Montana Dam Safety Program

DESIGN REVIEW PROCESS MANUAL FOR DAM PROJECTS

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Revised August 2019

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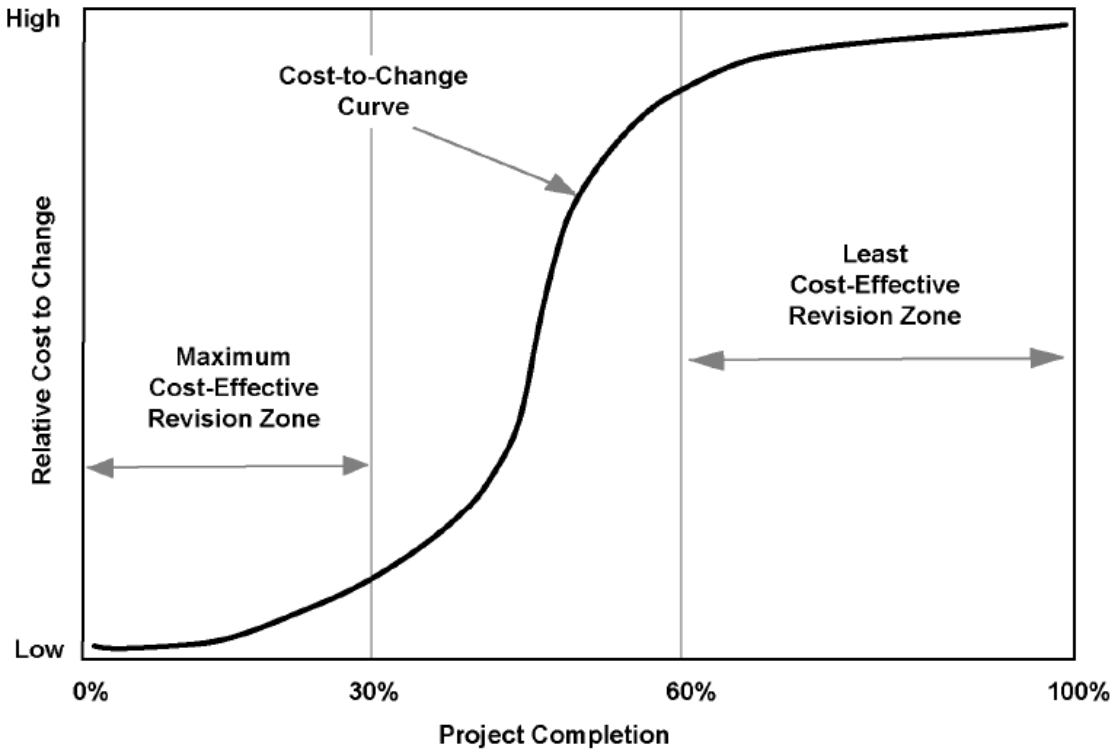
1.0 INTRODUCTION AND PURPOSE

The Montana Dam Safety Program (MTDSP), which is part of the Department of Natural Resources and Conservation (DNRC), regulates the construction, operation and maintenance of Montana's dams to protect life and property from damages due to failure. For dams that are classified as high hazard (ARM 36.14.206), a Construction Permit is required prior to any construction, alteration, repair, enlargement, or removal (ARM 36.14.301). The design of these construction projects requires collaboration between the dam owner, the design engineer, and the MTDSP. **The purpose of this manual is to promote this collaboration by establishing guidelines and procedures for the design review process for a dam construction project**. The process includes all project stakeholders, including the owner, engineer, and the MTDSP, but could also include others if their involvement is important for the success of the project.

Early involvement of the MTDSP has been found to be cost effective as feedback is received early in the process so that significant changes are not required after the design is nearly complete. This is demonstrated in Figure 1-1 where it is shown that design changes made late in the design development process falls into the “least cost-effective revision zone”. . The goal of this document is to provide guidance on advancing a project from concept through construction efficiently and to provide a clear understanding of the various stages of the process.

FIGURE 1-1. EFFECT OF MAKING DESIGN CHANGES LATE IN THE DESIGN PROCESS



Source: *Guidelines for Cooperation with the Alaska Dam Safety Program*

These guidelines also include methods for documenting decisions throughout the design review process. These guidelines are based on a National model that was developed to help States address a common problem: early involvement and communication with regulatory agencies.

Some goals and benefits to be realized from these guidelines include:

- Facilitate early involvement of the MTDSP in the design review process. Early feedback is believed to provide value and reduce design costs, as changes to the design concept later in the process have been found to be more costly (Figure 1-1).

- Promote collaboration between the design engineer, the MTDSP, and the dam owner. With early involvement and collaboration, the stakeholders can agree upon the design concept early and avoid the potential for a significant change to the concept later in the process, potentially resulting in a higher construction cost.
- Provide a scalable approach to the review process. Larger, more complex projects may require more requirements and guidance than small projects.
- Provide guidance on documenting decisions through correspondence and communication.

2.0 ROLES AND RESPONSIBILITIES

The *MTDSP* is responsible for reviewing Construction Permit application submittals for compliance with Montana dam safety laws and rules. The MTDSP also reviews submittals for compliance with current standards of care for dam safety design and construction. It is possible that several iterations of MTDSP comments and design engineer/dam owner replies are conducted prior to approval of the Construction Permit. If the application meets MTDSP standards, an approval letter is sent to the dam owner and design engineer.

The *design engineer* is responsible for the overall design of the project, including plans, specifications, and design reports, which include all calculations to support the design. The design engineer shall employ, if necessary, professional engineer(s) registered in Montana that will be in responsible charge of the various components of the work. If the firm of the design engineer lacks expertise in a component of the project, the design engineer has a responsibility to subcontract with qualified individuals outside of their firm. The engineer(s) shall affix his/her seal and signature to the drawings in accordance with Montana requirements (ARM 36.14.301(4) and MCA 37-67-314).

The *dam owner* is responsible for procuring and paying for the services of the design engineer. **It is important for the owner or their delegate to be involved in the design and design review process and provides input before major decisions are finalized.** The roles and responsibilities are further discussed in subsequent sections of this document.

3.0 DESIGN REVIEW PROCESS (COMPONENTS AND STAGES)

The design review process shall include submittal of work products at various stages of the design for review by the MTDSP. Where appropriate, meetings will be held at these milestones and include the appropriate stakeholders, as described herein. The following stages have been identified.

3.1 SCOPING / CONCEPTUAL DESIGN

Prior to initiating the detailed design, the dam owner and design engineer will collaborate to develop a scope for the design, including necessary field work and explorations. During this phase, the project goals and tasks are developed. Involvement of the MTDSP at this phase is important to ensure that the project goals are consistent with the identified deficiencies and regulatory requirements.

3.1.1 Predesign Meeting

A predesign meeting is considered an important component of the conceptual design phase and should occur prior to finalizing the scope of the project design. This phase may require an initial contract between owner and design engineer.

The predesign meeting should include, at a minimum, the dam owner, the design engineer, and representatives of the MTDSP. The meeting will be facilitated by the MTDSP. Either a representative of the design engineer or of the MTDSP, whoever is mutually agreed-upon, will be responsible for recording minutes from this meeting. Figure 3-1 shows a suggested predesign meeting agenda.

3.1.2 Communication

Communication protocols should be developed during the scoping phase and discussed during the predesign meeting. Unless otherwise requested by the dam owner, the MTDSP and the design engineer shall copy the dam owner on all correspondence. Decisions shall be documented in electronic file systems maintained by both the MTDSP and design engineer

FIGURE 3-1. SUGGESTED PRE-DESIGN MEETING AGENDA

- Dam Safety Program organization and guiding principles (MTDSP)
- Overview of design review process (MTDSP)
    - Stages of design review in which design package submittals are required (mutually-agreed upon by the MTDSP, design engineer, and dam owner for project scope and complexity)
    - Roles of stakeholders
- Communication
    - Identify primary points of contact for the MTDSP, Design Engineer, and the Dam Owner
    - Communicating decisions to the team
- Meetings – Held at design stages appropriate for the project (mutually agreed-upon)
- Overview of the Project (Design Engineer and MTDSP)
    - Identified regulatory deficiencies and concerns of the MTDSP
    - Identified concerns of the Dam Owner and Design Engineer
- Design criteria and resources for design
- Permits
    - Construction
    - Environmental
    - Operation
- Design and construction schedule
- Design Considerations
    - Analyses to be completed in advance of evaluating alternatives
- Construction considerations (ordering materials, diversion and control of water, dewatering, etc.)
- Communication with the Public

(the file directories can be labeled as appropriate, with headings such as “Correspondence from Dam Safety Program,” “Correspondence from Design Engineer,” “Meeting Minutes,” etc.).

During this phase, the MTDSP will establish means for providing review comments (e.g., formal letter, email, etc.). Verbal comments shall be documented in writing (meeting minutes or other correspondence).

In most cases, the MTDSP will identify a program engineer to be the MTDSP leader of the project. All communication to the dam owner or design engineer will come from this leader. The project leader has the responsibility of communicating with other MTDSP staff and collecting and organizing comments for transmittal to the dam owner and design engineer.

3.1.3 Other Considerations

This purpose for engaging all stakeholders at this stage of the project is to avoid future changes in the scope of the design, including:

- Consideration of other permits and approvals (easements, water rights, environmental, etc.) and possible mitigation to avoid delays.
- Clear definition of design standards and criteria.
- Identifying materials or construction approaches that could result in schedule impacts.

At this phase of the project, the MTDSP may request specific analysis or reviews, including, but not limited to:

- Completion of specific analyses (e.g., hydrology and hydraulic modeling) in advance of proceeding with evaluation of alternatives.
- Submittal of the scope of proposed subsurface or other field explorations to the MTDSP for review prior to performing these services.

If the project is high profile or controversial, it may be prudent to develop a plan for public communication. This could include a periodic bulletin, meeting with county officials or an

informational website. The need and approach for this communication could be established during this phase or during alternative development.

NOTE: The sections that follow define potential design review phases for any dam construction project. During the scoping phase, it is recommended that the MTDSP, design engineer and dam owner mutually agree to design phase reviews appropriate for the size of the project. Not all review phases are necessary for smaller projects, while large projects may require all review phases. The appropriate level of review shall be established at the Pre-Design Meeting.

3.2 ALTERNATIVES / FEASIBILITY EVALUATION PHASE (10%)

The evaluation of alternatives and feasibility analysis is critical to the design. During this phase, the stakeholders should identify the highest priority project needs and focus on these needs with the intent of making wise early decisions. During this phase, the design engineer will identify various alternatives to address deficiencies along with an **Engineers Opinion of Probable Construction Cost (EOPCC), or Feasibility-Level Construction Costs**, appropriate for the level of design for each of the options. The design engineer should also provide anticipated engineering costs associated with each option.

3.2.1 Content and Considerations

The alternatives/feasibility evaluation phase of the project shall be documented in a report developed by the design engineer. The report should document site inspections, field explorations, and analyses used in evaluation of the alternatives. The report should be appended with figures (plans, cross sections, etc.) illustrating the alternatives evaluation. The **EOPCC** could be prepared by estimating selected major quantities and applying cost curves. This would likely meet the general definition of a Class 4 Estimate as defined by AACE International (2005). The design engineer should provide the dam owner with guidance regarding the level of accuracy of the estimates to assist with project budgeting. For example an AACE International Class 4 Estimate is typically expected to have an accuracy range of -15% to -30% on the low side, and +20% to +50% on the high side. In addition to the **EOPCC**, the design engineer should present other criteria or issues to be considered in selecting an

alternative (e.g., environmental issues, construction risks, construction schedule, etc.). For some projects, there may be only one feasible alternative, which should be documented in the report.

The design engineer should consider the following items at this stage of the design. The MTDSP may suggest other considerations during the predesign meeting.

- Will the proposed work change the hazard classification of the dam? If so, ia hazard classification application should be submitted to the MTDSP.
- What design criteria and standards will be used?
- What alternatives are available? What are the advantages and disadvantages of each?
- What is the cost of each alternative? For design? For construction?
- Is there a need to construct the project in phases for cost or other reasons?
- What is the impact of implementing an alternative on the project as a whole (i.e., will modifying one component of a project have impact on another)?
- Is there a long lead time in ordering certain (e.g., mechanical) components of the project?
- What approximate quantity and type of materials will be needed?
- Are processed filter/drain materials (sands and gravels) locally available? What are the issues with onsite processing, even if feasible?
- What additional data is needed to further define alternatives?
- Is there a need for additional instrumentation and/or exploration to better define the dam, foundation or borrow sources?
- How will diversion of inflow during construction be handled?
- What is a reasonable schedule for the project, taking into account design, review, bidding, construction, access, environmental permitting and reservoir operating needs?
- Can the owner assist with any portion of the project to reduce costs?
- Will other government agencies need to be involved in the project?

- Are there environmental concerns with potential to dictate project direction?
- If the design engineer is proposing subsurface or other explorations to support the advancement of the project to preliminary design, it may be prudent to submit the proposed scope of the explorations to the MTDSP for review.

This phase of the project should **not** include:

- Detailed structural or geotechnical design calculations for each alternative.
- Detailed quantity or cost estimates to support the EOPCC.
- Detailed plans or specifications.

3.3 PRELIMINARY DESIGN (30%)

At the preliminary design stage of the project, the scope of the project has been generally defined and project constraints identified. The dam owner, the MTDSP and the design engineer have agreed to the general concept for the project based on the alternatives evaluation. At this level, the design engineer shall provide a preliminary **EOPCC** to assist the dam owner in budgeting. An initial schedule for the project (major milestones) shall be established. The purpose of the preliminary design is to begin verifying assumptions made during the feasibility phase and advance the design to further establish and validate the project goals and constraints.

3.3.1 Content and Considerations

The preliminary design should be documented with drawings and studies documenting site explorations and engineering analyses used to support the design. This submittal by the design engineer should typically include the following:

- Plans illustrating existing conditions, including structures, utilities, property limits and ownership, site access, etc.
- Documentation of subsurface conditions, including a summary of previous explorations and data and results of explorations performed for the preliminary design. This could include test borings, test pits, monitoring well or piezometer data, soil and rock laboratory testing, etc.
- Identification of proposed materials for the project, including evaluation of the suitability of onsite materials and the need for offsite borrow sources. This could also include identification of anticipated proprietary materials or products.
- A preliminary set of drawings that illustrate general project concepts, approximate limits of various aspects of the work (e.g., excavations, finished grading, overall disturbance, etc.), proposed spillway and outlet works structures, general concepts for filters and drains.
- Discussion of construction diversion and reservoir operation constraints. For many designs, a diversion and control of water plan is a submittal that must be approved by the design engineer.
- Discussion on dewatering and level of engineering reviews. For many designs, a dewatering plan is a submittal that must be approved by the design engineer.
- If appropriate for the project, a hydrology study should be prepared to develop the Inflow Design Flood (IDF) to be used for spillway sizing. It may be prudent to submit this study in advance of the other preliminary design documents for early concurrence or approval from the regulator so that the design can proceed with less risk of change.
- Hydraulic/geotechnical/structural analysis as needed to generally size the proposed components of work.

- An **EOPCC or Preliminary-Level Construction Cost Estimate** appropriate for this stage of design. At this phase, costs could be based on line item quantity estimates and unit costs for the large items of work. This estimate may be considered consistent with a Class 3 Estimate per AACE International (2005), which has an accuracy range from -10% to -20% on the low side, and +10% to +30% on the high side. While cost estimates are not necessarily required by the regulator, the **EOPCC** is important for the owner for project financing.
- It may be prudent to include a list of anticipated specifications, particularly if there are unique materials or construction methods proposed.

The preliminary design should **not** include:

- Final design calculations. The calculations should be sufficient to generally size the structures. For example, global stability analyses may be performed for hydraulic structures, but detailed analyses to detail reinforcing steel are likely not required.
- Detailed plans or specifications.

3.4 DRAFT DESIGN (60%)

The purpose of this submittal is to develop the design to a level suitable for detailed review by the MTDSP and provide the dam owner with more details on the construction cost and schedule, along with likely limits of work and permitting requirements.

For larger, diverse projects, it is sometimes recommended to advance more than one technically feasible alternative identified during the preliminary design stage to draft design to better understand the costs and impacts related to the alternatives. In these cases, alternative selection would be included in at the draft design stage.

3.4.1 Content and Considerations

The draft design should include more detailed drawings and a design report documenting the analyses performed to develop the design.

The draft design report would likely include the following:

- A "Basis of Design" section that describes the project deficiencies and includes the design criteria used.
- Hydraulic, geotechnical, and structural evaluations as needed to adequately develop the design.
- Construction diversion and diversion and reservoir operation requirements.
- Estimated material quantities and source identification (on site/off site).
- Required mechanical components, including identification of long lead items.
- Data to support the design, including detailed calculations, digital computer model printouts, catalog cut sheets, and other information as needed. This information can be included in Appendices.
- An **EOPCC or Draft Design-Level Construction Cost Estimate** appropriate for this stage of design. This cost estimate includes line item quantities and unit prices developed based on designers experience with similar projects and/or cost estimating guidance documents. This estimate may be considered consistent with a Class 2 Estimate per AACE International (2005), which has an accuracy range from -5% to -15% on the low side, and +5% to +20% on the high side.
- A list of anticipated regulatory permits and their responsible parties (owner, design engineer, contractor) for obtaining permits. It should be noted that some permitting activities should be complete or well underway at this stage, depending on the project impacts.

The drawings should be relatively complete, with layouts of all proposed features and sufficient details to perform quantity takeoffs and understand the limits of work. Items such as detailed drawings for concrete reinforcing steel or layouts (elevations, coordinates, etc.) of pipes or other systems may not be needed at this stage.

At the draft design stage, construction specifications may not be needed; however, a technical specifications outline should be developed, listing the anticipated specification sections and

key components of each specification. For unique components of a project, such as roller compacted concrete, it may be prudent at this stage to develop targeted specifications that address items not normally found in more common construction materials, and which require more detailed review by the MTDSP. Note that the MTDSP does not allow incorporation of a specification by reference. If a standard specification is used in the project, it must be included in its entirety.

3.5 FINAL DESIGN (90%)

The purpose of the final design is to refine the preliminary design through additional details and develop complete construction specifications for MTDSP review. The design engineer will incorporate comments from the MTDSP and the dam owner on the draft design documents.

3.5.1 Content and Considerations

The final design should include a final design report along with detailed drawings and specifications that the designer would consider essentially suitable for construction. All documents should be signed and sealed by a Montana-registered professional engineer representing the design engineer and considered by design engineer to be complete for MTDSP review.

All technical specifications, including quality control and assurance specifications, should be included with this submittal. The front end documents (i.e., construction contract, instructions for bidders, etc.) need not be included.

The final design report will be similar to the draft design report, but should include all supporting calculations, including documentation of the design engineer internal Quality Assurance/Quality Control (QA/QC).

At this stage of design, the **EOPCC, or Final Design-Level Construction Cost Estimate**, should include all line item quantities, generally consistent with bid items (assuming a unit price contract is proposed for construction). This estimate may be considered consistent with

a Class 1 Estimate per AACE International (2005), which has an accuracy range from -3% to -10% on the low side, and +3% to +15% on the high side.

At this stage, the MTDSP may require a submittal documenting the proposed involvement of the design engineer during construction, including specific aspects of the work to be observed by the design engineer. A discussion of documentation and MTDSP involvement should be included.

This submittal would also include requirements for final (warranty) inspection of the constructed work.

Note that a first filling plan of inspection will be required before the final project inspection., with the design engineer recommendations for reservoir filling rate, observations, and documentation during filling. It is important to plan for this and if necessary discuss with the dam owner in advance. Often, the dam owner can help with first fill inspection duties, reducing costs.

Depending on the completeness of the submittal and number of review comments, the MTDSP may request a revised final design submittal from the design engineer prior to proceeding with development of bid documents. Otherwise, comments can be incorporated into the Bid Documents/Permit Issuance (100%) submittal.

3.6 BID DOCUMENTS / PERMIT ISSUANCE (100%)

The Bid Documents are complete drawings and specifications considered suitable for obtaining a final Construction Permit from the MTDSP and to proceed with obtaining bids from construction contractors.

3.6.1 Content and Considerations

The submittal will include the complete drawings and specifications, along with a final design report that includes revisions to the report submitted at final design. All documents will be

signed and sealed by a Montana-registered professional engineer representing the design engineer.

Front-end documents (construction contract, instructions for bidders, bid forms, etc.) should be included with this submittal. Other information to be provided to the bidders should also be included. This could include geotechnical and/or hydrologic data, borrow area studies, etc.

The **EOPCC** should be updated as needed and prepared so that it can be compared with the bids received.

It is possible that the MTDSP will not approve the documents as submitted and request a revised submittal. It should be noted that advertising the project for bids before obtaining a permit for construction from the MTDSP is at the risk of the dam owner.

4.0 EXTERNAL REVIEW PANELS / SUBCONTRACTING WITH REVIEWERS

In cases where the MTDSP has inadequate resources to complete the review of a project, the use of external reviewers may be necessary. This could be due to either limited MTDSP resources or because components of the project require expertise that is not available within the MTDSP. The dam owner may also consider using external reviewers to expedite the design review process.

The dam owner shall be responsible for contracting with and compensating the external reviewers. Proposed reviewers shall be approved by the MTDSP.

5.0 DEFINITIONS

The following definitions are offered for terms used in this manual:

Alternatives Analysis – An engineering analysis for a dam construction project that evaluates different options for accomplishing a common goal. Each option is evaluated for its feasibility, constructability, cost, and achievement of the project's goals. The result of an alternatives analysis is a preferred alternative for which a final design is completed. This is also commonly called a feasibility analysis.

Bid Documents – Documents that are legally binding between the dam owner and the construction contractor. They describe the work, rights, duties, and responsibilities of all parties. Bid documents include construction documents that contain contract forms, conditions of the contract, specifications, and drawings. Bid documents also include bidding documents that include a bid form, bonding forms, and insurance forms. Stringent contractor qualifications are delineated, ensuring that only contractors with a proven track record will be prequalified to bid.

Construction Permit – A written authorization issued by the Montana Dam Safety Program giving the owner authorization to construct a dam or reservoir in accordance with conditions that ensure construction of the dam and reservoir in a thorough, secure, and substantial manner (ARM 36.14.101).

Dam Owner – The legal owner of the dam and property that may be affected by any construction work. In the context used in this document, the dam owner can be a private individual or organization, an irrigation district, a county, city, or state agency. The dam owner is ultimately responsible for the proper care and operation of the dam. The dam owner is also responsible for payment of all services, fees, and construction costs. See Section 2.0 of this manual for further details on the responsibilities of the dam owner.

Design Engineer – The professional engineer in charge of the overall design for dam construction, rehabilitation, or repair. The design engineer shall be a registered professional engineer in Montana with experience in dam safety design. See Section 2.0 of this manual for further details on the responsibilities of the design engineer.

Design Standards and Criteria – Engineering design standards and criteria are documents that specify characteristics and technical details that must be met by the products, systems and processes that the standards cover. Design standards are developed by industry, government, professional societies, academia, and other groups as standard methods accepted for engineering design. The purpose of developing and adhering to standards is to ensure minimum performance, meet safety requirements, make sure that the product/system/process is consistent and repeatable, and to ensure compatibility with other standard-compliant equipment.

Draft Design Phase (60% completion) – The engineering design stage in which the final design is approximately 60% complete. At the draft design stage, the project design is at a level suitable for detailed review by the MTDSP. The dam owner is provided with more details on the construction cost and schedule, along with likely limits of work and permitting requirements. Draft plan sets and initial technical specifications have been completed at this phase.

Engineers Opinion of Probable Construction Cost (EOPCC) – Construction cost estimates appropriate for the level of design being evaluated, as determined by the design engineer. The accuracy of cost estimates are commensurate with the design phase – early phases of design will have wider cost ranges, and later stages of design will have more refined cost estimates with narrow cost ranges.

Final Design Phase (90% completion) – The engineering design stage in which the final design is approximately 90% complete. At this stage, the preliminary design has been refined through additional details and complete construction specifications have been developed. At

this stage, all comments from the MTDSP and the dam owner have been incorporated into the draft design documents. Construction plans are nearly complete at this stage.

First-Fill Monitoring Plan – This plan is developed in cooperation with the MTDSP, dam owner, and design engineer to monitor the dam's performance during the first filling of the reservoir after completion of construction. This is critical in order to avoid catastrophic failure of the dam in the event deficiencies are discovered during filling. The plan includes the rate of acceptable reservoir rise; instrumentation monitoring; visual monitoring; and actions to be taken if problems arise. First fill inspection activities can be completed by either dam owner or engineer, depending on the circumstances. A first fill plan is commonly required before final inspection.

Hazard Classification – A classification of a dam is based on the consequences of dam failure, not the condition, probability, or risk of failure. For dams regulated by the Montana Dam Safety Program, there are two classifications: not-high hazard and high hazard.

High Hazard Dam – According to the Administrative Rules of Montana (ARM 36.14.206), a high hazard dam is one that impounds 50 acre-feet or more in reservoir volume to the level of the normal operating pool and whose failure would likely cause a loss of life.

Montana Dam Safety Program – The program within the Montana Department of Natural Resources and Conservation that regulates the construction, operation and maintenance of Montana's dams to protect life and property from damages due to failure. The Montana Dam Safety Program (MTDSP) issues Construction Permits for major work conducted on high hazard dams in Montana that are regulated by Montana dam safety laws.

Not-High Hazard Dam – In Montana, a not-high hazard dam is one whose failure would not likely result in a loss of life.

Plans – The set of construction drawings that detail the structure or system to be constructed or modified.

Preconstruction Meeting – A preconstruction meeting is held prior to project construction and is intended to make sure all parties are aware of the project goals and construction deadlines. The meeting is typically attended by the construction contractor, major subcontractors, the MTDSP, the dam owner, and the design engineer representatives (including on-site representatives providing construction oversight). A pre-construction meeting provides an opportunity to communicate the requirements and expectations of a construction project to the contractor hired to complete the work. At this meeting, the approved drawings and documents should be thoroughly reviewed with major items discussed by the participants. The intent is to avoid or reduce possible conflicts and delays in completing the work.

Predesign Meeting – A predesign meeting takes place prior to design of a project. It is a meeting between the MTDSP, the dam owner, and the design engineer. It is in this meeting where the scope of the project design is determined. The meeting is facilitated by the MTDSP. Procedures are agreed upon and communication processes are established. In this meeting the MTDSP identifies a program engineer to be the project leader.

Preliminary Design Phase (30% completion) – The engineering design stage in which the final design is approximately 30% complete. At the preliminary design stage, the scope of the project has been generally defined and project constraints identified. The dam owner, the MTDSP and the design engineer have agreed to the general concept for the project based on the alternatives evaluation. At this stage, budget-level cost estimates have been completed and an initial construction schedule has been established.

Scoping – The planning and identification of work tasks to be performed for a particular purpose; for this manual, scoping is done for the completion of a dam safety project, which includes all design and construction phases. Scoping is typically broken out into specific tasks with deadlines.

Specifications – For construction projects, specifications are typically a set of documented requirements to be satisfied by materials, products, or procedures. A specification is often a type of technical standard.

Standard of Care – For dam safety, the standard of care is the accepted and required practice of operating, maintaining, and repairing a dam in order to protect the water resource and the citizens and property downstream of the dam. The MTDSP has guidance materials for dam owners to help them maintain a standard of care. This includes knowing what is downstream of the dam and the consequences of dam failure. Not meeting the standard of care can be interpreted as negligence on the part of the dam owner.

State of Practice – In engineering and construction, it is the most up-to-date methods of analysis, design, and construction methods and materials. Practices are developed through cooperative research, testing and experience in specific areas of engineering and construction. These practices come from industry, academia, and professional societies. Engineers and construction contractors are expected to be familiar with the most up-to-date practices developed for their specific areas of technology.

Warranty Inspection – the inspection of a dam usually one year after completion of a construction project. This inspection is to ensure that construction was performed according to plans and specifications and that the dam is operating as intended following a year of operation. Any deficiencies found during the warranty inspection are to be fixed by the contractor.

6.0 REFERENCES

Paxson G., (2018), Model Design Review Process, Schnabel Engineering

Association of State Dam Safety Officials Dam Design and Construction Committee (2019), Design Review Process Guidance, Association of State Dam Safety Officials 2019 Annual Conference Proceedings.

Administrative Rules of Montana 36.14 - Dam Safety

APPENDIX

DESIGN REVIEW PROCESS CHECKLISTS

PRE-DESIGN MEETING PREPARATION CHECKLIST

Pre-Design Meeting Preparation – Design Engineer

- ☐ Project team and expertise; project lead, internal quality assurance
- ☐ Design criteria and standards to be used
- ☐ General list of alternatives available
- ☐ Additional data needs to further define alternatives, dam, foundation or borrow sources
- ☐ A preliminary schedule for the project

Pre-Design Meeting Preparation – MTDSP

- ☐ MTDSP Engineering staff assigned and Project Lead
- ☐ Design criteria and standards – recommendations
- ☐ Expectations:
    - Submittals
    - Design analysis
    - Design report components
    - Timing (if restriction or operation permit condition in place)
    - External review (Internal, State Consultant or Owner funded review panel)
    - Inspection and oversight flexibility
- ☐ Communication protocol to be used

Pre-Design Meeting Preparation – Dam Owner

- ☐ Primary owner contact
- ☐ Reservoir operation constraints / required releases
- ☐ Time and budget constraints
- ☐ Site access constraints

Considerations/Questions

- ☐ Is there a need to construct the project in phases for cost or other reasons?
- ☐ Will the proposed work change the hazard classification of the dam?
- ☐ Can the owner assist with any portion of the project to reduce costs?
- ☐ Will other government agencies need to be involved in the project?
- ☐ Are there environmental concerns with potential to dictate project direction?

ALTERNATIVES/FEASIBILITY EVALUATION CHECKLIST

(10% DESIGN LEVEL)

Failure Mode Analysis (for complex projects with multiple deficiencies or high downstream risk)

Feasibility Report

- ☐ Evaluation of alternatives; advantages/disadvantages
  - Report on recent data collected
  - Feasibility level engineering analysis of alternatives
    - Calculations and assumptions
  - Impact of implementing an alternative on the project as a whole (i.e., will modifying one component of a project have impact on another)?
  - Rough cost of each alternative for design and for construction
  - Identification of additional data needed to further define alternatives
  - Conceptual drawings of each alternative
  - Justification for preferred alternative(s)
- ☐ For Preferred Alternative(s)
  - Proposed schedule for design, regulatory review and construction
  - Approximate quantity and type of materials needed
  - Location of processed filter/drain materials (sands and gravels)
  - Issues with onsite processing of material, even if feasible.
  - Identification of components of the project with potential long lead time
  - Rough plan for diversion of inflow and reservoir operation before and during construction
  - Engineers Opinion of Probable Construction Cost

10% Design Review Meeting

(Following review of feasibility report by owner and MTDSP)

- ☐ Discussion of alternatives and justification for preferred alternative
- ☐ Funding deadlines if any (Grants, appropriations from legislature, etc.)
- ☐ Additional data needs and schedule for collection
- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ Analysis expectations for *Preliminary Design Report*
- ☐ Expectations for future design phases
  - Meetings
  - Submittals
- ☐ Submittal format for MTDSP and Dam Owner – electronic or hardcopy

PRELIMINARY DESIGN EVALUATION PHASE CHECKLIST

(30% DESIGN LEVEL)

Preliminary Design Report

- ☐ General concept of project / alternative(s) under consideration
- ☐ Documentation of subsurface conditions, including a summary of previous explorations and data and results of explorations performed for the preliminary design. This could include test borings, test pits, monitoring well or piezometer data, soil and rock laboratory testing, etc
- ☐ Identification of proposed materials for the project, including evaluation of the suitability of onsite materials and the need for offsite borrow sources.
- ☐ Construction diversion and reservoir operation constraints.
- ☐ Discussion on dewatering and level of engineering reviews.
- ☐ If appropriate for the project, a hydrology study should be prepared to develop the Inflow Design Flood (IDF) to be used for spillway sizing
- ☐ An EOPCC or Preliminary-Level Construction Cost Estimate appropriate for this stage of design
- ☐ Hydraulic/geotechnical/structural/hydrological analysis as needed to generally size the proposed components of work

Preliminary Drawings

- ☐ Plans illustrating existing conditions, including structures, utilities, property limits and ownership, site access, etc.
- ☐ A preliminary set of drawings that illustrate general project concepts, approximate limits of various aspects of the work (e.g., excavations, finished grading, overall disturbance, etc.), proposed spillway and outlet works structures, general concepts for filters and drains.

Specifications List (Optional)

- ☐ A list of anticipated specifications, particularly if there are unique materials or construction methods proposed

30% Design Review Meeting

(following review of *Preliminary Design Report* by dam owner and MTDSP)

- ☐ Acceptable simplifying assumptions
- ☐ Additional data needs and schedule for collection
- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ Analysis expectations for *Draft Design Report*
- ☐ Agreement on diversion plan and reservoir operation
- ☐ Engineer internal QA/QC procedures and expectations
- ☐ Environmental Requirements (NEPA, MEPA, etc.)

DRAFT DESIGN EVALUATION PHASE

(60% DESIGN LEVEL)

Draft Design Report

- ☐ Basis of Design
  - Project deficiencies and plans to address
  - Design criteria used
- ☐ Hydraulic, geotechnical, and structural evaluations as needed to adequately develop the design
- ☐ Construction diversion and diversion and reservoir operation requirements.
- ☐ Estimated material quantities and source identification (on site/off site).
- ☐ Required mechanical components, including identification of long lead items
- ☐ Data to support the design, including detailed calculations, digital computer model printouts, catalog cut sheets, and other information as needed. This information can be included in Appendices
- ☐ Discussion on dewatering and level of engineering reviews.
- ☐ Identification of proposed materials for the project, including evaluation of the suitability of onsite materials and the need for offsite borrow sources.
- ☐ Identification of anticipated proprietary materials or products
- ☐ Documentation of subsurface conditions, including a summary of previous explorations and data and results of explorations performed for the preliminary design. This could include test borings, test pits, monitoring well or piezometer data, soil and rock laboratory testing, etc.
- ☐ An EOPCC or Preliminary-Level Construction Cost Estimate appropriate for this stage of design
- ☐ A list of anticipated regulatory permits and their responsible parties for obtaining permits.

Draft Drawings

- ☐ The drawings should be relatively complete, with layouts of all proposed features and sufficient details to perform quantity takeoffs and understand the limits of work.

Specifications Outline

- ☐ A technical specifications outline should be developed, listing the anticipated specification sections and key components of each specification.

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60% Design Review Meeting

(following review of *Draft Design Report* by dam owner and MTDSP)

- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ Additional analysis expectations for *Final Design Report*
- ☐ Discuss: diversion plan, reservoir operation and dewatering
- ☐ Drawings – clarifications, additional detail and corrections
- ☐ Cost estimate uncertainties

FINAL DESIGN EVALUATION PHASE

(90% DESIGN LEVEL)

Final Design Report

- ☐ All components of Draft Design Report in final form
- ☐ All supporting calculations
    - Documentation of the design engineer internal Quality Assurance/Quality Control (QA/QC).
- ☐ Signed and sealed by a Montana-registered professional engineer representing the design engineer

Final Drawings

- ☐ Detailed drawings and specifications that the designer would consider essentially suitable for construction signed and sealed by a Montana-registered professional engineer representing the design engineer

Specifications

- ☐ All technical specifications, including quality control and assurance specifications. The front-end documents (i.e., construction contract, instructions for bidders, etc.) need not be included.

Final Design Transmittal to MTDSP

- ☐ Final Design Report, Final Drawings and Specifications
- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ Documentation of the proposed involvement of the design engineer during construction, including specific aspects of the work to be observed by the design engineer

Note: Anything submitted to the MTDSP is considered open to the public. If it is preferred that the EOPCC not be disclosed to potential bidders in the project, do not provide to the MTDSP.

Final Design Transmittal to Dam Owner

- ☐ Final Design Report, Final Drawings and Specifications
- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ An EOPCC, or Final Design-Level Construction Cost Estimate, should include all line item quantities, generally consistent with bid items (assuming a unit price contract is proposed for construction).

90% Design Review Meeting

(Only required if there are significant issues with the submittal)

BID DOCUMENT/PERMIT ISSUANCE DESIGN EVALUATION PHASE
(100% DESIGN LEVEL)

Final Design Report

- ☐ Incorporate any revisions

Bid Document Drawings & Specifications

- ☐ Construction ready drawings and specifications. All documents shall be signed and sealed by a Montana-registered professional engineer representing the design engineer.
- ☐ Front-end documents (construction contract, instructions for bidders, bid forms, etc.)
- ☐ Other information such as geotechnical and/or hydrologic data, borrow area studies, etc.

Transmittal to MTDSP

- ☐ Signed Construction Permit Application
- ☐ Final design report (if revised)
- ☐ Construction ready drawings and specifications
- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ Plans for construction documentation, communication and inspection (report intervals, inspection responsibility, preconstruction meetings, onsite communication, safety protocol etc.)

Transmittal to Dam Owner

- ☐ Final design report (if revised)
- ☐ Construction ready drawings and specifications *in hard copy format*.
- ☐ Schedule and uncertainties with potential to impact schedule
- ☐ Plans for construction documentation, communication and inspection (report intervals, inspection responsibility, preconstruction meetings, onsite communication, safety protocol etc.)
- ☐ An updated EOPCC so that it can be compared with the bids received