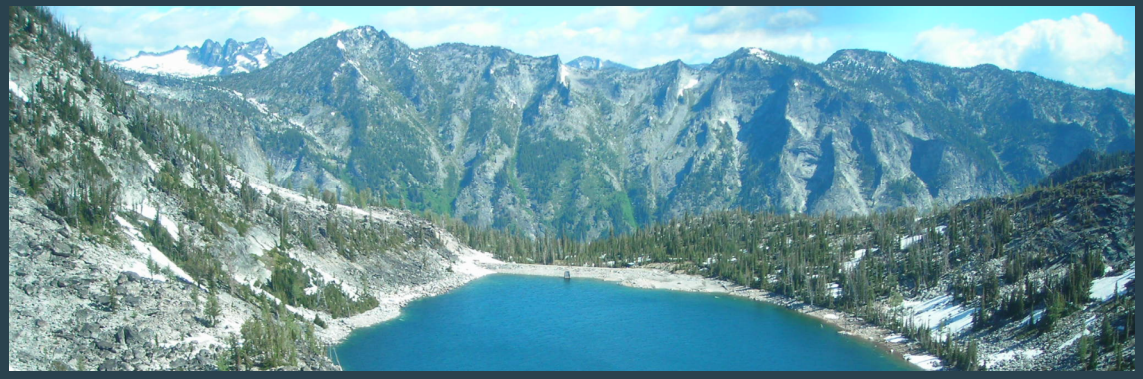
MONTANA ASSOCIATION OF DAM AND CANAL SYSTEMS

Updates to Montana's Operations and Maintenance Manual Guidelines and Template

Karl Kingery, P.E., CFM
Water Resources Engineer

Brent Zundel, P.E., CFM
MT Dam Safety Program Manager



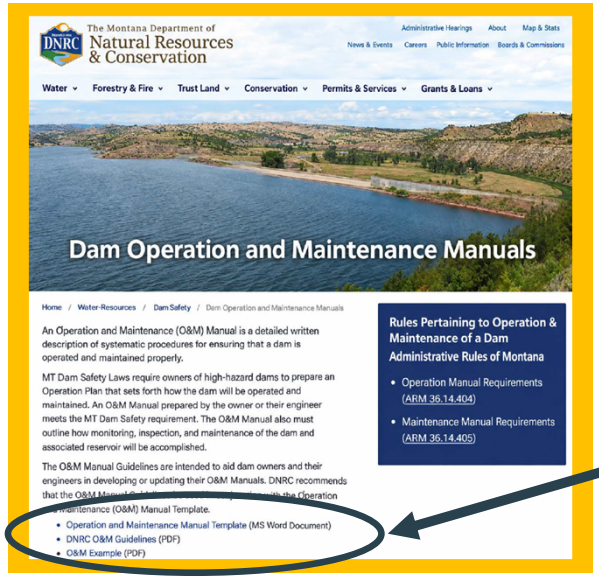
DAM OPERATION AND MAINTENANCE MANUALS

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WHAT IS AN OPERATION AND MAINTENANCE MANUAL?

- An Operation and Maintenance (O&M) Manual is a detailed written description of systematic procedures for ensuring that a dam is operated and maintained properly.
- https://dnrc.mt.gov/Water-Resources/Dam-Safety/Dam-Maintenance-Information



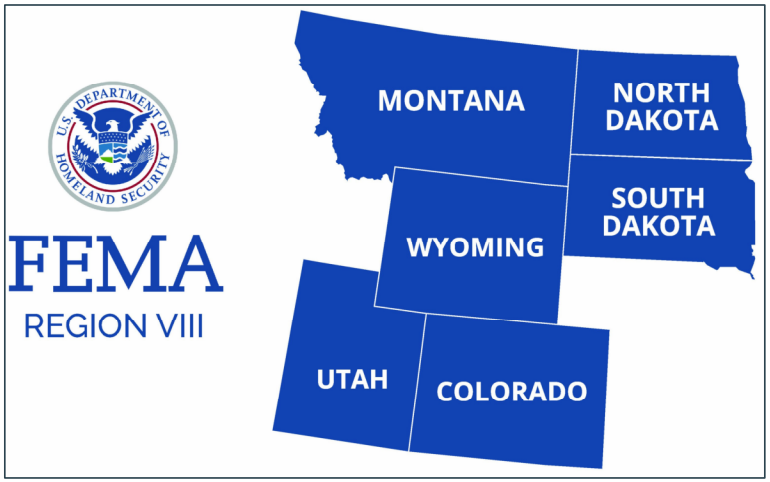
PROJECT NEED

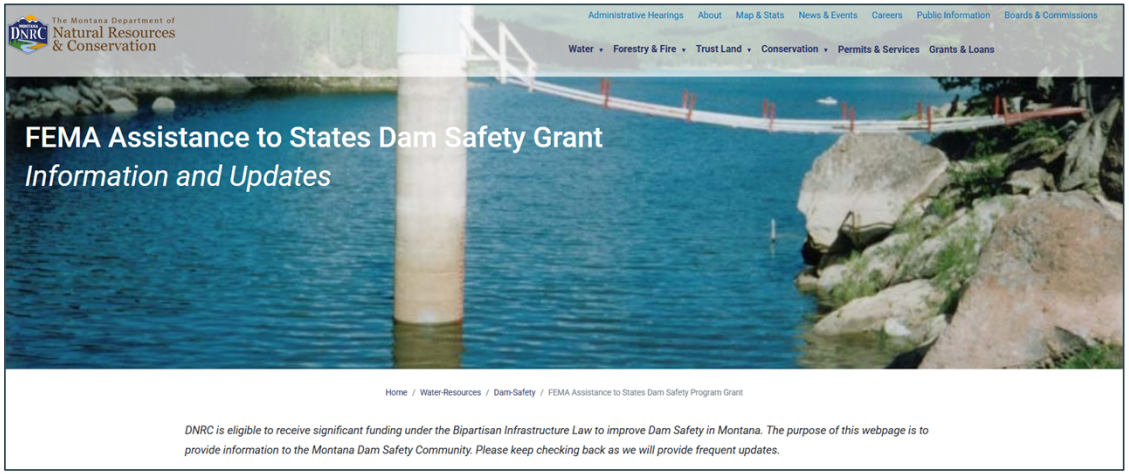
- More User-Friendly (AND USEFUL) O&M Manual.
- Updated O&M Manual Guidelines to meet standard of care present in other states and nationwide.
- The O&M Manual Guidelines are intended to aid dam owners and their engineers in developing or updating their O&M Manuals.



PROJECT FUNDING

- Bipartisan Infrastructure Law (2021)
- Two phases to this project





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STATE OF MONTANA DAM SAFETY LAWS

MONTANA CODE ANNOTATED (MCA) 85-15-212

- MT Dam Safety Laws require owners of high-hazard dams to prepare an Operation Plan that sets forth how the dam will be operated and maintained. An O&M Manual prepared by the owner or their engineer meets the MT Dam Safety requirement. The O&M Manual also must outline how monitoring, inspection, and maintenance of the dam and associated reservoir will be accomplished.

ARM 36.14.404

- Operation Plan – Reservoir Operation Procedures

ARM 36.14.405

- Operation Plan – Maintenance Procedures

ARM 36.14.407 (1)

- Operating Permit – Conditions and Terms

STATE OF MONTANA DAM SAFETY LAWS

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MONTANA CODE ANNOTATED (MCA) 85-15-212

85-15-212. Operating permit. (1) An operation plan must be prepared by the owner and approved by the department prior to operation of the high-hazard dam or reservoir. The operation plan must set forth at a minimum:

(a) a reservoir operation procedure;

(b) a maintenance procedure for the high-hazard dam and appurtenant works; and

(c) emergency procedures and warning plans.

(2) When construction is complete and if the high-hazard dam or reservoir conforms to the construction permit and when an operation plan has been approved, the department shall issue a permit to operate the high-hazard dam or reservoir, containing conditions on the safe operation of the high-hazard dam as it considers necessary.

History: En. Sec. 9, Ch. 501, L. 1985; amd. Sec. 5, Ch. 418, L. 1993.

STATE OF MONTANA DAM SAFETY LAWS

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ARM 36.14.404 OPERATION PLAN – RESERVOIR OPERATION PROCEDURES



36.14.404 OPERATION PLAN - RESERVOIR OPERATION PROCEDURES

(1) The reservoir operation procedures must describe the method and schedule of operation of the high-hazard dam and reservoir, which must include:

(a) procedures for safe drawdown rate of the reservoir;

(b) a description of the capabilities and limitations of the outlet facilities, spillways, and other dam appurtenances;

(c) a description of the authority granted to the dam tender and the training and direction or instruction necessary to properly and safely operate the gates and other dam appurtenances during normal, flood, and emergency conditions;

(d) a description of the availability of the dam tender, means of communication between the dam tender and his supervising authority, and method of gate operation, for example, manual, automatic, or remote control;

(e) a plan to monitor and anticipate unusual weather and hydrologic conditions and incorporate these conditions into the operation plan;

(f) a plan including the method and frequency for routine inspections conducted by an engineer, or owners or dam tender, at least once per year as well as inspections after critical events identified in the plan, for example, during and after heavy runoff, a severe rainstorm, a severe wind storm, or after an earthquake, and during periods of high storage. The plan must identify an inspection checklist and other directions to complete the required inspections. Inspections following critical events must be performed by an engineer, who may also be the owner or the dam tender, experienced in dam inspection. The completed inspection checklist and any other report must be maintained in the owner's records;

(g) a plan for permanent monitoring of the dam, for example, instrument installations, seepage collection systems, and water levels necessary to ensure the safe operation of the dam. The plan must identify the frequency of the data collection and the data value(s) that would constitute an unsafe or watch condition. If no monitoring is considered necessary, the reasons for this judgment must be stated; and

(h) a plan for interaction with operations of other dams and reservoirs, upstream and downstream, that may affect or be affected by the dam or reservoir operations during normal and emergency releases.

STATE OF MONTANA DAM SAFETY LAWS

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ARM 36.14.405 OPERATION PLAN – MAINTENANCE PROCEDURES



36.14.405 OPERATION PLAN - MAINTENANCE PROCEDURES

(1) Maintenance procedures of the high-hazard dam and its appurtenant works must include:

(a) the method and frequency of routine inspections and maintenance of the dam necessary to:

(i) remove and prevent the growth of trees or brush on the embankment of the dam and on the spillway system;

(ii) remove and prevent the accumulation of debris, obstructions, or other deleterious materials from upstream face of the dam and the spillway system;

(iii) ensure that all gates, orifices, dissipators, trash racks, and other appurtenances--including monitoring devices--that affect the proper operation of the dam and reservoir are kept in good repair and working order;

(iv) maintain adequate and suitable vegetation to prevent the erosion of the embankment and earth spillway for the dam; and

(v) determine that any seepage on the downstream slopes of the dam does not present a situation indicative of potential dam failure; and

(b) a plan for a detailed record of all maintenance required, including dates and results of inspections and complete information on all maintenance, rehabilitation, and improvements. This record must also include data, including photographic documentation, on the structural behavior of the dam embankment and spillway system for all major flood and seismic events.

STATE OF MONTANA DAM SAFETY LAWS

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ARM 36.14.407 (1)(a)

The owner of the dam or reservoir shall at all times follow the operation plan of the dam or reservoir, including the reservoir operation procedure, maintenance procedure for the dam and appurtenant works, and emergency procedures and warning plans as approved by the department;

ARM 36.14.407 (1)(d)

a copy of the current and approved operation plan must be provided to the dam tender or operator.

WHAT IS IN THE GUIDELINES/TEMPLATE?

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HOW DO I USE THIS NEW INFORMATION?

- The O&M Manual Guidelines are intended to aid dam owners and their engineers in developing or updating their O&M Manuals. DNRC recommends that the O&M Manual Guidelines be used in conjunction with the Operation and Maintenance (O&M) Manual Template.

HIGH-HAZARD DAM
OPERATION AND MAINTENANCE MANUAL (O&M)
GUIDELINES



Prepared for:

Montana Department of Natural Resources and Conservation
Floodplain and Dam Safety Bureau - Dam Safety Program
1425 Ninth Ave.
Helena, MT 59601

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WHAT IS IN THE GUIDELINES/TEMPLATE?

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HOW DO I USE THE TEMPLATE?

7.3 CRITICAL OR UNUSUAL EVENT INSPECTIONS / NON-ROUTINE INSPECTIONS

{Add additional text as necessary}

A qualified professional engineer will conduct the critical or unusual event/non-routine inspection to determine the impact of the critical event on the dam's performance.

Critical events include, at a minimum:

1. Earthquakes which may have caused a peak ground acceleration (PGA) greater than {0.1} g, or a magnitude {4.0} earthquake to be felt at the site (DNRC, 2025).
2. Precipitation events which are likely to produce greater than {____} inches of rainfall in the dam's drainage basin.
3. *{Add additional critical event criteria, as necessary.}*

Documentation of the critical or unusual event/non-routine inspection will be maintained by {Name and/or Title} and reported to DNRC Dam Safety.

The Emergency Action Plan (EAP) provides emergency response information. The responsible parties listed in Section 2.0 hold a copy of the EAP. The EAP is updated every {indicate month}.

→

OPERATION AND MAINTENANCE MANUAL (O&M)

{Enter Dam Name}

National Inventory of Dams (NID) No. [MT-00000]
{Dam Owner Name}
{County, Section, Township, Range}
{Latitude, Longitude}

7.3 CRITICAL OR UNUSUAL EVENT INSPECTIONS / NON-ROUTINE INSPECTIONS

A qualified professional engineer will conduct the critical or unusual event/non-routine inspection to determine the impact of the critical event on the dam's performance.

Critical events include, at a minimum:

1. Earthquakes which may have caused a peak ground acceleration (PGA) greater than {0.1} g, or a magnitude {4.0} earthquake to be felt at the site (DNRC, 2025).
2. In the first 60 years of the Box Elder Creek Dam's existence, it has never filled much more than about 3 or 4 feet above the normal pool elevation (2,088.5 feet). The emergency spillway elevations are 24.5 feet and 25.5 feet above the normal pool elevation, so the dam remains untested at the significantly higher water levels that would occur during large runoff events. For this reason, significant events (6 inches of rainfall over the dam's drainage basin) that raise the water level in the lake beyond its historic highs should be considered "first fillings" and should be inspected by a professional engineer.

Documentation of the critical or unusual event/non-routine inspection will be maintained by the City of Plentywood and reported to DNRC Dam Safety.

The Emergency Action Plan (EAP) provides emergency response information. The responsible parties listed in Section 2.0 hold a copy of the EAP. The EAP is updated annually.

1.0 INTRODUCTION

- 1.0 General Background
- 1.1 Process for Updating O&M Manuals

1.1 UPDATING O&M MANUALS

DNRC recommends that dam owners review their O&M Manual annually and record incidents and procedural changes. Updates can be made at any time, but O&M Manuals must be reviewed and evaluated by an engineer at least once every 5 years, within 180 days after completion of 5-year periodic inspections. (ARM 36.14.602(d) and 36.14.603(c))

When updating an O&M Manual, the following items must be reviewed, and, if appropriate, updated:

- *The list of staff responsible for the dam's operation or maintenance needs to be reviewed and updated if staff or responsibilities have changed.*
- *The planned frequency of inspections and anticipated maintenance activities need to be reviewed and adjusted based on the performance of the dam.*
- *If changes to the dam are made, information may need to be added or removed.*
- *If the dam's operation and/or maintenance procedure(s) change, those procedural changes need to be reflected in the O&M Manual.*
- *If additional or better information becomes available, the respective sections of the O&M Manual need to be updated.*

After updates to the manual are made, older versions must be archived and removed from circulation. The updated O&M Manual must also be distributed to the appropriate participants. The distribution list may include:

- *Hardcopy manual at dam site.*
- *Dam tenders' and/or owners' personal copy.*
- *Engineer's file.*
- *Regulatory agency file (i.e., MT DNRC Dam Safety Program).*

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TEMPLATE SECTIONS

2.0 DAM INFORMATION

- 2.1 Purpose of Project
- 2.2 Project History
- 2.3 Contact List
- 2.4 Record Keeping
- 2.5 Location of Dam, Access to Dam Facilities and Required Safety and Security Procedures
- Table 2-1 Dam Data

TABLE 2-1. DAM DATA

General

Dam Name:	
NID ID #:	
Owner & Operator:	
Primary Contact Name:	
Organization/Affiliation:	
Primary Phone Number:	
Alternative Phone Number:	
Email Address:	
Physical Address:	

Dam Location

Location:	Lat, Long:	
	Sec. ( ), T( ), R( )	
Project Horizontal Datum:		
Project Vertical Datum:		
On-Site Benchmark Elev:		

Reservoir

Watershed:				
Drainage Area (sq mi):				
	Elevation (ft)	Surface Area (Ac)	Total Storage (AF)	Active Storage (AF)
Minimum Operating Pool:				
Normal Full Pool:				
Maximum Flood Pool:				
Maximum Reservoir Contour:				

Dam

Dam Type:		
Height (ft):	Structural (ft):	Hydraulic (ft):
Crest Elevation (ft):	Crest Length (ft):	Crest Width (ft):
Upstream Slope:		
Downstream Slope:		
Hazard Classification:		

Outlet Works

Outlet Type:
Outlet Size:
Maximum Outlet Capacity (cfs):
Control Gate(s):

Spillway

Spillway Type:
Spillway Width (ft):
Spillway Freeboard (ft):
Maximum Spillway Capacity (cfs):
Spillway Passes 100-year Flood? (Y/N)

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TEMPLATE SECTIONS

3.0 OPERATING INSTRUCTIONS FOR RESERVOIR

The purpose of Section 3.0 is to provide general information about the operation of the reservoir, specifically the goals and methods for storing and releasing water. DNRC recommends including technical information in Appendix A.

Provide the following Information:

- *Maximum and minimum typical pool levels at different times of the year (e.g.,* the gate is closed in the spring when the reservoir elevation reaches 95 feet).
  - *This may be presented as a table and/or as a graph.*
  - *The table is informed by historical water levels, water use, gate opening schedule, flood control needs, etc.*
- *Maximum and minimum permissible outlet releases.*
  - *May be presented as a table and/or as a graph using the appropriate unit of measure for the dam (cubic feet per second (cfs), gate position, number of threads on stem, feet of drawdown per day, etc.).*
  - *Consider downstream water use, instream flow rights, maximum permissible drawdown, gate operations, etc.*
- *Typical and seasonal filling, storage, and release schedules.*
  - *Include monitoring methodology (SNOTEL, water level, gauges, etc.).*
- *Flood Operations:*
  - *Rainfall/flood forecasting; and*
  - *Emergency Action Plan (EAP) triggers.*
- *Instructions for operation of the outlet to limit or prevent excessive spillway flow.*
- *Description of the process for lowering the reservoir to permit outlet or upstream slope inspection (if applicable).*
- *Instructions on the general operation of the reservoir, including the regulation of inflow and outflow ditches (if applicable).*
- *Discussion of interaction of the dam with other dams, such as dams in series (if applicable).*
- *Provide an operation schedule (see Template, Section 3.7 and Table 3-1).*
- *Provide an operation log (see Template, Appendix C).*

Appendix A includes diagrams (Stage Storage Curve, Discharge Curves, etc.). DNRC recommends that the diagrams not be replicated within Section 3.0 but can be referenced herein.

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TEMPLATE SECTIONS

3.0 OPERATING INSTRUCTIONS FOR RESERVOIR

TABLE 3-1. TYPICAL FILLING AND RELEASE SCHEDULE

Date	Operator	Movement Direction (Open/Close)	Box Elder Lake Elevation (feet)	Gate Position (inches/turns/boards/etc.)	Post Operation Flow (cfs)	Snow-Water Equivalent (inches)	Additional Comments
Varies	City of Plentywood	Open/Close	Varies	100% capacity, 26.5 turns	N/A	N/A	As the dam's primary purpose is for flood control, the outlet is infrequently operated. The low-level outlet is tested annually by City personnel by fully opening the gate and letting it run until the discharge is relatively clear before closing fully.

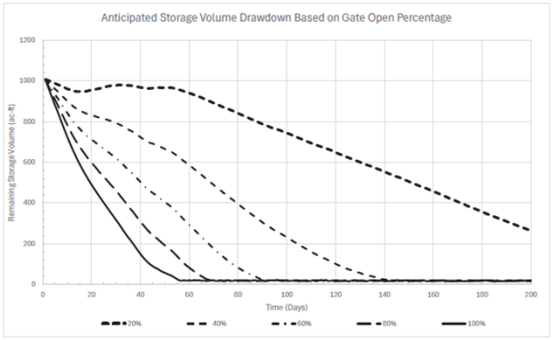
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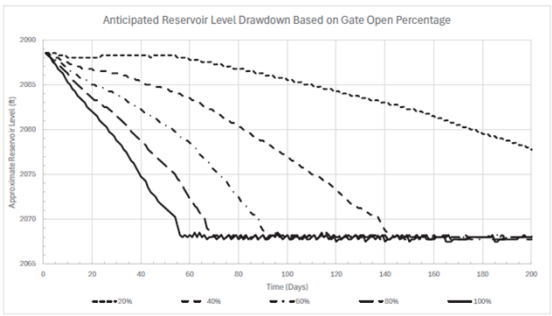
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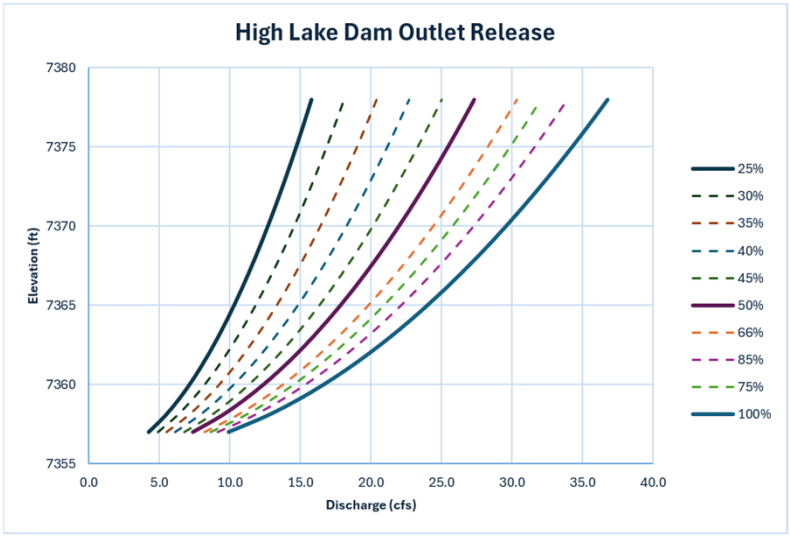
TEMPLATE SECTIONS

3.0 OPERATING INSTRUCTIONS FOR RESERVOIR

- Helpful Graphs may be included in Appendix A







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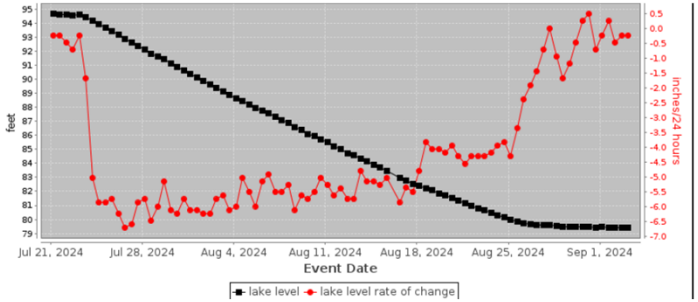
TEMPLATE SECTIONS

3.0 OPERATING INSTRUCTIONS FOR RESERVOIR

- Helpful Graphs/Information may be included in Appendix A

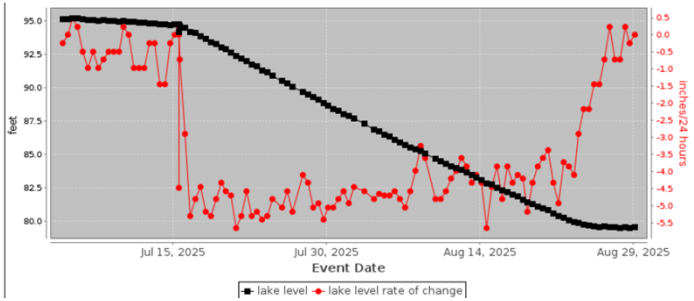
2024 – OPEN TO 5 INCHES

35 days of drawdown



2025 – OPEN TO 4.5 INCHES

41 days of drawdown



Opening (Summer)		
Open Pool Elev	Open Date	Opening Height
86	Sunday, August 5, 2012	5.5 inches
83.9	Friday, July 19, 2013	4.5 inches
92	Wednesday, August 6, 2014	4.5 inches
83.1	Wednesday, July 22, 2015	4.5 inches
84.1	Tuesday, August 2, 2016	4.5 inches
93.7	Sunday, July 23, 2017	4.5 inches
93.7	Sunday, July 29, 2018	4.5 inches
88.7	Monday, July 29, 2019	4.5 inches
89.5	Thursday, August 6, 2020	6 inches
94.63	Friday, July 23, 2021	4.5 inches
94.73	Friday, August 5, 2022	4.5 inches
94.59	Wednesday, July 19, 2023	4.5 inches
94.61	Tuesday, 7/23/2024 @ 9:30 AM	5 inches
94.75	Tuesday, July 15, 2025 @ 2:10 PM	4.5 inches

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TEMPLATE SECTIONS

3.0 OPERATING INSTRUCTIONS FOR RESERVOIR

- Helpful Graphs/Information may be included in Appendix A

Closing (Spring)							
Year	Closing Date	Close Pool Elevation	Storage in Reservoir @ Close (ac-ft)	Remaining Storage to Fill to 94.5 (ac-ft) (Full Pool)	SWE @ Close (Twin Lakes)	SnoTel 0-in SWE Date	Max SnoTel Value (in)
2012	Saturday, June 16, 2012				8.8	6/22/2012	44
2013	Saturday, June 1, 2013	83.9	136	282	8.4	6/7/2013	36
2014	Thursday, June 19, 2014	91.7	332	86	5	6/24/2014	59
2015	Thursday, May 21, 2015	83.1	119	299	7.2	5/27/2015	35
2016	Thursday, May 26, 2016	84.1	140	278	9.0	6/3/2016	38
2017	Saturday, June 10, 2017	93.5	386	32	0.0	6/10/2017	39
2018	Tuesday, June 19, 2018	93.53	387	31	0.0	6/15/2018	60
2019	Thursday, June 13, 2019	87.8	226	192	0.0	6/9/2019	44
2020	Friday, June 12, 2020	89.52	271	147	0.0	6/7/2020	44
2021	Monday, June 21, 2021	94.85	429	-11	0.0	6/9/2021	41
2022	Wednesday, June 22, 2022	94.06	403	14	1.4	6/23/2022	38
2023	Tuesday, June 6, 2023	91.56	328	90	0.0	6/1/2023	40
2024	Friday, June 14, 2024	89.55	271	147	0.0	6/9/2024	27
2025	Monday June 6, 2025	89.25	256	190	1.0	6/7/2025	39
2026	Tuesday, June 2, 2026	89.23	245	-245	2.9	6/5/2026	37

Closing (Spring)			
Year	Post-Closure Lake High Water Level (ft)	Post-Closure Lake High Water Level Date	Post-Closure Lake High Water Level Notes
2012			
2013	95.1	6/11/2013	95.1 on 6/11 and stayed there until July 5
2014	94.8	6/22/2014	94.8 on 6/22
2015	96	6/1/2015	96.0 on 6/1 and stayed until 6/10
2016	95.5	6/6/2016	95.5 on 6/6
2017	95.7	6/20/2017	95.7 on 6/20
2018	95.56	6/22/2018	95.56 on 6/22
2019			-
2020	95.31	6/29/2020	95.31 on 6/29, new Trans turned on w / 33 inches SWE
2021	95.34	6/23/2021	95.34 ft on 6/23
2022	95.52	6/29/2022	95.52 ft on 6/29
2023	95.38	6/11/2023	95.38 ft on 6/11, late turn on for transducer 3.3 SWE
2024	95.17	6/27/2024	95.17 on 6/27
2025	95.34	6/21/2025	
2026	95.48	6/17/2026	

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TEMPLATE SECTIONS

4.0 OPERATING INSTRUCTIONS FOR CONTROL MECHANISMS

4.1 WATER CONTROL MECHANISMS

The primary outlet to Box Elder Creek Dam consists of a low-level outlet that is directly connected to, and utilizes the same discharge piping as, the principal spillway. A diagram of the outlet is shown in Figure 4-1 below, and the overall outlet configuration is included within the as-builts in Appendix A. The principal spillway has a 5-foot by 6.3-foot rectangular opening that drops into a vertical, 3.5-foot by 3.5-foot square, reinforced concrete riser. This riser discharges into a 30-inch-diameter, prestressed concrete cylinder pipe (PCCP) at its base. An in-line gate valve is positioned at the base of the riser structure to allow water from the bottom of Box Elder Lake to be discharged. This low-level outlet, located upstream of the spillway riser, consists of 76 feet of 12-inch steel pipe. Water discharging through the low-level outlet enters the principal spillway riser structure and then flows out of the 30-inch-diameter PCCP outlet pipe. The 30-inch PCCP is 296 feet long and discharges into a stilling basin. Outlet discharge rating curves and tables are also provided in Appendix A.

FIGURE 4-1. PRINCIPAL SPILLWAY AND OUTLET DIAGRAM

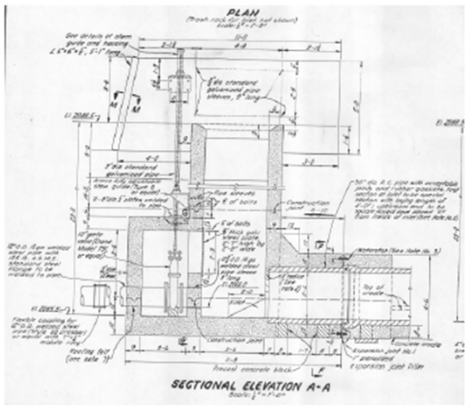




PHOTO 4-1. PRINCIPAL SPILLWAY AND OUTLET GATE
(Electric powerhead is being used to open the outlet gate. Note staff gauge on the east side of the trash rack.)

4.2.1 Operational Checklist

To open the gate, the following steps should be performed:

1. Access the dam and set up a generator with an extension cord reaching down to the power head.
2. Affix nut and power head to gate stem.
3. Open (counterclockwise) gate 26.5 turns.

To close the gate, perform the open gate steps in reverse order.

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TEMPLATE SECTIONS

5.0 MAINTENANCE PLAN

Anticipated maintenance activities may include:

- *Schedules for servicing equipment, replacing parts, or performing routine tasks.*
- *Gate/valve lubrication routine.*
- *Debris maintenance procedures.*
- *Mowing, burning, and/or removal of vegetation:*
  - *E.g., On Dam embankments, crest, at outlet, or other locations.*
- *Burrowing animal removal and repair procedures.*
- *Annual replacement of materials and parts:*
  - *E.g., Concrete repair, metal repair, etc.*
- *Instrumentation validation/calibration/maintenance.*
- *Electrical/security/cathodic protection/other maintenance.*

Appendix C includes a schedule of the anticipated maintenance activities, which may include a timeline for performing those activities (e.g., daily, weekly, monthly, yearly, hours of operation, number of cycles, etc.), and a surveillance schedule based on predictions of the wear rates of certain types of equipment or materials. Equipment maintenance schedules are normally based on the manufacturers' specifications. Refer to Appendix C in the O&M Template for sample tables. DNRC recommends that the tables not be replicated in Section 5.0 but can be referenced herein.

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TEMPLATE SECTIONS

5.0 MAINTENANCE PLAN

EXAMPLE

5.1 OUTLET

The outlet pipe should be inspected every five years during the five-year engineering inspection.

PCCP joints may need to be periodically repaired based on the results of the inspection.

The stilling basin should be cleaned annually (see Photo 5-1 below).

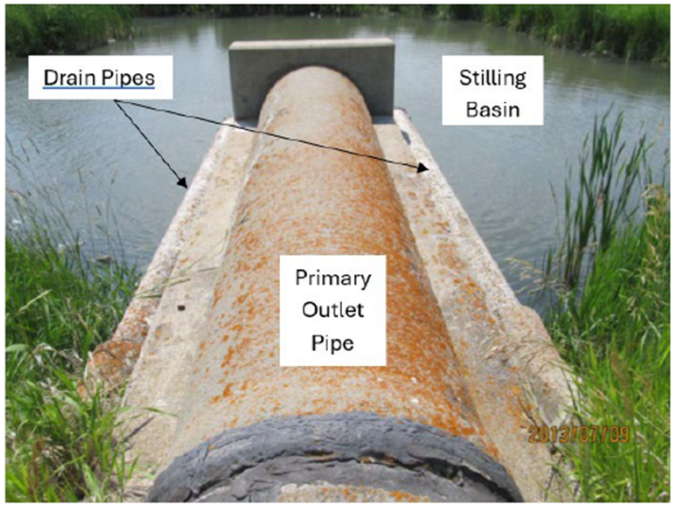


PHOTO 5-1. OUTLET AND STILLING BASIN

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TEMPLATE SECTIONS

6.0 UNEXPECTED REPAIRS

- Refer to the Emergency Action Plan (EAP) if emergency repairs are necessary

Unexpected repairs involve making repairs/modifications that would not typically be scheduled on a regular basis. Repairs to dams and their appurtenances are inevitable regardless of whether or not there is a proper maintenance program. Examples may include:

- *Repairing defective gates, valves, and other equipment discovered during inspections.*
- *Repairing damage to earth lined emergency spillways following a flood.*

Maintain an index of useful information for addressing unexpected repairs, such as:

- *Known items that could create problems for the dam in the future (e.g., past sinkhole locations, corroded gate components, etc.).*
- *A list of available sources, suppliers, and manufacturers' submittals for repairs and emergency intervention. Alternatively, may also include a table in Appendix E.*
- *Information on gate specifications (e.g., gate stem diameter, thread pattern, manufacturer, model number, etc.).*
- *Telemetry system repair information.*
- *Physical replacement parts for parts with known lifespans, or which have a high probability of being damaged (e.g., batteries, transducers, bearings, signs, etc.).*
- *Historic repair/rehabilitation information or references to the project documentation.*

Dam owners must anticipate repairs and the rehabilitation of unexpected deficiencies. Best practice is to include a list of legitimate failure modes and realistic planned responses to those failure modes. DNRC recommends that the dam owner establish protocols and procedures for addressing unscheduled repairs. Dam owners are also encouraged to budget for repairs and long-term dam rehabilitation by creating and contributing towards a secured investment portfolio.

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TEMPLATE SECTIONS

7.0 INSPECTIONS

7.1 ROUTINE INSPECTIONS

The purpose of Section 7.1 is to provide guidance and relative information associated with performing routine inspections.

Routine inspections are typically performed on a frequent basis (e.g., weekly, monthly, annually) by the dam owner or operator. The frequency of routine inspections depends on operation and monitoring needs at the facility. The tools, materials, and equipment needed to prepare for inspections are described and provided within Section 7.1. The required inspection frequency and procedure for high-hazard dams is outlined in ARM 36.14.404.

Inspections usually include the gathering of monitoring data. This may include creating a record of items such as the following:

- *Reservoir level;*
- *Seepage flow;*
- *Toe drain flow; and*
- *Piezometer levels.*

For additional information, see Appendix B – Instrumentation and Monitoring.

Routine inspections include a visual inspection of the major project features to observe obvious changes that may threaten dam safety (e.g., seeps, bogs, settlement, sinkholes, debris, etc.). A checklist is effective to ensure that critical features are examined.

Typical inspection items on the checklist may include:

- *The condition of the dam crest, upstream, and downstream slopes.*
- *Condition of the spillway and outlet works.*
- *Observation and measurement of seepage and other important project-specific items.*

- *Testing valves, control works, and other mechanisms to ensure they are in proper working order.*
- *Reviewing the monitoring information from the past year for unusual changes or trends, such as increased seepage or higher piezometer levels.*
- *Taking photographs of the dam components and observed problems or obvious changes to the dam.*

Record information and photographs from the annual inspection on an inspection form. Dam owners may use their own format, or they can use one of Montana Dam Safety's Dam Owner Annual Inspection Form templates located online at https://dnrc.mt.gov/Water-Resources/Dam-Safety/For-Dam-Owners, or in Appendix C. The Federal Emergency Management Agency (FEMA) published a pocket safety guide, which may be a useful resource for performing inspections. https://www.fema.gov/sites/default/files/2020-08/fema_911_pocket_safety_guide_dams_impoundments_2016.pdf. The Association of State Dam Safety Officials (ASDSO) Dam Safety Toolbox is also a good source for information on dam safety.

7.2 PERIODIC (5-YEAR) INSPECTIONS

The purpose of Section 7.2 is to provide guidance and relative information associated with performing periodic five-year Engineer's inspections.

Per MCA 85-15-213, dam owners of high-hazard dams are required to conduct a Periodic Inspection. The inspections must be performed at least once every 5 years by a qualified engineer, registered in Montana, and familiar with the design and construction of dams.

The Periodic inspection involves:

- *Review and analysis of available data on the design, construction, operation, and maintenance of the dam and its appurtenances.*
- *Visual inspection of the dam and its appurtenances, including an outlet conduit inspection.*

- *Evaluation of the safety of the dam and its appurtenances, which must include:*
  - *Assessment of the hydrologic and hydraulic capabilities;*
  - *Structural stabilities;*
  - *Seismic stabilities; and*
  - *Other conditions which could constitute a hazard to the integrity of the structure.*
- *Evaluation of the downstream hazard classification. Evaluation of the operation, maintenance, and inspection procedures employed by the owner and/or operator.*
- *Review of the dam's EAP, including reviewing and updating the dam breach inundation maps.*

7.3 CRITICAL OR UNUSUAL EVENT INSPECTIONS / NON-ROUTINE INSPECTIONS

The purpose of Section 7.3 is to provide guidance and information to assist with performing non-routine or critical event inspections.

Per ARM 36.14.404 (e) and (f), some inspections are necessary for non-routine reasons during or after critical events or other unusual circumstances. For example, these non-routine inspections may be necessary during and/or after heavy runoff or a severe rainstorm; after an earthquake; during periods of high storage or high winds; unique potentially damaging events; dam failures; or other site-specific critical events. The dam's O&M Manual must list minimum thresholds for each of the criteria that would trigger an inspection by an experienced engineer. For other unusual events not meeting listed thresholds, the owner is responsible for inspecting the dam and exercising reasonable judgement for seeking professional assistance, as well as documenting the incident.

Inspections following critical events must be performed by an engineer experienced in dam inspection. Inspection documentation must be maintained in the owner's records.

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TEMPLATE SECTIONS

7.0 INSPECTIONS

EXAMPLE

7.1.1 Materials and Equipment Needed

A portable generator, extension cords, and a 115 V plug-in electric power head are needed to operate the outlet gate. A ladder is necessary to view the downstream side of the outlet pipe. All of these items are stored in the City of Plentywood materials and equipment building.

7.2 PERIODIC (5-YEAR) INSPECTIONS

Per Montana Code Annotated (MCA) 85-15-213, a Periodic Inspection is required at least every five years by a professional engineer, registered in Montana, and familiar with the design and construction of dams. The most recent Five-Year Dam Evaluation was conducted in 2023.

7.3 CRITICAL OR UNUSUAL EVENT INSPECTIONS / NON-ROUTINE INSPECTIONS

A qualified professional engineer will conduct the critical or unusual event/non-routine inspection to determine the impact of the critical event on the dam's performance.

Critical events include, at a minimum:

1. Earthquakes which may have caused a peak ground acceleration (PGA) greater than {0.1} g, or a magnitude {4.0} earthquake to be felt at the site (DNRC, 2025).
2. In the first 60 years of the Box Elder Creek Dam's existence, it has never filled much more than about 3 or 4 feet above the normal pool elevation (2,088.5 feet). The emergency spillway elevations are 24.5 feet and 25.5 feet above the normal pool elevation, so the dam remains untested at the significantly higher water levels that would occur during large runoff events. For this reason, significant events (6 inches of rainfall over the dam's drainage basin) that raise the water level in the lake beyond its historic highs should be considered "first fillings" and should be inspected by a professional engineer.

Documentation of the critical or unusual event/non-routine inspection will be maintained by the City of Plentywood and reported to DNRC Dam Safety.

The Emergency Action Plan (EAP) provides emergency response information. The responsible parties listed in Section 2.0 hold a copy of the EAP. The EAP is updated annually.

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TEMPLATE SECTIONS

APPENDIX A – OPERATION DIAGRAMS

Include drawings (if available) showing:

- *Historical Construction Sheets:*
  - *As-builts of the original dam construction;*
  - *As-builts of any dam enlargements or large rehabilitation projects; and*
  - *Embankment Cross-Sections.*
- *Where hydraulic elements are located, such as:*
  - *Areas of surface runoff inflow to reservoir from upstream watershed;*
  - *Inflow pipeline or channel (include gates, valves);*
  - *Drop inlet spillway(s) (include gates, valves);*
  - *Open channel or weir spillway (include gates, valves, stoplogs);*
  - *Culvert spillway (include gates, valves, stoplogs);*
  - *Storm pond flow control structure (include gates, valves, orifices);*
  - *Low outlet pipeline – reservoir drain (include gates, valves);*
  - *Low outlet pipeline – water supply (include gates, valves); and*
  - *Diversion channel to divert runoff away from or around reservoir.*
- **Hydrologic Diagrams**
  - *Stage-Storage Curve; and*
  - *Discharge Curve for Outlet(s) and Spillway(s).*

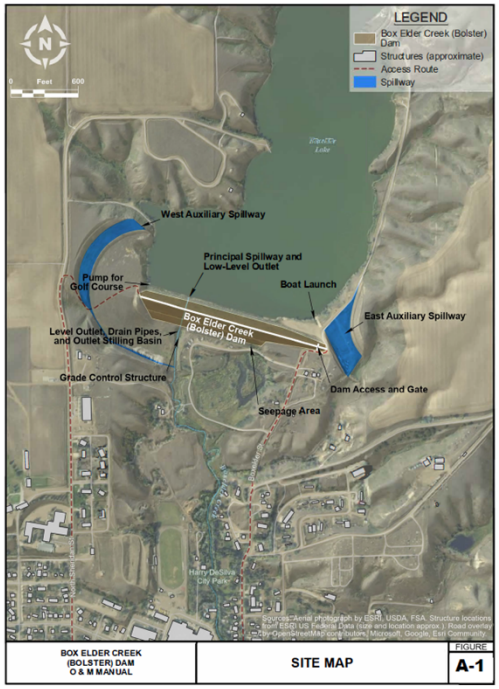
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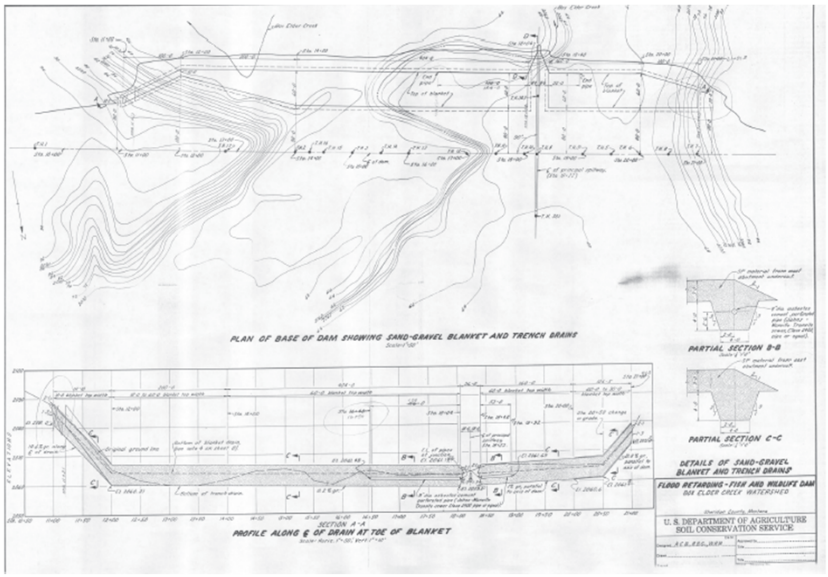
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TEMPLATE SECTIONS

APPENDIX A – OPERATION DIAGRAMS

EXAMPLE





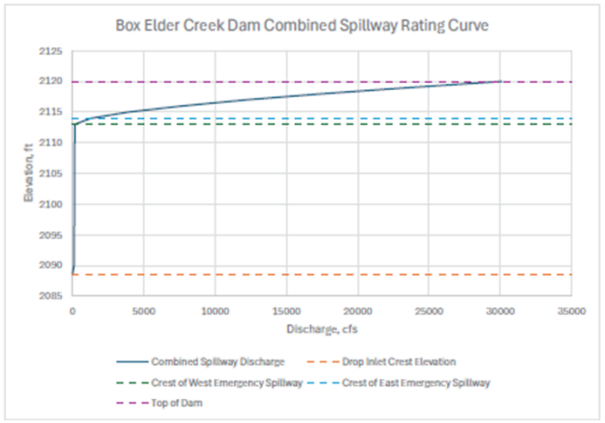
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APPENDIX A – OPERATION DIAGRAMS

EXAMPLE



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3020 Bozeman Ave.
Helena Montana, 59602
Tel. (406)443-4150

Hydrometrics, Inc.
Consulting Scientists and Engineers

Date: 6/9/2026
Project No: 25000
Project Name: Plentywood O&M
By: EGH

References

1 Elevations and volumes from the 1999 Spillway Analysis.

Assumptions

1 Both sources were assumed to be using the same datum, as no datum information was provided in the references.

Calculations

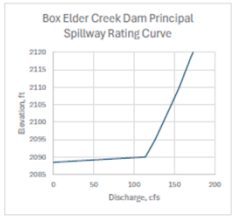
1999 Spillway Analysis

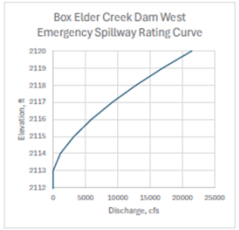
Contour Elevation (ft)	Accumulated Volume (acre-feet)
2066.0	0
2068.0	11
2070.0	34
2074.0	125
2078.0	302
2082.0	531
2086.0	834
2088.0	1010
2088.5	1056
2090.0	1200
2094.0	1622
2098.0	2117
2102.0	2710
2106.0	3394
2110.0	4150
2113.0	4763
2120.0	6378

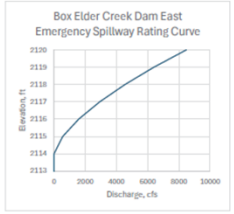
Normal Operating Pool	
Elevation (ft)	2088.5
Volume (AF)	1056

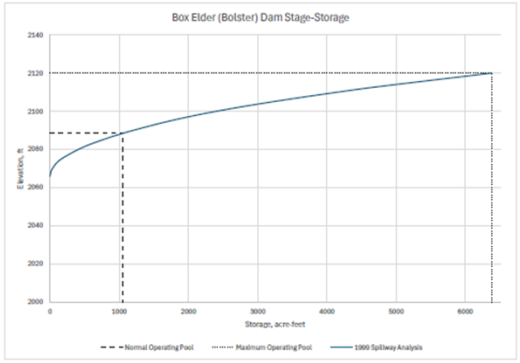
Maximum Operating Pool	
Elevation (ft)	2120.0
Volume (AF)	6378

ions









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TEMPLATE SECTIONS

APPENDIX B – INSTUMENTATION AND MONITORING

Instrumentation at a dam furnishes data to determine if the structure is functioning as intended, provides a continuing surveillance of the structure, and may provide fore-warning of potential dam safety issues. The extent and complexity of instrumentation at a dam depends on the size of the structure, its intended purpose, and the potential for loss of life and property damage downstream from the facility.

Typical monitoring instrumentation at dams may include:

- *Weirs, flumes, pipes, buckets, and other means to measure seepage flow.*
- *Monitoring wells to measure water levels, and piezometers to measure pore pressures within the embankment and/or foundation.*
- *Survey monuments to measure horizontal and vertical movement.*
- *Staff gauges to measure reservoir levels.*
- *Flumes, weirs, and/or gauges to measure reservoir inflow and/or outflow.*
- *Weather monitoring equipment (rain gauge, anemometer, etc.).*

Further information on monitoring equipment at dams can be found in Association of State Dam Safety Officials (ASDSO) – Dam Ownership Fact Sheets.
https://damsafety-prod.s3.amazonaws.com/s3fs-public/files/All%20Dam%20Owner%20Fact%20Sheets_2022_0.pdf.

The O&M Manual must contain clear instructions on how to use monitoring equipment and take measurements at monitoring points, as well as documentation of developed rating curves, measurement frequency, typical baseline readings, and abnormal thresholds.

Provide a location map for identifying instruments and monitoring points. Include forms for recording the data. Provide instructions on how to appropriately mark the instruments and monitoring points at the site, and how to keep them clear of vegetation, algae, or debris.

Record data on an appropriate form. Monitoring can only be beneficial if the observations are recorded in an orderly way and form a clear performance record. See the example O&M Manual in Appendix H for an example of monitoring instructions, and Appendix C for sample monitoring forms.

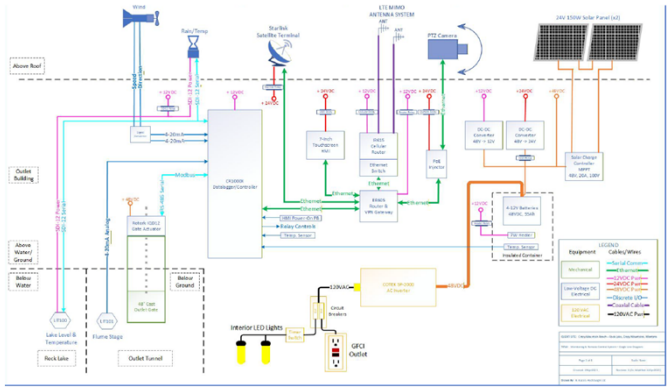
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TEMPLATE SECTIONS

APPENDIX B – INSTUMENTATION AND MONITORING

EXAMPLE



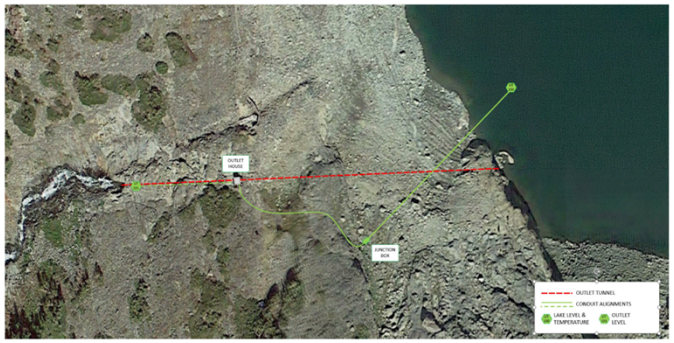
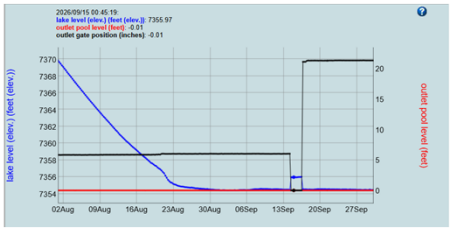


Figure 3 - Site Layout (Lake Shown at Minimum Pool)

Most Recent Status

DISPLAY DISABLED DATA POINTS | EXPAND DATA POINT SUMMARY

Component	Data Point Number	Status	Value	Last Update	Graph?
lake level (elev.)	31	OK	7354.45 feet (elev.)	2026-09-30 06:45:19 MDT	
outlet pool level	32	LOW	-0.01 feet	2026-09-30 06:45:19 MDT	
outlet gate position	33	TOO-HIGH	21.28 inches	2026-09-30 06:45:19 MDT	
lake high level alarm float switch	24	OK	0	2026-09-30 06:45:19 MDT	
lake level rate of change	300	-none-	0 inches/12 hours	2026-09-30 06:45:19 MDT	
enclosure temperature	6	OK	46.4 deg. F	2026-09-30 06:45:19 MDT	
12V solar-charged battery	7	OK	12.668 volts	2026-09-30 06:45:19 MDT	
satellite signal strength	10	-none-	44.8 C/N	2026-09-29 21:35:19 MDT	



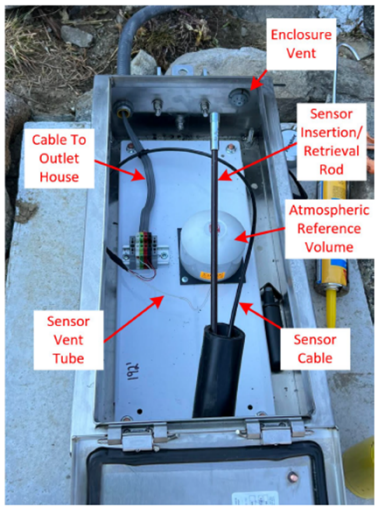


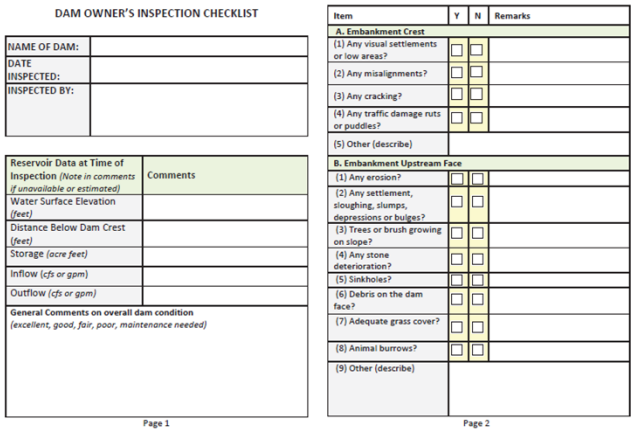
Figure 7 - Lake Sensor On-Shore Enclosure

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TEMPLATE SECTIONS

APPENDIX C – OPERATION AND MAINTENANCE AND INSPCTION MONITORING SCHEDULES, RECODING FORMS, AND LOGS



DAM OWNER'S INSPECTION CHECKLIST

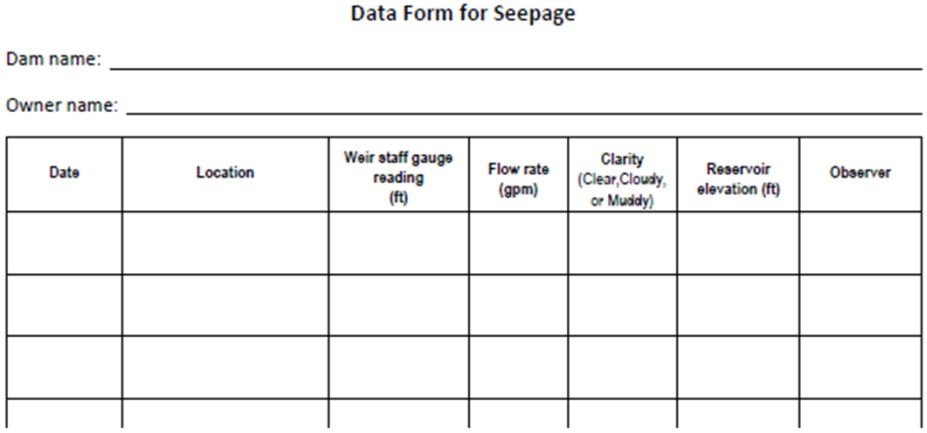
NAME OF DAM:	
DATE INSPECTED:	
INSPECTED BY:	

Reservoir Data at Time of Inspection *(Note in comments if unavailable or estimated)*	Comments
Water Surface Elevation *(feet)*	
Distance Below Dam Crest *(feet)*	
Storage *(acre feet)*	
Inflow *(cfs or gpm)*	
Outflow *(cfs or gpm)*	
General Comments on overall dam condition *(excellent, good, fair, poor, maintenance needed)*	

Page 1

Item	Y	N	Remarks
A. Embankment Crest			
(1) Any visual settlements or low areas?	☐	☐	
(2) Any misalignments?	☐	☐	
(3) Any cracking?	☐	☐	
(4) Any traffic damage ruts or puddles?	☐	☐	
(5) Other (describe)			
B. Embankment Upstream Face			
(1) Any erosion?	☐	☐	
(2) Any settlement, sloughing, slumps, depressions or bulges?	☐	☐	
(3) Trees or brush growing on slope?	☐	☐	
(4) Any stone deterioration?	☐	☐	
(5) Sinkholes?	☐	☐	
(6) Debris on the dam face?	☐	☐	
(7) Adequate grass cover?	☐	☐	
(8) Animal burrows?	☐	☐	
(9) Other (describe)			

Page 2



Data Form for Seepage

Dam name: _____

Owner name: _____

Date	Location	Weir staff gauge reading (ft)	Flow rate (gpm)	Clarity (Clear, Cloudy, or Muddy)	Reservoir elevation (ft)	Observer

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TEMPLATE SECTIONS

APPENDIX C – OPERATION AND MAINTENANCE AND INSPCTION MONITORING SCHEDULES, RECODING FORMS, AND LOGS

Observation Well Data Form

Dam name: _____

Owner name: _____

Date	Location	Elevation Top of Casing (ft)	Depth to Water* (ft)	Equivalent Water Surface Elev. (2 – 3)	Previous Elevation (ft)	Change in Elevation (4 – 5)	Reservoir Elevation (ft)
(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)

Settlement/Movement Monitoring Data

Dam name: _____

Owner name: _____

Monument Number	Date	Elevation (ft)	Total Settlement	Lateral Displacement and Direction
1 2 3 4 5 6 7			None As Constructed	None As Constructed

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TEMPLATE SECTIONS

APPENDIX C – OPERATION AND MAINTENANCE AND INSPCTION MONITORING SCHEDULES, RECODING FORMS, AND LOGS

Element	Additional Details *{as needed}*	Continuous	Twice Daily	Weekly	Every 3 Wks	Every 6 Wks	Monthly	Quarterly	Annually	Every 5 years	As needed
Operate Outlet									X		
Record Water Level									X		X
Monitor/Record Piezometer Data	NA										
Monitor/Record Weir Data	NA										
Calibrate Instrumentation	NA										
Instrumentation Inspection	NA										
Embankment Inspection	Informal inspections are completed on a monthly basis.								X		
Outlet Video Inspection										X	
Owner's Inspection	This inspection is completed with a DNRC representative.								X		
Instrumentation Analysis	NA										
Dam Safety Training	Confined space training for new employees prior to access to confined spaces.										X
EAP Communication Drill/Training	In coordination with Sheridan County DES.									X	
Seepage											X
Toe Drains											X

MAINTENANCE LOG

DATE	NAME	WATER LEVEL	DESCRIPTION OF ACTIVITIES

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TEMPLATE SECTIONS

APPENDIX C – OPERATION AND MAINTENANCE AND INSPCTION MONITORING SCHEDULES, RECODING FORMS, AND LOGS

INSPECTION LOG

DATE	PARTY COMPLETING THE INSPECTION	TYPE OF INSPECTION			ADDITIONAL COMMENTS
		ROUTINE	PERIODIC	NON-ROUTINE/ CRITICAL EVENT	

OPERATION LOG

(To be completed each time the dam is operated.)

Date	Operator	Movement Direction (Open/Close)	Box Elder Lake Elevation (feet)	Gate Position (inches/turns/boards/etc.)	Post Operation Flow (cfs)	Snow-Water Equivalent (inches)	Additional Comments

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TEMPLATE SECTIONS

APPENDIX D – HISTORICAL DATA TABLES

EXAMPLE

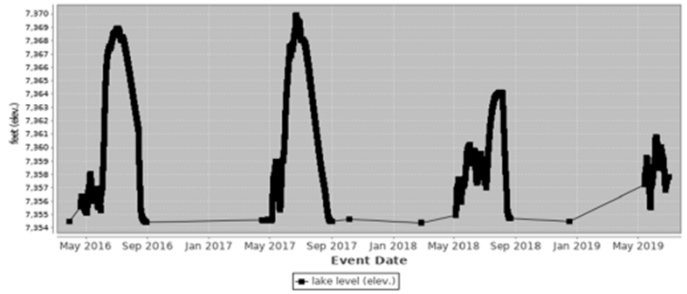
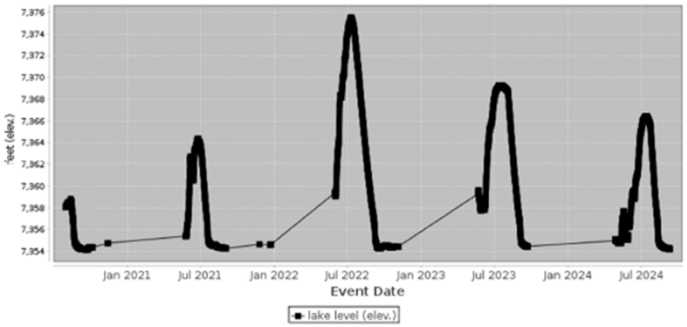


FIGURE 10-2. HISTORIC LAKE LEVEL (2021-2024)



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TEMPLATE SECTIONS

APPENDIX E – LOCAL CONTRACTORS AND REGULATORY CONTACTS

LOCAL CONTRACTORS AND REGULATORY CONTACTS

Provide a table listing, describing, and providing contact and location information for resources that aid in the operation and maintenance of the dam. Examples of such information may include the following:

- *Contact information for the owner, dam tenders, maintenance personnel, board members, etc.*
- *Contact information for regulatory agencies (e.g., Montana Dam Safety Program, United States Forest Service, local Conservation District, etc.).*
- *Contact information for contractors that regularly work on the dam or who have performed past repairs.*
- *Contact information for materials suppliers (e.g., pipe suppliers, electronics and telemetry equipment, machinists, etc.).*
- *Contact information for specialty personnel/contractors that aid in the operation of and maintenance of the dam (e.g., helicopter, outfitter, remote telemetry suppliers, etc.).*
- *Contact information for technical assistance personnel (e.g., dam engineer, dam designer, water rights attorneys, etc.).*

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TEMPLATE SECTIONS

APPENDIX F – LIST OF ACRONYMS AND ABBREVIATIONS AND WATER UNIT CONVERSION CHEAT SHEET

WATER CONVERSION TABLE

1 CUBIC FOOT OF WATER	7.48 GALLONS 62.4 POUNDS
1 AF OF WATER (ACRE-FEET)	1 FOOT OF WATER ON 1 ACRE 325,851 GALLONS 43,560 CUBIC FEET
1 GPM (GALLONS PER MINUTE)	1,440 GALLONS PER 24-HOUR DAY 1.61 AF PER YEAR 0.089 MI
1 SURFACE ACRE	SIZE OF AREA IN SQUARE FEET ÷ 43,560
1 CFS (CUBIC FEET PER SECOND)	40 MI 448.8 GPM 1.98 AF/DAY
1 MI (MONTANA MINER'S INCH)	11.22 GPM 0.05 AF/DAY 0.025 CFS
1 PSI (POUNDS PER SQUARE INCH)	2.31 FEET OF WATER 6.89 kPa 0.49 $inHg$
1 Hp (HORSEPOWER)	745.7 WATTS
1 AF/DAY (ACRE-FEET PER DAY)	0.50 CFS 226.67 GPM 20.2 MI
1 MPH (MILES PER HOUR)	1.467 FEET/SECOND
1 MILE	5280 FEET 1.61 KILOMETERS
1 METER	3.281 FEET
1 POUND	0.454 KILOGRAMS (kg) 4.45 NEWTONS (N)

TYPICAL DEMANDS

1 family – up to 5 people, domestic use ..... 1 AF/YR
1 acre lawn & garden ..... 2.50 AF/season
Number of AUs × 0.017 = AF/YEAR [1]

OTHER RELEVANT EQUATIONS & UNITS

$$Hp = \frac{Q_{GPM} \times TDH_{FT}}{3960} \qquad 1\,Hp = 33{,}000 \times 1\,FTLB_F/MIN \qquad 1W = 1V \times 1A \qquad °F = 32 + \left(\frac{9}{5}\right)°C$$

GPM GALLONS PER MINUTE	CFS CUBIC FEET PER SECOND	AF ACRE-FEET	MI MONTANA MINER'S INCHES
AU ANIMAL UNIT	TDH TOTAL DYNAMIC HEAD (FT)	Q FLOW	PSI POUNDS PER SQUARE INCH

LIST OF ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
AF	Acre-Feet
AOP	Annual Operating Plan
ARM	Administrative Rules of Montana
ASDSO	Association of State Dam Safety Officials
AU	Animal Unit
BMPs	Best Management Practices
CFS or cfs	Cubic feet per second

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TEMPLATE SECTIONS

APPENDIX G – MONTANA CODE ANNOTATED (MCA) AND ADMINISTRATIVE RULES OF MONTANA (ARM) REGULATIONS

TITLE 85
WATER USE

Ch.
15. Dam Safety Act.

CHAPTER 15
DAM SAFETY ACT

Part 1 — General Provisions

85-15-101. Renumbered 85-15-207.
85-15-102. Renumbered 85-15-208.
85-15-103. Repealed.
85-15-104. Renumbered 85-15-107.
85-15-105. Short title.
85-15-106. Definitions.
85-15-107. Exemptions.
85-15-108. Entry upon land.
85-15-109. Legal assistance.
85-15-110. Rules.
85-15-111 through 85-15-114 reserved.
85-15-115. Purpose.

Part 2 — Construction, Inspection, and Repair of Dams

85-15-201. Renumbered 85-15-506.
85-15-202. Renumbered 85-15-507.
85-15-203. Renumbered 85-15-508.
85-15-204. Renumbered 85-15-509.
85-15-205. Renumbered 85-15-510.
85-15-206. Renumbered 85-15-511.
85-15-207. Dams and reservoirs — how constructed.
85-15-208. Construction in a secure manner.
85-15-209. High-hazard dam — determination.
85-15-210. Preparation and approval of plans.
85-15-211. Inspection and reports during construction.
85-15-212. Operating permit.
85-15-213. Periodic inspections after construction.
85-15-214. Requested inspections — costs — limitations against unsafe structures.
85-15-215. Emergency repairs or breaching.
85-15-216. High-hazard dam permit cancellation.

Part 3 — Court Proceedings

85-15-501. Renumbered 85-15-402.
85-15-502. Renumbered 85-15-405.
85-15-503. Renumbered 85-15-404.
85-15-504. Renumbered 85-15-501(2).
85-15-505. Liability of owners for damage.
85-15-506. Repealed.
85-15-507. Repealed.
85-15-508. Repealed.
85-15-509. Repealed.
85-15-510. Repealed.
85-15-511. Repealed.

Part 4 — Local Government Proceedings

85-15-401. Municipality or county prohibited from regulation.
85-15-402. Repealed.
85-15-405. Repealed.
85-15-404. Repealed.

Part 5 — Penalties

85-15-501. Repealed.
85-15-502. Deposit of penalties and costs.
85-15-503. Civil penalty.



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APPENDIX H – EXAMPLE OPERATION AND MAINTENANCE MANUAL

OPERATION AND MAINTENANCE MANUAL (O&M)

Box Elder Creek (Bolster) Dam

National Inventory of Dams (NID) No. MT-00934
City of Plentywood
SW ¼, Section 17, T 35N, R 55E
48.7863°, -104.5546°



Prepared for:

City of Plentywood
201 1st Avenue West
Plentywood, MT 59254

Prepared by:

Hydrometrics, Inc.
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Helena, MT 59601

Version 1
July 2026

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QUESTIONS?

