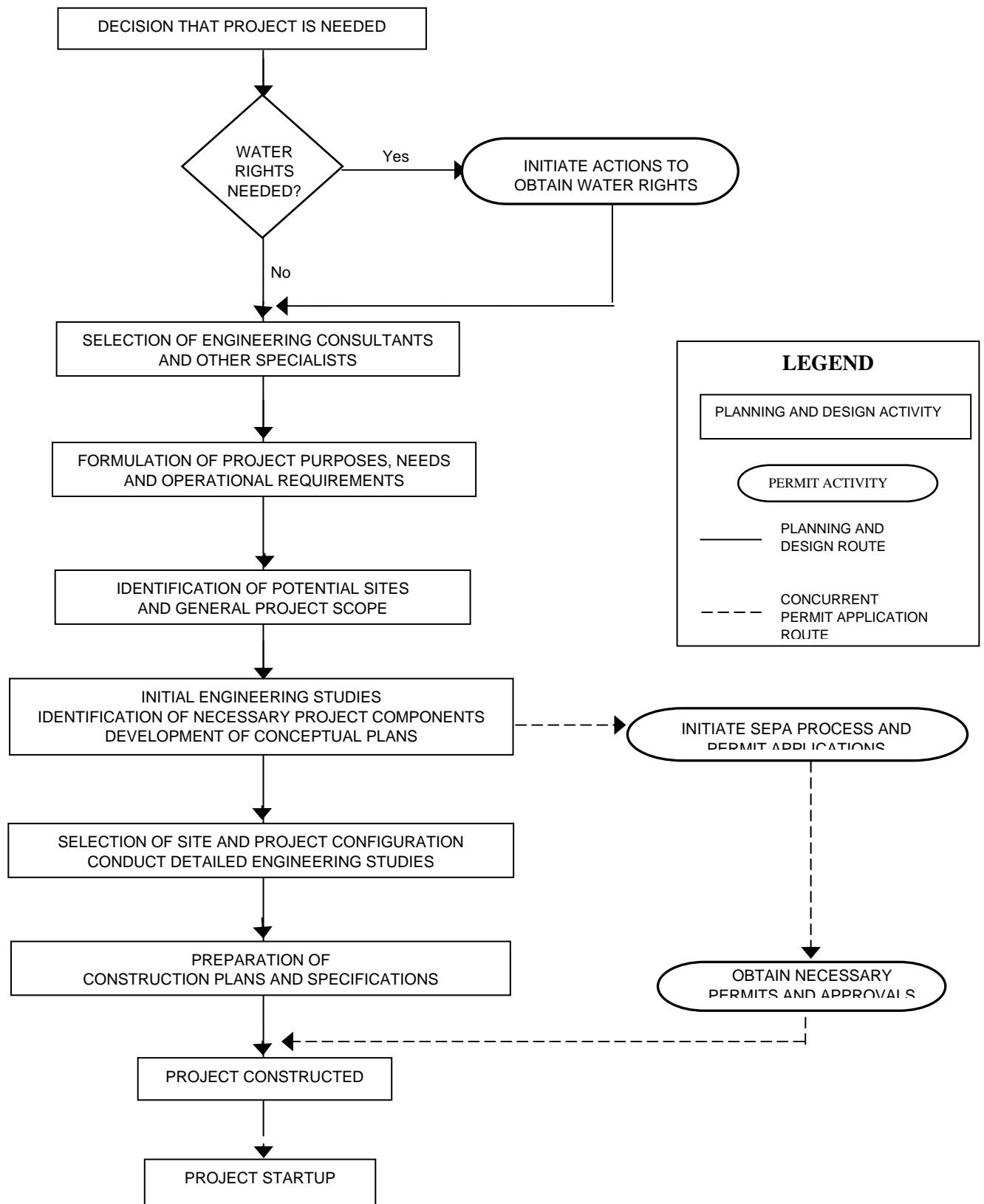


FIGURE 1. GENERALIZED FLOW CHART OF PLANNING, DESIGN AND PERMIT PROCESS INVOLVED IN DEVELOPING DAM AND RESERVOIR PROJECTS IN WASHINGTON

2.2 PERMITS AND APPROVALS

Prior to or concurrent with the beginning stages of planning, it is important to investigate the need for various government permits and approvals and initiate action to secure all necessary authorizations that may be required for the proposed project.

Where the intended use of the project requires the appropriation and storage or diversion of water for a "beneficial use," the project proponent should obtain the required "water rights." The term "beneficial use" of water refers to a variety of purposes including, but not limited to: irrigation, domestic, community, municipal, commercial, industrial, and stock water supply; fish and/or wildlife propagation; recreation; preservation and enhancement of environmental and aesthetic values; and hydroelectric power generation. Water rights normally are not required where an impoundment will store wastes or will be used for detaining and controlling storm or flood waters. The procedures for obtaining water rights are defined in the State Water Code (Chapter 90.03 RCW) and associated rules (Titles 173 and 508 WAC). The issues of water availability and water rights should be resolved prior to making major investments in planning and engineering.

Similarly, since compliance with the State Environmental Policy Act (SEPA) is mandatory for nearly all actions involving the construction of impoundments, this process should also be started in the early stages of planning. The SEPA process is initiated by completing an Environmental Checklist which may be obtained from most local government planning departments or from Ecology Regional Offices.

The construction permit procedures administered by the DSO are normally started somewhat later in the planning process, usually at the time when conceptual or preliminary plans are prepared. Specific requirements for approval of construction plans and specifications are described in Section 3, Plan Review.

Along with these requirements for dam safety approval, some of the other more common permits and authorizations that may be involved in a typical dam and reservoir project are listed in Table 1.

For a complete listing of possible permits required for a project, see the publication *Commonly Required Environmental Permits for Washington State* (Ecology, 2004)

<http://www.ecy.wa.gov/pubs/9029.pdf>

Further assistance in obtaining environmental permits can be obtained through the Office of Regulatory Assistance, One Stop Service Center. The One Stop Service Center is located in the Washington State Department of Ecology Building at 300 Desmond Dr. SE, Lacey, WA. Staff are available Monday, Tuesday, Wednesday and Thursday 9am-4pm and by appointment only on Friday

Although you can drop in anytime during those hours, it is recommended that you first schedule an appointment. You may call the Center at 360-407-7037 or 800-917-0043, or send e-mails to ecypac@ecy.wa.gov. Their internet address is: <http://www.ecy.wa.gov/programs/sea/pac/index.html>

**TABLE 1
COMMONLY REQUIRED PERMITS AND APPROVALS FOR DAM CONSTRUCTION
PROJECTS IN THE STATE OF WASHINGTON**

TYPE OF PERMIT OR APPROVAL	ADMINISTRATIVE AGENCY
Dam Construction Permit	Washington State Department of Ecology (ECOLOGY)
State Environmental Policy Act (SEPA) Compliance	Local Government Agencies and/or Other State Agencies
Reservoir Storage Permit (Water Rights) (Application, Permit, Certificate, and Recording Fees Required)	ECOLOGY
Surface Water (or Groundwater) Appropriation permit (Water Rights) (Application, Permit, Certificate, and Recording Fees Required)	ECOLOGY
State Power License Fee (Hydroelectric Projects)	ECOLOGY
Shoreline Management Substantial Development Permit (Fees vary)	Local Government Planning Department
Joint Aquatic Resource Permit Application (JARPA). Includes: Hydraulic Project Approval (HPA), Shoreline Management Permits, Water Quality Certifications, and U.S. Army Corps of Engineers Section 404 and Section 10 permits. http://www.ecy.wa.gov/programs/sea/pac/jarpa.html	ECOLOGY
Federal Hydropower License (Non-Federal Hydroelectric Projects)	Federal Energy Regulatory Commission (FERC)

2.3 CONCEPTUAL PLANS

Following initial investigations, conceptual plans depicting possible site options and project configurations are normally prepared by the engineering consultant. Typically, the basic elements of the impounding barrier, outlet works, spillways, and appurtenances are shown on the conceptual plans. These plans assist the owner in making final decisions on site selection and project configuration. In addition, they provide valuable information on the proposed layout to aid the involved government agencies in their permit requirement determinations. The submittal of conceptual plans to the DSO, along with a construction permit application, initiates the plan review process described in Section 3. The submittal of conceptual plans and design reports at an early stage in project formulation allows for DSO review and comments to be addressed at a time when changes can more easily be incorporated into the plans.

3. PLAN REVIEW

3.1 CONSTRUCTION PERMIT PROCESS

The DSO plan review process (Figures 2 & 3) is structured to parallel the normal progression of planning and design for a dam and reservoir project. Ideally, this minimizes delays and allows the DSO review to proceed concurrently with project formulation. The Flowcharts in Figures 2 & 3 may be used as guides in following the topics in the remainder of Section 3.

Upon receipt, the design reports and plans and specifications are reviewed for conformance with accepted engineering practice and in accordance with the submittal requirements and the Dam Safety Guidelines. If deficiencies or problems are noted, specific changes or corrections are required and revisions are requested.

3.1.1 Dam Safety Office Review Time

The amount of time required for the DSO to complete its review is dependent upon the complexity of the project and the time of year the construction plans are submitted for review. During the summer and fall construction season, DSO workloads for construction inspection and periodic inspections of existing dams reduces the time available for plan review. Thus, where possible, owners are requested to submit plans in the winter or early spring to allow sufficient lead time for review prior to the proposed construction date.

Past experience has shown that revisions are required on many of the construction plans, and time should be allotted for the resubmittal of plans and subsequent review by the DSO.

In general, owners and project engineers should allow at least 60 days for plan review by the DSO. More or less time may be needed dependent on the complexity of the project and/or the DSO workload.

3.1.2 Application for Construction Permit

An application for a construction permit must be submitted when the first substantive engineering information about the proposed project becomes available. This usually occurs at the time that conceptual plans are completed. A copy of the application form is included in Appendix A of this document for photocopying. The application form lists required information to be submitted and initiates the process for obtaining the construction permit. An initial, non-refundable payment of one thousand four hundred dollars, which may represent all or a portion of the construction permit fee, is to be included along with the application form. The fee for removal of a dam with safety deficiencies is ten dollars.

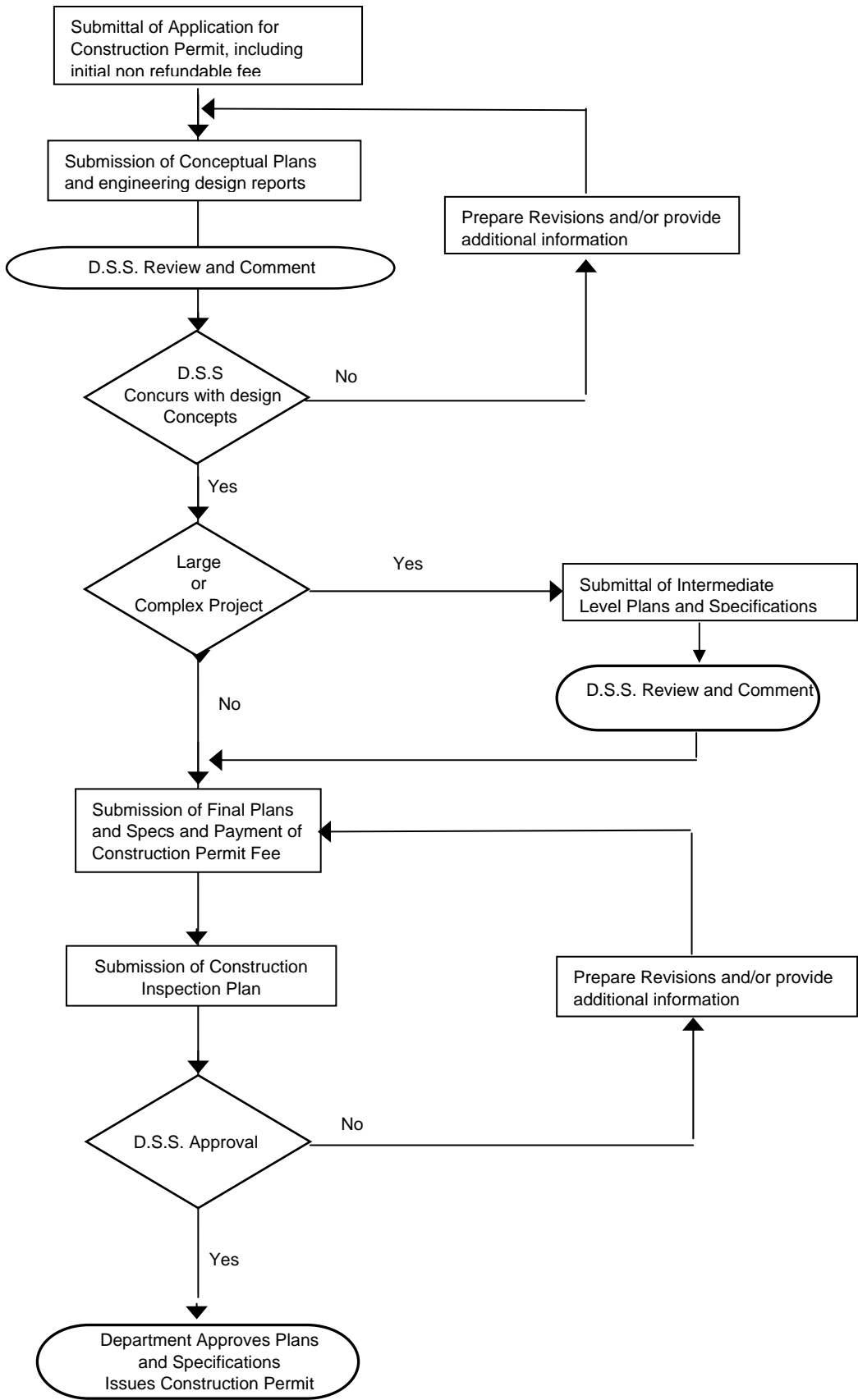


FIGURE 2. FLOWCHART FOR PLANNING AND DESIGN PHASE FOR PROJECTS CONSTRUCTED IN WASHINGTON

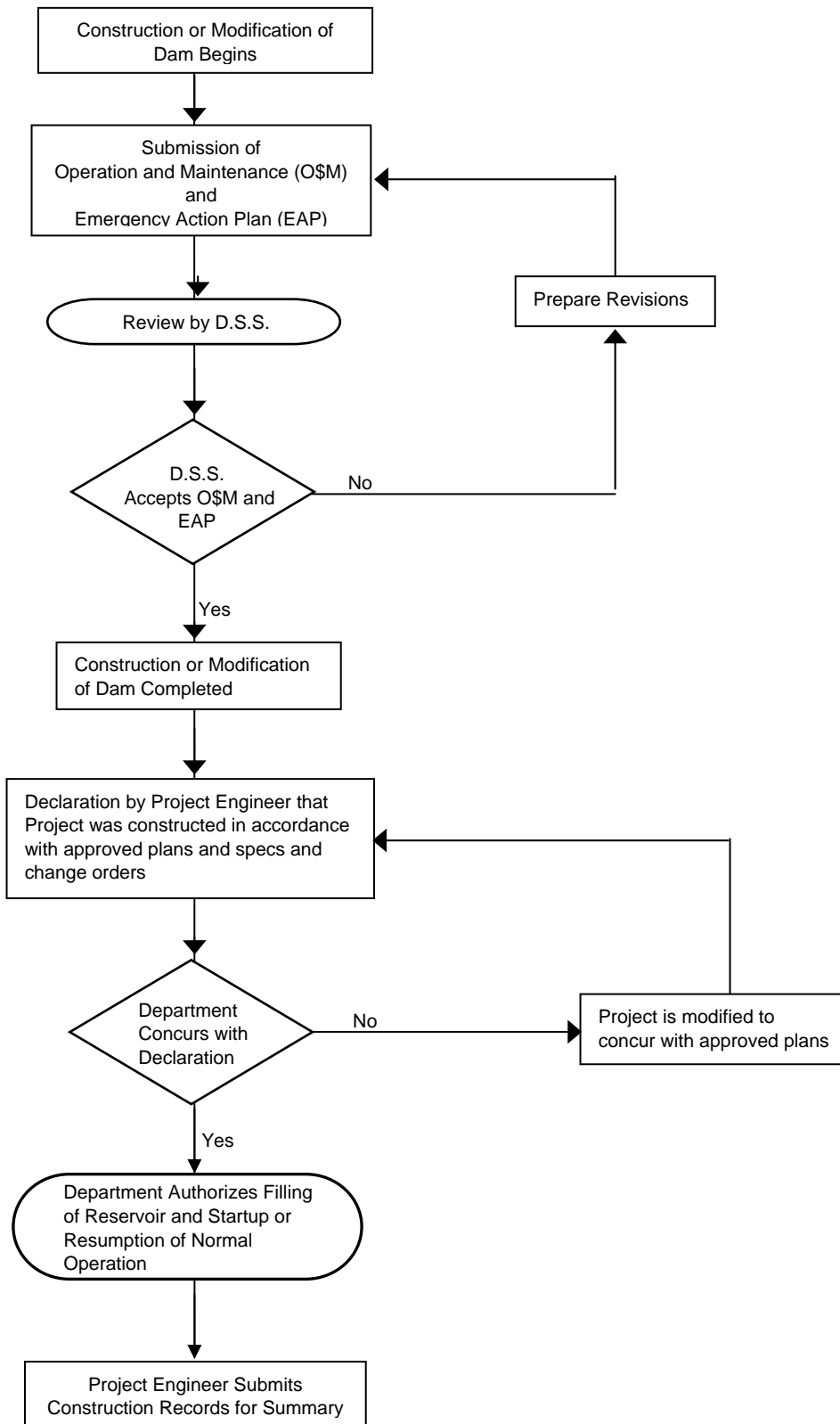


FIGURE 3. FLOWCHART FOR CONSTRUCTION AND PROJECT STARTUP PHASE FOR PROJECTS CONSTRUCTED IN WASHINGTON

3.2 ENGINEERING INVESTIGATIONS AND ANALYSES

Engineering investigations and analyses provide the basis for design. These investigations often progress in two stages, particularly when more than one site is under consideration. The first stage represents reconnaissance level site investigations which provide information needed for identifying necessary project components and possible project configurations. Conceptual plans are then developed as a method of conveying to the owner a specific option or series of options for project location and configuration. Stage one is completed with the selection of the desired project site and final project configuration.

The second stage constitutes more detailed investigations necessary for engineering design of chosen project components. The results of the detailed investigations are normally presented in the form of engineering design reports (see Section 3.3).

Specifically, engineering investigations of the project locale are performed to identify basic design considerations posed by the geologic and hydrologic setting. Typically, a geologic assessment of the region is conducted to identify probable foundation conditions, to investigate the seismicity of the area, and to examine reservoir rim stability. Explorations, comprised of test pits and/or borings, are made to characterize dam foundations in greater detail and to determine the suitability of proposed soil borrow areas. The magnitude of the exploration program should be commensurate with the scale of the project and the difficulties posed by anticipated foundation conditions. Specialists in geotechnical and geologic investigations are usually needed for larger or complex structures.

Hydrologic studies are conducted to determine runoff and streamflow characteristics which serve as the basis for sizing the reservoir, spillway(s) and outlet(s), and in developing normal operating requirements and procedures. Determination of the Inflow Design Flood (IDF) is of primary importance for sizing the project spillway(s). The level of sophistication of the hydrologic investigations will vary depending on the size and complexity of the tributary drainage basin. A minimal effort is usually needed where the impoundment will be an off-channel storage facility, with inflow limited to that from normal controlled operations and precipitation falling directly within the contained reservoir area. In contrast, extensive analyses are often needed for an onstream reservoir when the watershed is large and encompasses a number of tributaries with significant climatic, soils, land use, and topographic differences. Also, complex storm sewer networks in urban areas can often make even small basins difficult to analyze. The use of specialists in hydrologic analysis may be warranted for large or otherwise complex drainage basins.

3.3 ENGINEERING DESIGN REPORTS

Engineering design reports summarizing the various engineering investigations and pertinent project information are an important element of the project design documents. All pertinent design reports shall be submitted to the DSO to provide basic information about the project.

The content of design reports will normally include a general section describing the proposed project and sections relating to specific areas of engineering design. The general section should include:

- A description of the basic purposes of the project;
- A description of the normal operational requirement; and
- A discussion of any unique or important design considerations associated with the site and project configuration.

Those sections involving the various areas of engineering design should address the pertinent items listed below and be supported by appropriate engineering analyses.

3.3.1 Dam Size and Reservoir Operation Classification

The size classification and reservoir operation classification of the proposed project should be listed as defined by Tables 2 and 3. These classifications are used throughout *Part IV of the Dam Safety Guidelines* for determining the degree of conservatism of design, and the sophistication of the methodologies to be used in analyses.

TABLE 2. DAM SIZE CLASSIFICATION

SIZE CLASSIFICATION	DAM HEIGHT
Small Dam	Less than 15 feet
Intermediate Dam	15 feet or greater but less than 50 feet
Large Dam	50 feet or greater

TABLE 3. RESERVOIR OPERATION CLASSIFICATION

RESERVOIR OPERATION CLASSIFICATION	DETERMINING FACTOR
Permanent Pool or Seasonal Pool Operation	Steady state seepage or saturated flow conditions occur in impounding barrier and foundation at or near normal pool conditions.
Intermittent Operation	Duration of normal high pool condition is insufficient for steady state seepage or saturated flow conditions to develop in impounding barrier and foundation.

3.3.2 Geologic/Geotechnical Analyses and Reports

A Geologic/Geotechnical report should provide, as a minimum, the following basic information:

- A presentation of the findings from subsurface explorations based on test pits and/or boring logs, field tests, laboratory testing, and classification of samples.
- A characterization of the site geology and identification of potential problems posed by site conditions. Generalized subsurface formations or stratigraphy, profiles, and sections should be developed.
- An identification and characterization of the seismotectonic provinces that could generate earthquakes large enough to significantly affect the project site.
- A description of the local groundwater regime.

3.3.3 Hydrologic/Hydraulic Analyses and Reports

A hydrologic/hydraulic report should address the pertinent items listed below and provide the following information:

- A topographic map delineating the watershed boundary and stream network. For extensively urbanized watersheds, an outline of storm sewer networks and pertinent hydraulic features should be included. Where it is necessary to divide a watershed into subbasins for analysis, a map is needed delineating the subbasins, along with a schematic description of the stream network used in the analysis.

- A description and a map delineating the various land uses, soil types, ground covers, and associated runoff characteristics of the subbasins or watershed.
- A listing of all sources of inflow to the reservoir.
- A description of initial watershed conditions and associated assumptions prior to the occurrence of the Inflow Design Flood (IDF). Initial conditions of interest may include streamflow and/or other inflow to the reservoir, reservoir levels, gate settings or outlet works discharge, antecedent soil moisture and associated runoff characteristics, antecedent snowpack conditions, and climatic information such as temperature and wind speeds needed for snowmelt computations and any other pertinent information.
- The unit hydrograph(s) or other similar flood response parameters for the subbasins or watershed, together with calculations or data supporting the selection of the parameters.
- The magnitude and temporal distribution of the design storm selected for use in computing the IDF described in either graphical or tabular form. Specific guidelines for selecting the design storm are provided in *Part IV* and *Technical Notes 2 and 3* of the *Dam Safety Guidelines*.
- A listing of input and output of any computer models used in the analysis.

3.3.4 Dam Failure Analysis

An assessment of the consequences of a dam failure on downstream areas is required and should include the following:

- An estimation of the magnitude of the dam break flood hydrographs resulting from a hypothetical dam failure occurring with the reservoir at normal storage elevation and maximum storage elevation.
- A general description of the areas downstream of the dam that could be affected by floodwater from a dam failure.
- If there is the potential for loss of life, an inundation map delineating the maximum areal extent of flooding that could be produced by a dam failure. Inundation mapping should extend to a point downstream where the dam break flood would no longer pose

a risk to life. This is often interpreted to be coincident with the point where inundation from the dam failure is within the 100 year floodplain for the affected watercourse.

- The downstream hazard classification as defined by Table 4, which reflects the above conditions and those conditions that might be reasonably anticipated from future downstream development. The most serious potential consequences of failure for those conditions listed in columns 4A, 4B, and 4C shall be used to establish the appropriate downstream hazard classification.

Specific guidelines for dam break analyses are found in the *Dam Safety Guidelines - Technical Note 1, Dam Break Inundation Analysis and Downstream Hazard Classification*.

TABLE 4. DOWNSTREAM HAZARD CLASSIFICATION

Downstream Hazard Potential	Downstream Hazard Classification	Column 4A Population at Risk	Column 4B Economic Loss Generic Descriptions	Column 4C Environmental Damages
Low	3	0	Minimal. No inhabited structures. Limited agriculture development.	No deleterious materials in water
Significant	2	1 to 6	Appreciable. 1 or 2 inhabited structures. Notable agriculture or work sites. Secondary highway and/or rail lines.	Limited water quality degradation from reservoir contents and only short-term consequences.
High	1C	7 to 30	Major. 3 to 10 inhabited structures. Low density suburban area with some industry and work sites. Primary highways and rail lines.	Severe water quality degradation potential from reservoir contents and long-term effects on aquatic and human life.
High	1B	31-300	Extreme. 11 to 100 inhabited structures. Medium density suburban or urban area with associated industry, property and transportation features.	
High	1A	More than 300	Extreme. More than 100 inhabited structures. Highly developed, densely populated suburban or urban area with associated industry, property, transportation and community life line features.	

3.3.5 Engineering Calculations

Engineering calculations and data supporting the detailed design of project components should be included with the submittal of the design reports. The design, analyses, and construction details should satisfactorily address the conditions at the proposed site. The supporting information should generally include:

- The design step level(s) used in the design of the critical project elements based on guidance contained in *Part IV of the Dam Safety Guidelines* and information in *Technical Note 2*.
- Stability analyses corroborating the design of the proposed embankment/barrier section under static and seismic loadings and rapid drawdown conditions.
- An assessment of the impoundment permeability and any associated local groundwater problems which may develop from the impoundment of water.
- Calculations for the design of any hydraulic structures, particularly outlet works, which are subject to high lateral earth pressures, relatively large seismic loads or excessive uplift pressures.
- Computations for sizing the principal and emergency spillways, and routing computations defining the reservoir inflow and outflow design flood hydrographs. If a computer model of the watershed is developed, a listing of pertinent input and output data should be included.
- A graph or chart describing the relationship between reservoir pool elevation and reservoir surface area (in acres).
- A graph or chart describing the relationship between reservoir pool elevation and reservoir storage volume (in acre-feet).

It should be emphasized, particularly for small projects, that many of the foregoing items, and those items described in the geologic, hydrologic and dam failure analyses sections can be adequately addressed through a simple reconnaissance of the site and surrounding topography. In addition, much of the needed guidance and information is contained in standard engineering texts, references and publications, some of which is summarized in *Part IV of the Dam Safety Guidelines*.

More detailed information on items commonly covered in design reports is provided in the U.S. Bureau of Reclamation's publication *Design of Small Dams*.

3.4 CONSTRUCTION PLANS AND SPECIFICATIONS

Construction plans are usually prepared in several steps progressing from preliminary to intermediate to final plans. This procedure provides the owner and engineer an opportunity for discussion and for decisions to be made on details of the project design.

For large and/or complex projects, the DSO must be provided with preliminary or intermediate level plans, in addition to the final plans, to allow for adequate review time and independent analysis. For small projects, involving relatively simple designs, preliminary or intermediate plans are normally not needed for review.

The submitted plans and specifications should consist of those drawings and specifications which the contractor will use to construct the facility. For approval, the construction plans and specifications must contain sufficient detail and information to adequately describe and control the proposed construction work.

The following items, as a minimum, must be included as part of the construction plans:

- Project location and vicinity map.
- Site map of dam, reservoir area, and appurtenances.
- Sectional view along longitudinal axis of dam and foundation.
- Cross-sectional view of dam at location of maximum height.
- Cross-sectional views and profiles of spillway(s), outlet facilities, and other appurtenances.
- Steel reinforcement placement and bar sizing for concrete construction must be shown in at least one section or profile.
- The plan for diversion and control of water during construction.

Water impounding facilities pose unique problems not generally encountered in other structures. Particular care should, therefore, be taken in writing specifications for foundation treatment and preparation, the gradation of borrow materials and filters, fill placement, moisture control and compaction, and mix design and quality control of concrete for hydraulic structures subjected to intermittent or continuous flow.

The following items, as a minimum, must be included as part of the construction specifications:

- The type, class, and/or description of all materials to be used.
- The requirements for fill placement, moisture conditioning, and minimum level of compaction of all earthen zones.
- The requirements, procedures, and minimum standards for concrete construction and/or construction details.

These topics are covered in more detail in the *Part IV of the Dam Safety Guidelines*. Sample specifications are also provided in the previously cited reference, *Design of Small Dams*.

The plans and specifications must bear the seal and signature of the project engineer. Two copies of the plans and specifications must be submitted to the DSO for engineering review. Upon approval, one copy will be retained by the DSO and the other copy will be returned to the project engineer.

3.5 REVIEW STANDARDS

The DSO will review engineering design reports, plans and specifications, and the construction inspection plan to ascertain that the proposed project will be designed and constructed in a manner which will reasonably secure safety to life and property. The review is not intended to extend to more general issues of safety not directly related to the structural stability and integrity of the project, which are the purview of other governmental agencies. The DSO will review documents submitted to ascertain that they conform to accepted engineering and construction practice and the Dam Safety Regulations Chapter 173-175 WAC, and are in agreement with guidance contained in *Part IV of the Dam Safety Guidelines*. Those elements of a document(s) which are not found to be in conformance with the above will be identified to the owner or the project engineer and changes may be required to conform to accepted engineering practice.

Where differences of opinion arise on the suitability of certain engineering or construction practices and cannot be readily resolved, the burden of proof will rest on the owner and the project engineer to demonstrate the suitability of the proposed plan or action.

3.6 CONSTRUCTION PERMIT FEE

As required by statute and administrative code, a fee for plan review and subsequent construction inspections must be paid to the Department of Ecology before plans are approved and the construction permit is issued. Fee amounts for new construction for fiscal year 2005 range from a minimum of \$1400 to a maximum of \$56,000 depending on the size of the project. The exact amount of the fee is set by WAC 173-175-360 and 370, and is determined by the DSO based on the height and crest length of the dam as shown on the construction plans. The fees will be automatically adjusted annually on July 1st by the fiscal growth factor as calculated under RCW 43.135. The DSO will publish the adjusted fees after July 1st on our internet site (<http://www.ecy.wa.gov/programs/wr/dams/dss.html>), and by providing written notification by mail or e-mail to permit applicants.

An initial payment of \$1400 dollars, which may represent all or a portion of the construction permit fee is to be paid in conjunction with the submittal of the construction permit application. The

balance of the fee amount is to be paid following notification by the DSO of the balance due. Table 5 provides an abbreviated listing of the construction permit fees for new projects in FY 2005.

TABLE 5. CONDENSED FEE SCHEDULE FOR NEW DAM CONSTRUCTION.

DAM HEIGHT (feet)	DAM CREST LENGTH (Feet)						
	100	200	400	600	800	1000	2000
200	37128	44492	49532	51380	52556	53452	56000
150	30352	38640	45668	48664	50260	51184	53984
100	18872	28840	37548	42308	44800	46844	50792
80	14392	22204	32368	37240	40656	42980	45696
60	10192	15708	24248	30660	34020	34496	34496
40	5908	9128	14084	18144	21728	22176	22176
30	4480	6916	10668	13748	16436	17696	17696
20	2800	4312	6664	8596	10276	11816	12096
15	2156	3108	4788	6188	7392	8512	9296
10	1652	2128	3052	3920	4704	5404	6496
5	1400	1484	1736	2044	2296	2576	3696

Fees for modifications of existing structures are charged at a reduced rate depending on the intended scope of work. Fees for minor modifications of the impounding barrier, spillways, or outlets and appurtenant works are charged at 25%, 25% and 10% respectively of the amounts in Table 5, or \$1400, whichever is greater.

If an existing project is to undergo a significant enlargement, (raising of the barrier height by an amount greater than 5 feet, or a 10% or more increase in overall dam height or normal pool elevation), then the fees for the impounding barrier, spillways or outlets and appurtenant works are 35%, 35%, and 10% respectively of the amounts shown in Table 5, or \$1400, whichever is greater.

For the planned abandonment and reclamation of dams and reservoir areas used in mining operations, the fee is \$1400.

The fee for the removal of a dam with safety deficiencies is ten dollars.

The complete fee regulation, and fee scale contained in WAC 173-175-350 through 173-175-400, is provided in *Part I of the Dam Safety Guidelines*, and is available on the internet at: <http://www.ecy.wa.gov/biblio/wac173175.html>.

3.7 ISSUANCE OF CONSTRUCTION PERMIT

When all review comments have been satisfactorily addressed, the fee has been paid in full, and the construction inspection plan (see Section 4.1) has been reviewed and accepted by the DSO, the plans and specification will be approved, and a construction permit will be issued which authorizes construction to commence.

Construction cannot begin until the construction permit has been issued by the DSO. However, preliminary work such as mobilization of equipment, stripping and grubbing, and other site preparation work is allowed prior to receipt of the construction permit, provided no permanent features of the dam are started, and no other permits are required for this type of work.

A number of other permits and approvals are often required at the local, state, and federal levels for the construction of impoundment facilities. Receipt of the construction permit does not relieve the owner of the responsibility to secure all other applicable permits and approvals before proceeding with construction work. Some of the more common permits and approvals that may be required for the typical dam and reservoir project are outlined in Section 2 of this document, and described in more detail in the Ecology publication *Commonly Required Environmental Permits for Washington State*.

4. CONSTRUCTION INSPECTION

It is the responsibility of the owner, usually through the project engineer, to provide for adequate engineering control and inspection of the work to ensure that it conforms with the approved plans and specifications. For small projects this generally involves verifying the following:

- The foundations have been adequately prepared and treated.
- Embankment fill has been properly moisture conditioned and compacted.
- The various construction materials conform to the specifications.
- Concrete work conforms to the plans and is accomplished in a satisfactory manner.
- Spillways and appurtenant works are constructed to the specified size and elevation.

Table 6 outlines the normal inspection effort for typical projects. This information may also be used to assist in writing the scope of work for contracting for engineering services. Site specific considerations or project characteristics may warrant a more or less stringent approach than that described.

4.1 CONSTRUCTION INSPECTION PLAN

A detailed plan, incorporating the construction inspection activities shown in Table 6, must be submitted to the department describing how adequate and competent construction will be provided. The Construction Inspection Plan must be reviewed and accepted by the DSO prior to issuance of the Construction Permit. The Construction Inspection Plan must be prepared by a professional engineer and shall include, as a minimum:

- A listing of construction activities related to critical project elements and planned inspection effort including staffing levels, responsibilities, frequency and duration of site visits;
- A description of the quality assurance testing program which describes the type of test, general frequency, acceptable results, handling of deficient materials, and the individual(s) responsible for overseeing the testing;
- A description of construction management organization, lines of communication, and responsibilities;
- A description of the change order process including who is responsible for coordinating the change order review process with the department;
- A description of the technical records handling and the content and frequency of construction progress reports.

TABLE 6. NORMAL CONSTRUCTION INSPECTION ACTIVITIES

DAM SIZE CLASSIFICATION	FREQUENCY OF SITE INSPECTION	QUALITY ASSURANCE TESTING PROGRAM	INSPECTION DOCUMENTATION SUBMITTED TO DSO	INSPECTION REPORT SUBMITTAL FREQUENCY
SMALL Height < 15 Ft.	Intermittent On-Site for Inspection of Critical Elements	. Field Memoranda and Inspection Notes . Periodic Compaction Control . Gradations of Representative Samples of Embankment Materials . Photos of Construction of Critical Elements	. Change Order Documentation . Summary of Field Density Test Results . Summary of Gradation Test Results	. As Material is Developed . Provide Abbreviated Construction Summary of Project Containing Representative Photos
INTERMEDIATE Height ≥ 15 Ft. but Height < 50 Ft.	Frequent On-Site Several Times Each Week and Present During Construction of Critical Elements	. Field Memoranda and Inspection Notes . Periodic Compaction Control . Gradations of Representative Samples of Embankment Materials . Concrete Cylinders for all Structural Concrete . Photo Record of all Critical Elements and Construction Chronology	. Change Order Documentation . Summary of Field Density Test Results . Summary of Gradation Test Results . Summary of Concrete Test Results	. Provide Initial Material Gradation and Compaction Control Results As Developed to Confirm Compliance with Specifications and Adequacy of Test Procedures . Provide Construction Summary Report at Completion of Project Include Representative Photo Chronology
LARGE Height ≥ 50 Ft.	Continuous Inspector(s) On-Site Throughout Construction Consideration of Increased Inspection Staff During Construction of Critical Elements	. Maintain On-Site Complete Set of Daily Inspection Memoranda and All Test Results . Periodic Compaction Control . Gradations of Representative Samples of Embankment Materials . Concrete Cylinders for all Structural Concrete and air entrainment testing . Complete Photo Record Construction Chronology	. Change Order Documentation . Periodic Summaries of Field Density Test Results . Periodic Summaries of Gradation Test Results . Periodic Summaries of Concrete Strength Test Results	. Provide Initial Material Gradation and Compaction Control Results as Developed to Confirm Compliance with Specifications and Adequacy of Test Procedures . Provide Construction Summary Report at Completion of Project Include Representative Photo Chronology

4.2 DAM SAFETY OFFICE ROLE IN CONSTRUCTION INSPECTION

The role of the Dam Safety Office during construction will be to confirm that the project engineer, acting as representative for the owner, is properly implementing the approved Construction Inspection Plan. The DSO will periodically observe the construction work to independently confirm that the conditions assumed in the design stage are valid for actual field conditions, and that construction is proceeding in accordance with the approved plans and specifications. The DSO may require changes to be made to the approved plans and specifications to reasonably secure safety to life and property. Reasons for changes may include:

- To address unanticipated field conditions.
- To correct omissions or errors in the approved plans and specifications.
- To correct situations where the construction work clearly is not being performed satisfactorily, and does not meet the performance intent of the specifications.

Where deemed necessary by the DSO, a stop-work order may be issued to temporarily halt construction until a problem can be resolved.

4.3 CONSTRUCTION CHANGE ORDERS

After construction is in progress, a variety of problems such as unanticipated foundation conditions or shortages of materials may necessitate a change to the plans. Where such changes represent a significant modification of the approved plans or specifications that could have an impact on the structural integrity or safe operation of the impoundment, the change must be submitted to the DSO for a determination if an approval is required. The following flowchart (Figure 4) illustrating the review process, directs the project engineer to notify the DSO of the need for a change order (usually by phone) where a judgment as to the need for an approval would be made. If submittal of a change order is deemed necessary, two complete sets should be forwarded to the DSO for review and approval. The DSO will review the construction change order and provide a response to the project engineer in a timely manner consistent with the complexity and safety concerns of the situation.

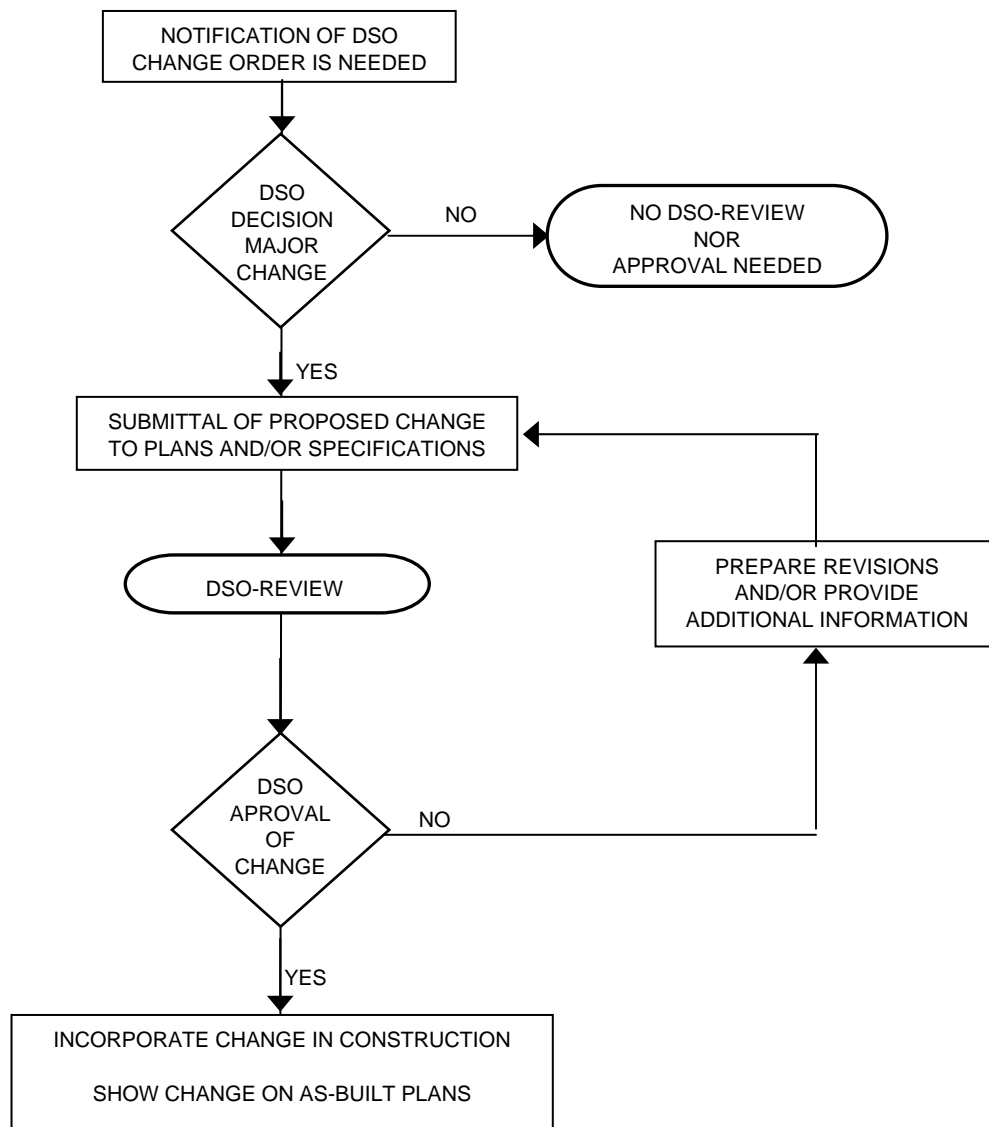


FIGURE 4. FLOWCHART OF REVIEW PROCESS FOR CONSTRUCTION CHANGE ORDERS

4.4 OPERATION AND MAINTENANCE PLAN

An Operation and Maintenance (O&M) Plan must be developed for all dams being constructed or modified, and submitted to the DSO for review and acceptance before project operation can be initiated or resumed. The O&M Plan is a summary and outline of how the project is to be operated, and how monitoring, inspection and maintenance are to be accomplished. A copy of the form to be used in completing an O&M Plan is provided in Appendix B. Owners are responsible for incorporating details of the O&M Plan into an O&M Manual, which is described in Section 5.1.

4.5 EMERGENCY ACTION PLAN

If a failure of the dam could pose a risk to life based on the current level of development in downstream areas, an Emergency Action Plan must be developed and submitted to the DSO for review and acceptance before project operation can be initiated or resumed. Requirements associated with EAPs are described in Section 5.2.

4.6 DECLARATION OF CONSTRUCTION COMPLETION

Within 30 days following substantial completion of construction or modification of a dam, the project engineer shall submit to the DSO a declaration stating that the project was constructed in accordance with the DSO approved plans and specifications and construction change orders. The following declaration form may be used or altered, as appropriate, by the project engineer.

DECLARATION OF DAM CONSTRUCTION COMPLETION	
<p>In accordance with WAC 173-175-230, the undersigned professional engineer states that:</p>	
<p>He/she, or a designated representative under his/her supervision, was present during construction to observe construction activities, and that he/she has reviewed the results of the field testing of materials, and to the best of his/her knowledge, the following dam project,</p>	
<p>_____, was constructed in accordance with the</p>	
<p>(Project Name)</p>	
<p>approved plans, specifications, construction change orders, and construction inspection plan. Based on the forgoing, the project can be put into service.</p>	
<p>_____</p> <p>(Name)</p>	<p>_____</p> <p>(Date)</p>
<p>P.E. Seal and Signature</p>	

FIGURE 5. DECLARATION OF CONSTRUCTION COMPLETION

4.7 AUTHORIZATION TO COMMENCE OR RESUME PROJECT OPERATION

Once the project engineer's declaration of acceptable construction completion has been received, the DSO will authorize the owner or the project engineer, as appropriate, to commence controlled reservoir filling, or resume normal project operation, provided that:

- The DSO concurs with the project engineer that the project was constructed in accordance with the approved plans and specifications and construction change orders, and the project is expected to function satisfactorily.
- The proposed O&M Plan, and Emergency Action Plan (if required) are acceptable to the DSO.

If the above conditions are not met, the owner will not be allowed to commence or resume normal operation of the project until all outstanding issues or problems are resolved.

4.8 CONSTRUCTION RECORDS SUMMARY

Within 120 days following completion of construction or modification of a dam, the project engineer must submit a report to the DSO on construction activities. This report should include:

- A summary of results from the field testing of all materials used in construction. The summary shall identify both representative values and the range of test values.
- A discussion of any notable problems, incidents, exceptions, etc. encountered during construction.
- One complete set of drawings depicting the as-built condition of the dam. These drawings shall be submitted in both paper and electronic format.

5. PROJECT OPERATION DOCUMENTS

It is the responsibility of dam owners to operate and maintain their dam(s) in a safe manner and condition, and to notify the Dam Safety Office (DSO) when modifications to the dam are proposed or unusual or unsafe circumstances occur. The following sections list documents and activities that are required of dam owners once the project is completed and in service.

5.1 OPERATION AND MAINTENANCE MANUAL

As discussed in Section 4.4, owners of new project are required to submit an Operation and Maintenance (O&M) *Plan* as part of the construction permit process. The O&M *Plan* provides a brief summary of how the project is to be operated, and outlines how the basic elements of monitoring, inspection and maintenance are to be accomplished. Once the project is completed, owners are then responsible for incorporating the information in the O&M *Plan* into an O&M *Manual*, suitable for use by dam operators. The O&M *Manual* should contain detailed information on how the project is to be operated, monitored, inspected, and maintained.

The development of the manual for directing and controlling normal operations and maintenance should be an integral part of project formulation. Ideally, it should be included as part of the scope of work for development by the engineering consultant. The O&M Manual is necessarily multipurpose. Its size and complexity would be a function of the characteristics of a specific project. In general, the manual should describe procedures for the operation of the project under normal, and extreme or emergency conditions and provide technical guidance and procedures for monitoring, inspection, and long-term maintenance. For detailed information on O&M manuals, refer to Ecology Publication 92-21, *Guidelines for Developing Dam Operation and Maintenance Manuals*.

5.2 EMERGENCY ACTION PLAN

Emergency Action Plans (EAPs) must be developed for all projects that could pose a threat to life (Downstream Hazard Classes 1A, 1B, 1C, and 2). In general, the EAP should describe procedures for responding to unusual or emergency situations and procedures for initiation of notification or warning of individuals who may be at risk in downstream areas. As a minimum, the EAP should include the following:

- Notification procedures (preferably in the form of a flow chart) and responsibilities for notifying downstream residents in the event of an impending dam failure.

- A notification list that includes the names and telephone numbers of all affected downstream residents, dam owner and operator, local emergency officials, and appropriate government agencies (including the Dam Safety Office).
- Specific instructions for responsible parties to be followed at the dam site in response to emergencies such as floods, equipment failures, or other unusual events where the situation is evolving slow enough that immediate remedial action can be effective to prevent failure.
- Procedures to follow for emergency situations which probably would not lead to dam failure, but still could represent a hazard for downstream residents.

Detailed information on the development of EAPs is contained in Ecology Publication 92-22, *Guidelines for Developing Dam Emergency Action Plans*. Owners are required to coordinate the development of the EAP with representatives from the local Emergency Services staff, the State Department of Community Development, Emergency Management Division, and other appropriate local authorities. Copies of the completed EAP must be provided to the State Emergency Management Division, local Emergency Services, and to the DSO.

**APPENDIX A
DAM CONSTRUCTION PERMIT
APPLICATION FORM**



WATER RESOURCES PROGRAM DAM SAFETY OFFICE

APPLICATION FOR DAM CONSTRUCTION PERMIT

\$1400.00 initial non-refundable payment required with application

or \$10.00 Fee for Dam Removal
(GRAY BOXES FOR OFFICE USE ONLY)

File No.	County Code	WRIA	Date Rec'd	Initial Fee Paid
1. OWNER INFORMATION				
Owner's Name			Telephone Number ()	
Mailing Address (Street or P.O. Box)		(City)	(State)	(Zip)
2. PROJECT ENGINEER INFORMATION				
Project Engineer for Dam Design:			Telephone Number: ()	
Address (Street or P.O. Box)		(City)	(State)	(Zip)
Washington State P.E. #			Expiration Date	
3. CONSTRUCTION ENGINEER INFORMATION				
Project Engineer for Oversight of Dam Construction:			Telephone Number: ()	
Address (Street or P.O. Box)		(City)	(State)	(Zip)
Washington State P.E. #			Expiration Date	
4. PROJECT INFORMATION				
Project Name:				
Dam Name(s) (Also List Names of All Impounding Structures Associated with Project)				
Reservoir/Impoundment Name:				
New Construction <input type="checkbox"/> Modification of Existing Dam <input type="checkbox"/> Dam Removal <input type="checkbox"/>				
Name of Stream (If Offstream, Write Offstream and Name of Nearest Stream)				
Location of Dam (Include Map Showing Location of Project)		Section	Township N.	Range (E. or W.)
Location of Dam		Latitude		Longitude

4. PROJECT INFORMATION (cont.)		
Purpose of Dam and Reservoir (Water Supply, Recreation, Power, Fish Propagation, etc.)		
Reservoir Operation Class (Permanent, Seasonal, or Intermittent Pool)	Dam Size - <input type="checkbox"/> Small <input type="checkbox"/> Intermediate <input type="checkbox"/> Large	
Downstream Hazard Classification (Class 1A, 1B, 1C, 2, or 3)		
Is Dam Regulated by Federal Agency?	If yes, Name of Agency	
Is Dam a Hydropower Project?	If yes, FERC License #	
Is Dam Constructed on Federal Land?		
Has Environmental Checklist Been Completed in Accordance with SEPA?		
Has Determination Been Made if Water Right Permit and/or Reservoir Storage Permit is Needed?		
5. DAM INFORMATION		
Proposed Dam Height (Crest to Toe)	Length Along Dam Crest	Width of Dam Crest
Type of Construction and Material of Which Dam is to be Built (Examples: Homogeneous Earthfill, Zoned Earthfill, Concrete Gravity)		
Proposed Date of Construction Startup	Anticipated Date Construction will Be Completed	
6. RESERVOIR INFORMATION		
Number of Acres Submerged at Normal Full Pool		
Number of Acre-Feet to be Stored at Normal Full Pool		
Number of Acre-Feet that can be Stored at Dam Crest Level		
7. PROJECT OPERATION		
Who Will Be Responsible for Project Operation & Maintenance?		
Who Will Be Responsible for Project Inspections & Monitoring?		

Date

Name of Project Contact

Telephone Number

**INSTRUCTION SHEET
FOR COMPLETING APPLICATION FOR DAM CONSTRUCTION PERMIT**

1. **OWNER INFORMATION:** Name, Address, and Telephone of individual, corporation, public entity, etc., that is the legal owner of the project.

2. **PROJECT ENGINEER INFORMATION:** Name, Address, Telephone No., and P.E. No. of person who is to be Project Engineer. The Project Engineer has direct supervision in managing the engineering aspects of the project as representative of the owner.

3. **CONSTRUCTION ENGINEER INFORMATION:** Name, Address, Telephone No. of person who is to be Construction Engineer. The Construction Engineer is responsible for managing the construction of the project as representative of the owner, in accordance with the construction inspection plan. If same as Project Engineer, write "Same".

4. PROJECT INFORMATION:

Project Name: Name given to overall project.

Dam Name(s): Name for each dam, berm, dike, involved in project.

Reservoir Name: Name to be given to reservoir, lake, pond, impoundment, etc.

Name of Stream: Name of stream, creek, river that dam is to be constructed across. If the impoundment is not to be constructed across a stream, write "Offstream". If stream is unnamed, write "unnamed tributary of _____ Creek".

Location of Dam: Legal Description of land on which dam is built. Provide a map showing the project location.

Purpose of Dam and Reservoir: Indicate purpose(s) for which proposed project is to be used. Types of purposes would include: Water Supply (Irrigation, Industrial, or Municipal), Hydropower, Flood Control, Stormwater Detention, Recreation, Mine Tailings, Wastewater, Wildlife/Fish Propagation.

Reservoir Operation Class: Indicate how reservoir is to be operated:

Permanent Pool - Operated year round at approximately same elevation.

Seasonal Pool - Operated at full pool part of the year, with seasonal drawdown.

Intermittent Pool - Impounds water infrequently and for short duration, such as flood control dams.

Dam Size: Small - Dam Height less than 15 feet.

Intermediate - Dam Height 15 feet or greater, but less than 50 feet.

Large - Dam Height 50 feet or greater.

Downstream Hazard Classification: Indicates level of downstream development that would be affected in the event of a dam failure:

3 - Low	No inhabited structures
2 - Significant	1 or 2 inhabited structures
1C- High	3 to 10 inhabited structures
1B- High	11 to 100 inhabited structures
1C- High	More than 100 inhabited structures

Note: See *Dam Safety Guidelines - Technical Note 1* for assistance in assessing the downstream hazard classification.

Has Environmental Checklist been Completed in Accordance with SEPA?: State Environmental Policy Act (SEPA) requires that agencies issuing permits, approvals, etc., must assure that appropriate consideration has been given to the environment. The SEPA process is initiated by the project proponent completing an Environmental Checklist. Information on the SEPA process can be obtained at local (city, county) planning departments, or from the Environmental Review Section of Ecology at (206) 459-6025. SEPA must be complied with before a Dam Construction Permit can be issued.

Has Determination Been made if Water Right and/or Reservoir Permit is Needed?: If water impounded by the dam is considered a beneficial use (e.g. water supply, recreation, fish propagation) then a water right and/or Reservoir Permit is required. Information and application forms can be obtained at the Ecology Regional Offices in Bellevue, Tumwater, Yakima, or Spokane.

- 5. DAM INFORMATION:** Provide general dimensions and information about dam type.
- 6. RESERVOIR INFORMATION:** Provide area and volume information for reservoir.
- 7. PROJECT OPERATION:** Indicate responsible individuals for Operation & Maintenance, and Inspection & Monitoring once the project has been built and put into service.

Ecology is an equal opportunity employer. To receive this document in an alternate format, contact the Water Resources/Dam Safety Office at (360) 407-6623(voice), or 711 or 1-800-833-6388 (TTY).

**APPENDIX B
OPERATION & MAINTENANCE PLAN
FORM**



**WATER RESOURCES PROGRAM
DAM SAFETY OFFICE**

OPERATION AND MAINTENANCE PLAN FORM

1. PROJECT DATA:

Dam Name: _____

Reservoir Name: _____

Owner's Name: _____

Creek/River: _____

Location: Section _____ Township _____ Range _____

Dam Type: _____

Dam Height: _____ Crest Length: _____ Crest Width _____

2. INDIVIDUALS WHO ARE RESPONSIBLE FOR:

Name	Title	Telephone #
------	-------	-------------

Operation: _____

Maintenance: _____

Inspections: _____

Monitoring of
Instrumentation: _____

**3. LISTING OF HYDRAULIC ELEMENTS FOR CONTROLLING INFLOW TO OR
OUTFLOW FROM RESERVOIR:** *(Include gates, valves, spillways, stoplogs, structures, etc. location and
dimensions of structures)*

4. **RULES AND PROCEDURES FOR RESERVOIR OPERATION** (*How is reservoir level controlled? Include proposed reservoir levels for given time of year, periods of drawdown and filling, and operation during floods*)

5. **LIST OF ITEMS REQUIRING PERIODIC MAINTENANCE, AND PROCEDURES FOR PERFORMING MAINTENANCE.** (*Include type of maintenance performed, frequency, method, and record keeping*):

6. **LIST OF INSTRUMENTATION, FREQUENCY OF MONITORING, AND METHOD OF RECORD KEEPING:**

7. LIST OF EQUIPMENT TO BE PERIODICALLY TEST OPERATED. (*Gates, valves, hoists, etc. Include frequency of test operation.*):

8. FREQUENCY OF ROUTINE INSPECTIONS: (*e.g. Weekly, monthly, or quarterly. Include list of key elements inspected*)

9. ANNUAL INSPECTIONS BY OWNER: (*Time of year when performed, special items to be examined, reviewed, and/or test operated*)
