**COMMONWEALTH OF MASSACHUSETTS**

**Department of Conservation and Recreation**

**Office of Dam Safety**

**PHASE I FORMAL DAM INSPECTION REPORT FORMAT and Submission Requirements**

Amended by the Office Dam Safety June 2021.

**Available Assistance:** Please contact the Office of Dam Safety at 508-792-7716 ext 41828 or [dam.safety@mass.gov](mailto:dam.safety@mass.gov) if you need assistance or have any questions pertaining to preparation of Phase I Formal Dam Inspection Reports.

**Report Format:**

General guidelines for conducting Phase I inspections and presenting Phase I inspection reports are included within this document.

The attached file contains a format to be followed in the preparation of dam safety Phase I inspection reports in accordance with current dam safety procedures of the Massachusetts Office of Dam Safety. The format is based upon the Phase I inspection format from the Army Corps of Engineers and includes inspection checklists and definitions for use during both the inspection process and in reviewing the completed report.

302 CMR 10.00 requires inspecting engineers to be Commonwealth of Massachusetts Registered Professional Engineers with a Civil Engineering license with experience in dam safety inspections and engineering.

This report format is provided as a guide to establish minimum report requirements. It should be noted that sections may need to be added to the report or expanded to accommodate the features and configurations specific to the dam being evaluated. Each dam inspection must be conducted and the report prepared and stamped by a Massachusetts registered professional engineer experienced in dam inspection, engineering, and design to assess the need to provide additional information.

The content of completed inspection reports shall be the sole responsibility of the inspecting engineer and user of this report format.

It is the responsibility of the inspecting engineer to verify the basic statistical data for the dam (e.g., structural height, hydraulic height, normal and maximum impoundment size, drainage area, latitude and longitude, etc.) by visual inspection and simple measurements (e.g., measuring tape, click wheel, surveyors rod and level, etc. for field measurements; planimeter, CAD for drainage areas; conic method of computing reservoir volume from surface area, etc.). Use of sophisticated survey techniques is not expected. If measured statistical data are substantially different from those values currently in the Office of Dam Safety database, provide a description of how the measured values were obtained and a statement that the measured data are the correct values.

The document is intended to be made available in an editable form to serve as a guide or template for presenting dam safety inspection results to the Office of Dam Safety.

**Submission Requirements:**

* ***All reports shall be printed double-sided without plastic or laminated covers. Paper shall be sufficiently opaque so that text and illustrations on one side of a page do not impair readability of the other side. In the instance where readability is compromised, printing single-sided is acceptable for those affected pages.***
* ***The reports shall be bound only by staples on the left edge of the report document.***
* ***One bound color copy of the final inspection report shall be provided to the Office of Dam Safety along with an electronic copy of the complete report in unlocked, searchable PDF (compatible with Adobe Reader Version 6.0 or later) format, and an electronic copy of the completed Excel inspection checklist worksheet file using the latest DCR prescribed format. Electronic files shall be provided via email attachment to*** [***DAM.SAFETY@MASS.GOV***](mailto:DAM.SAFETY@MASS.GOV)***, via ftp site, or otherwise via the internet. If this is not possible, CD, thumb drive, or other portable media will be accepted. The electronic copy in PDF shall consist of a single unlocked, searchable file containing the entire report (cover page, P.E. stamp and signature, text of report, evaluation form, checklist, photographs, drawings, etc.) Electronic files should be saved using the following naming convention “MA#####\_Dam Name\_Town\_Phase I\_YYYY-MM-DD”. Submission of incomplete reports, reports not in PDF, or collections of separate files will be considered to be non-compliant and will be returned to the owner for resubmission.***
* **Mail one required hard copy to:**

**Commonwealth of Massachusetts**

**Department of Conservation and Recreation**

**Office of Dam Safety – Inspections Unit**

**180 Beaman Street**

**West Boylston, MA 01583**

>>These two pages are to be omitted from the final inspection report.<<

***[Add corporate logo in bottom right corner of cover]***

Dam Name:

National ID No.:

Owner:

Town:

Consultant:

Date of Inspection:

***-- DAM NAME --***

**PHASE I**

INSPECTION / EVALUATION REPORT

* ***One bound color copy of the final inspection report shall be provided to the Office of Dam Safety along with an electronic copy of the complete report in unlocked, searchable PDF (compatible with Adobe Reader Version 6.0 or later) format, and an electronic copy of the completed Excel inspection checklist worksheet file using the latest DCR prescribed format. Electronic files shall be provided via email attachment to*** [***DAM.SAFETY@MASS.GOV***](mailto:DAM.SAFETY@MASS.GOV)***, ftp site, or otherwise via the internet. If this is not possible, CD, thumb drive, or other portable media will be accepted. The electronic copy in PDF shall consist of a single unlocked, searchable file containing the entire report (cover page, PE stamp and signature, text of report, evaluation form, checklist, photographs, drawings etc.) Electronic files should be saved using the following naming convention “MA#####\_Dam Name\_Town\_Phase I\_YYYY-MM-DD”. Submission of incomplete reports, reports not in PDF, or collections of separate files will be considered to be non-compliant and will be returned to the owner for resubmission.***
* ***Provide Overview Photo to Identify Dam –***

# EXECUTIVE SUMMARY

***[This section should consist of a narrative that provides an executive summary of this inspection report. At a minimum this section should include the following:***

* ***Name of dam and town***
* ***Date of inspection***
* ***Name of Engineering Consultant completing the inspection***
* ***Condition of the dam (Good, Satisfactory, Fair, Poor, Unsafe – choose one, do not use “Fair to Poor”)***
* ***Brief summary of major deficiencies***
* ***Brief summary of activities since the last inspection***
* ***Brief summary of major recommendations***

***Immediately following this section should be the* Dam Evaluation Summary Detail Sheet *that will be used by the Office of Dam Safety to update the database. This sheet is generated automatically from the inspection checklist. Modifications to the setup of this form shall not be made. An example of this form is shown.]***

**DAM EVALUATION SUMMARY DETAIL SHEET**

[Replace this page with “Dam Evaluation Summary Detail Sheet” from Excel checklist when report pdf is compiled.]

# PREFACE

The assessment of the general condition of the dam reported herein was based upon available data and visual inspections. Detailed investigations and analyses involving topographic mapping, subsurface investigations, testing and detailed computational evaluations were beyond the scope of this report unless reported otherwise.

In reviewing this report, it should be realized that the reported condition of the dam was based on observations of field conditions at the time of inspection, along with data available to the inspection team.

It is critical to note that the condition of the dam depends on numerous and constantly changing internal and external conditions and is evolutionary in nature. It would be incorrect to assume that the reported condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Licensed Professional’s Signature\**

*\* 302 CMR 10.00 requires inspecting engineers to be Commonwealth of Massachusetts Registered Professional Engineers with a* ***Civil Engineering license*** *with experience in dam safety inspections and engineering.*

**[Licensed Professional’s Typed Name]**

Massachusetts License No.: ***[Include Inspecting Engineer’s License Number]***

License Type:

***[Title]***

***[Company]***

Signature

*PROFESSIONAL*

*ENGINEERS*

*SEAL*

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***[Add additional tables as required.]***

FIGURES

Figure 1: Locus Plan ***[USGS topo sheet]***

Figure 2: Aerial Photograph

Figure 3: Drainage Area

Figure 4: Dam and Downstream Area

Figure 5: Site Sketch

***[Add additional figures as required to depict the configuration of the dam]***

APPENDICES

Appendix A: Photographs

Appendix B: Inspection Checklist

Appendix C: Previous Reports and References

Appendix D: Definitions

***[Add additional appendices as required]***

# SECTION 1

# 1.0 DESCRIPTION OF PROJECT

## 1.1 General

### 1.1.1 Authority

***[Client]*** retained ***[Consultant]***to perform a visual inspection and develop a report of conditions for the dam at the ***[Impoundment Name]***along the ***[River Name]*** in ***[Town or City Name]***, ***[County]*** County, Massachusetts. This inspection and report were performed in accordance with MGL Chapter 253, Sections 44-50 of the Massachusetts General Laws as amended by Chapter 330 of the Acts of 2002.

### 1.1.2 Purpose of Work

The purpose of this investigation was to inspect and evaluate the present condition of the dam and appurtenant structures in accordance with 302 CMR10.07 to provide information that will assist in both prioritizing dam repair needs and planning/conducting maintenance and operation.

The investigation was divided into four parts: 1) obtain and review available reports, investigations, and data previously submitted to the owner pertaining to the dam and appurtenant structures; 2) perform a visual inspection of the site; 3) evaluate the status of an emergency action plan for the site and, 4) prepare and submit a final report presenting the evaluation of the structure, including recommendations and remedial actions, and opinion of probable costs.

### 1.1.3 Definitions

To provide the reader with a better understanding of the report, definitions of commonly used terms associated with dams are provided in Appendix D. Many of these terms may be included in this report. The terms are presented under common categories associated with dams which include: 1) orientation; 2) dam components; 3) size classification; 4) hazard classification; and 5) miscellaneous.

## 1.2 Description of Project

### 1.2.1 Location

***[Insert description of the dam location including longitude, latitude, and proximity to population centers. Check the latitude and longitude using topo map, aerial photograph, GIS, Web-based GIS (MassGIS, Google Earth, etc.) or GPS unit in the field. Include directions to the dam from nearest population center or major roadway. Utilize GPS unit accurate to within 5 meters to check latitude and longitude. Report the location of dam in decimal degree format to at least 5 decimal places (about 1 meter precision). Utilize WGS84 datum, for compliance with MassGIS. Point location recorded for dam should be the intersection of the dam structure crest centerline and the primary spillway where the primary spillway abuts the dam. If the primary spillway is separated from the main dam, record the dam location as the point of intersection of the crest centerline and either: (1) the original stream bed, (2) the outlet structure, (3) the section of maximum height, or (4) the approximate mid-point along the crest length. Confirm accuracy of GPS collected point data with appropriate computer mapping tools that utilize MassGIS coordinate system. Alternative method for documenting the point location is to utilize computer mapping tools with sufficient base maps such as 1:5000 MassGIS ortho photos that are consistent with MassGIS coordinate system. Include the point latitude/longitude on your locus map in Figure 1 in this report.]***

### 1.2.2 Owner/Caretaker

See Table 1.1 for current owner and caretaker data (names and contact information).

### 1.2.3 Purpose of the Dam

See Table 1.1 for the current purpose of the dam.

***[Note current purpose of the dam (i.e., Recreation, Water Supply, Irrigation, Farm Pond, Flood Control, Hydropower). If the dam’s original design purpose is different from its current purpose that information should be provided in this section.]***

### 1.2.4 Description of the Dam and Appurtenances

***[Provide detailed description of the intended design of the dam and all appurtenant structures including spillways, instruments, dikes, cutoff walls, security devices, etc. This section should define the components of the dam, provide general dimensions, and discuss the configuration of the system and any known design features. The engineer is expected to check the basic statistical data (structural height, hydraulic height, normal and maximum impoundment volumes). If measured values differ substantially from data in Office of Dam Safety database, provide a description of the method used to obtain the measured data. Do not include here a description of deficiencies, if any, noted during the inspection.]***

### 1.2.5 Operations and Maintenance

***[Identify the party responsible for Operations and Maintenance of the dam and provide a description of ongoing maintenance activities. Describe normal operating procedures, if available, for summer and winter conditions.]***

### 1.2.6 DCR Size Classification

***[Dam Name]*** has a height of dam of approximately ***[dam structural height]*** and a maximum storage capacity of ***[storage at maximum water storage elevation]*** acre-feet. Refer to Appendix D for definitions of height of dam and storage. Therefore, in accordance with Department of Conservation and Recreation Office of Dam Safety classification, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, ***[Dam Name]*** is a ***[Size Classification]*** size structure.

***[Measure the vertical height of dam from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the low point of the crest of the dam.]***

### 1.2.7 DCR Hazard Potential Classification

***[Dam Name]*** is located upstream of ***[Description of inundation zone including specific developments as appropriate].*** It appears that a failure of the dam at maximum pool will ***[Describe impacts per 302 CMR 10.00]****.* Therefore, in accordance with Department of Conservation and Recreation classification procedures, under Commonwealth of Massachusetts dam safety rules and regulations stated in 302 CMR 10.00 as amended by Chapter 330 of the Acts of 2002, ***[Dam Name]*** should be classified as a ***[Hazard Potential Class (Level)]*** hazard potential dam. The Hazard Potential Classification recommendation ***[is / is not]*** consistent with the Hazard Potential Classification on record with the Office of Dam Safety for ***[Dam Name]***.

***[If the Consultant or Owner believes that the Hazard Potential Class should be changed from the current Class listed in the Office of Dam Safety Database, the Owner must separately file an Application for a Hazard Potential Class Change with the Office of Dam Safety. Additional studies may be required to be submitted with the application. The Application Form is available from the Office of Dam Safety website:*** [***https://www.mass.gov/service-details/hazard-reconsideration***](https://www.mass.gov/service-details/hazard-reconsideration)***]***

1.3 Pertinent Engineering Data

### 1.3.1 Drainage Area

The drainage area for ***[Dam Name]*** is approximately ***[Drainage Area]*** square miles and extends through the communities of ***[provide a list of Towns or localities within the drainage area]****.*

***[The inspecting engineer shall perform his/her own calculation of the drainage area – do not rely on data in prior reports. Comment upon relevant features within the drainage area (i.e., presence of upstream dams or reservoirs), prominent characteristics of the drainage area (i.e., hilly or flat topography, sluggish or flashy flood characteristics), and method used in determining the drainage area.]***

### 1.3.2 Reservoir

See Table 1.1 for data about normal, maximum, and spillway design flood (SDF) pools. These data were calculated based on ***[bathymetric surveys or data, U.S. Army corps of Engineers Conic Method for Reservoir Values, other]***.

***[Verify information obtained from previous reports and/or make reasonable estimates – do not state N/A. In the event no bathymetric study data exist for the impoundment make an estimate of the impoundment volume. In order to estimate the impoundment volume, collect existing available information (via topographic maps and orthophotos available from your own sources or MassGIS or other providers) on the surface area (in acres) to confirm or estimate the normal pool surface area and top of dam maximum pool surface area of the impoundment. Take measurements in the field to determine both the normal pool hydraulic height and maximum structural height of the dam consistent with 302 CMR 10.00. With available information on surface area, dam height and basin slopes, develop an estimate of the size (volume in acre-feet) of the impoundment at normal pool and maximum pool consistent with 302 CMR 10.00. The Corps of Engineers Conic Method for Reservoir Volumes can also be used to calculate the storage, see***

[***https://www.hec.usace.army.mil/software/legacy/hec1/documentation/hec1user.pdf***](https://www.hec.usace.army.mil/software/legacy/hec1/documentation/hec1user.pdf)***]***

### 1.3.3 Discharges at the Dam Site

***[Describe/reference records of discharges at the dam outlets including, but not limited to, date, flows, and maximum reservoir elevations.]***

### 1.3.4 General Elevations (feet)

A. Top of Dam

B. Spillway Design Flood Pool

C. Normal Pool

D. Spillway Crest

***E. [Additional elevations as appropriate for specific dam]***

F. Upstream Water at Time of Inspection

G. Downstream Water at Time of Inspection

H. Streambed at Toe of the Dam

I. Low Point along Toe of the Dam ***[Elevation and station]***

### 1.3.5 Main Spillway Data

A. Type ***[Material: concrete, stone masonry, bedrock, grassed,***

***wood, rubber; Form: ogee, drop, morning glory, broad-crested,***

***labyrinth, gated (type), siphon]***

B. Weir Length

C. Weir Crest Elevation

D. Upstream Channel

E. Downstream Channel

F. Downstream Outlet Invert or Channel Bottom Elevation

### 1.3.6 ***[Additional information and elevations as appropriate for specific dam (e.g., auxiliary/emergency spillway data, low-level outlet data, dike data, etc.)]***

### 1.3.7 Design and Construction Records and History

***[Description of available design and construction records, including any rehabilitation or other repairs, if any. The description should include a general description of the work completed, the extent of the work completed, date when the work was implemented, and the engineer of record for the work. A reference to this information should be included within Appendix C.]***

### 1.3.8 Operating Records

***[Provide a description of operating records, if any, where they are maintained, how often they are updated, and who is responsible for updating the data.]***

## 1.4 Summary Data Table

## ***[Replace this page with 1.1 Summary Data Table from the Inspection Checklist (Excel file) as completed by the inspecting engineer. In the case when there is no record hydrologic/hydraulic analysis report, the flood flow and spillway data will not be reported. Otherwise, all other data must be provided and presented as accurate data pertaining to the current inspection.]***

# SECTION 2

# 2.0 INSPECTION

## 2.1 Visual Inspection

***[Dam Name]*** was inspected on ***[Date]***. At the time of the inspection, the weather was ***[Weather including average temperature and indication of precipitation. If significant rainfall has occurred prior to the inspection and may be impacting the conditions as observed, that should be noted here. Similarly, for prolonged low water conditions, if appropriate]***. Photographs to document the current conditions of the dam were taken during the inspection and are included in Appendix A. The level of the impoundment was ***[Elevation with reference to normal pool elevation]****.* Underwater areas were not inspected ***[Unless completed as part of an expanded scope of work].*** A copy of the inspection checklist is included in Appendix B. ***[If the report covers two or more structures with separate ID numbers, provide a separate complete checklist for each structure].***

### 2.1.1 General Findings

In general, ***[Dam Name]*** was found to be in ***[Good, Satisfactory, Fair, Poor, or Unsafe] [do not use mixed condition codes, e.g., “Fair to Poor”]*** condition with ***[General Concern/Observations].*** The specific concerns are identified in more detail in the sections below:

***[Complete the following sections with specific descriptions of observations and conditions encountered during the inspection. Keep observations of structures with separate ID numbers separate. Observations should reference a baseline or other means of locating the referenced deficiency at some point in the future. Where photographs are taken of a particular deficiency, reference should be made to the specific photograph. In the event the dam is found to be breached, indicate whether the dam appears to be adequately breached or not. Breached condition indicates the water level is at streambed elevation and the dam is not impounding water. If the dam is partially breached and there exists the potential to re-impound, the dam should be described as being in Unsafe condition.]***

### 2.1.2 Dam

* ***Abutments***
* ***Upstream Face***
* ***Crest***
* ***Downstream Face***
* ***Drains***
* ***Instrumentation***
* ***Access Roads and Gates***

***[Comments should address compliance (e.g., healthy grass cover, uniform riprap cover, good abutment contact, etc.), as well as deficiencies (e.g., exposed sand and gravel, erosion, cracking, woody vegetation, seepage, flow rates, unusual movement, etc.). Information should be presented in a clear and organized fashion to expedite review and comparison to prior and future reports.]***

### 2.1.3 Appurtenant Structures

* Primary Spillway

*[This section should provide a description of the condition of the primary spillway structure including, but not limited to, the following components: left and right training walls; wing walls; weirs; aprons; stilling basins; gates/stoplogs; operators; operating platforms and bridges; piers and other support structures; and discharge channels.]*

* Low-Level Outlets

***[This section should provide a description of the condition of the low-level outlet structure including, but not limited to, the following components: wing walls; headwalls, gates and stop logs; approaches; trash racks; stilling or impact basins; operators; operating platforms and bridges; secondary (auxiliary) controls; and discharge channels. This section should indicate whether the system is operable and whether it results in a continuously charged pipe extending through the embankment.]***

* Auxiliary/Emergency Spillway

***[This section should provide a description of the condition of the auxiliary/emergency spillway structure including, but not limited to, the following components: left and right training walls; wing walls; weirs; aprons; stilling basins; gates/stoplogs; operators; operating platforms and bridges; piers; and other support structures; and discharge channels.]***

* Dikes

*[This section should provide a description of the condition of all dikes, including, but not limited to, the following: left and right abutments, upstream and downstream slopes/faces, and crest. The discussion should include applicable blanket, toe and chimney drains.]*

### 2.1.4 Downstream Area

***[This section should provide a description of the immediate downstream area including, but limited to, the following: vegetation, terrain, seepage, drainage, and access.]***

### 2.1.5 Reservoir Area

***[This section should describe the impoundment, including but not limited to the following: impoundment compass orientation, special features (e.g., dam is located within a protected cove or inlet), surrounding topography, level of surrounding development and use, potential for slides to impact water levels, and location of borrow areas that may be susceptible to slides.]***

## 2.2 Caretaker Interview

***[This section should include, but not necessarily be limited to: date of interview, name, and specifics of conversation with caretaker including, but not limited to: history, operating procedures, low-level outlet operation and maintenance history; emergency response procedures, current and historic concerns, documentation and records; recent developments; overtopping and flood of record events. This information should also be referenced in the appropriate section of the report.]***

## 2.3 Operation and Maintenance Procedures

***[A discussion of the availability of a formal operations and maintenance (O&M) manual should be discussed in this section. The intent of the following sections is to summarize the content of the manual and when it was last updated.]***

### 2.3.1 Operational Procedures

***[Describe Operational Procedures including frequency of tasks, record keeping and training. Discussion of low-level outlet exercising should be indicated]***

### 2.3.2 Maintenance of Dam and Operating Facilities

***[Describe maintenance including frequency of tasks, record keeping, and training.]***

## 2.4 Emergency Warning System

***[Describe response procedures, availability of an Emergency Action Plan (EAP), contents of EAP, and other emergency warning features or devices. This section should also indicate the applicability of the plan and when it was last updated and when and how training for an emergency has been conducted].***

## 2.5 Awareness of Potential Dam Related Safety Hazards at, near, and on Dams

***[It is the responsibility of the inspecting engineer to:***

* ***Identify potential safety hazards, that may exist at, near, and on the dam.*** 
  + ***The potential safety hazard considerations should be described as related to structural, mechanical, water and land related features pertaining to the dam including areas immediate upstream and downstream from the dam, as well as downstream from the dam along the stream channel if dam operations include deliberate releases of water from the dam.***
* ***Make specific recommendations to limit or prevent exposure to potential safety hazards at, near and on the dam, that are related to structural, mechanical, water and land related features pertaining to the dam.*** 
  + ***Make recommendations to erect fencing, railing, barricades, etc. that may be appropriate to limit or prevent exposure to potential safety hazards.***
  + ***Make recommendations to install signage that limits or prohibits access to areas that may present potential safety hazards.***
  + ***Make recommendations to install safety hazard warning signs to make visitors aware of specifically identified potential safety hazards.***
* ***Make specific recommendations for safety signage, booms, and buoys on the upstream approach to the dam and downstream from the dam as may be necessary to limit exposure to potential water-based safety hazards.  Potential water-based safety hazards, that should be identified include but shall not be limited to boating, fishing, swimming, and wading.  Such signage may also need to be recommended for placement at, near, and on the dam.***

Identify if it appears that the dam is a low head dam such that under certain conditions a potentially dangerous submerged hydraulic roller can form immediately downstream from the dam spillway.  As necessary, include additional information or comment on this condition.

***In addition to the above observations and recommendations, include the following notes.]***

Implementation of any recommendations may require local, state, or federal permits as well as securing property rights if subject areas are not owned by the dam owner. Securing such permits and/or land rights is the sole responsibility of the dam owner.

The dam owner is reminded that the Dam Safety Regulations *302 CMR Section 10.13: Liability (1),* states: *The owner shall be responsible and liable for damage to property of others or injury to persons, including but not limited to, loss of life resulting from the operation, failure of or mis-operation of a dam.*

## 2.6 Hydrologic/Hydraulic Data

***[Describe/summarize Hydrologic/Hydraulic (H&H) analyses and results presently or previously performed, if any. Include report titles, authors, and dates in Appendix C. This section should discuss the applicability of the previous results based upon changes within the drainage area or at the dam since the completion of the H&H analyses.]***

***[If insufficient data exist for a thorough review or significant changes have occurred since the last analyses, completion of a new H&H analyses should be recommended in Section 3.2.]***

***[A summary of available information provided within this section should include, but not be limited to:***

***A. Spillway Design Flood (SDF) Return Period***

***B. Precipitation (inches) and methodology***

***C. SDF Inflow (cfs)***

***D. SDF Outflow (cfs)***

***E. Principal Spillway Capacity (cfs)***

***F. Auxiliary Spillway Capacity (cfs)***

***G. Low-level Outlet Capacity (cfs)***

***H. Percentage of the SDF that can be safely routed through the reservoir without overtopping the dam.***

***I. SDF Peak Reservoir Elevation (feet)***

***J. Maximum Depth of Overtopping for SDF (ft) (if applicable)***

***K. Maximum Duration of Overtopping for SDF (hours) (if applicable)]***

***[Discuss the likelihood of overtopping based upon the results of current or previous H&H Evaluations. Evaluate the impact of overtopping as presented in the H&H analyses as it relates to erosion of the embankment, head cutting of channels and unlined spillways, and erosion of the downstream areas.]***

## 2.7 Structural and Seepage Stability

### 2.7.1 Embankment Structural Stability

***[Provide a summary of the stability of embankments based upon visual observation/inspection, an evaluation of previous structural stability analyses, and a reference to previous analyses performed. Any previous analyses should be listed in Appendix C. The evaluation should include static and dynamic stability based upon the usual, unusual, and extreme loading scenarios included in 302 CMR10.14(9). Physical evidence of instabilities should be highlighted.***

***Should insufficient data be available for a review, recommendations should be made to collect necessary data and complete analyses in accordance with 302 CMR 10.14.]***

### 2.7.2 Structural Stability of Non-Embankment Structures

***[Provide a summary of the stability of non-embankment structures based upon visual observation/inspection, an evaluation of previous structural stability, analyses, and a reference to previous analyses performed. The evaluation should include static and dynamic stability based upon the usual, unusual, and extreme loading scenarios included in 302 CMR10.14(9). Physical evidence of instabilities should be highlighted.***

***Should insufficient data be available for a review, recommendations should be made to collect necessary data and complete analyses in accordance with 302 CMR 10.14.]***

### 2.7.3 Seepage Stability

***[Provide an evaluation of the potential for seepage instability of water impoundment structures due to internal erosion or piping. Describe known data about seepage including:***

* ***Observations of seepage (locations, volume)***
* ***Seepage instrumentation***
* ***Filters or zonation of embankments***
* ***Foundation soils***

***If significant seepage exists at unfiltered locations, provide recommendations for appropriate data collection, monitoring, and analysis.]***

# SECTION 3

# 3.0 ASSESSMENTS AND RECOMMENDATIONS

## 3.1 Assessments

In general, the overall condition of ***[Dam Name]*** is ***[Good, Satisfactory, Fair, Poor, or Unsafe – do not use mixed conditions, e.g., “Fair to Poor”]***. The dam was found to have the following deficiencies:

1.

2.

3.

***[Provide a numbered list of deficiencies here – do not simply refer back to Section 2. Copy this list to the Deficiencies Tab in the Dam Inspection Checklist Excel spreadsheet. Provide the spreadsheet in electronic format as a separate file, in addition to the PDF copy of the report]***.

***[The rating for the overall condition of the dam should be based upon all aspects of the dam including structural integrity, operational procedures, maintenance, and compliance with design standards. Refer to the guidance in Appendix B.]***

***[A comparison to the previously reported condition of the dam should be included in this section. Conditions that have been improved as well as those that have worsened since the last inspection should be indicated. Major recommendations from previous inspections should be described, as well as the level of compliance with those recommendations.]***

|  |  |
| --- | --- |
| ***Previously Identified Deficiency*** | ***Resolution or Current Condition*** |
|  |  |
|  |  |
|  |  |

***[Provide assessment and implications of inspection observations as appropriate.]***

The following recommendations and remedial measures generally describe the recommended approach to address current deficiencies at the dam. Prior to undertaking recommended maintenance, repairs, or remedial measures, the applicability of environmental permits needs to be determined for activities that may occur within resource areas under the jurisdiction of local conservation commissions, MADEP, or other regulatory agencies.

## 3.2 Studies and Analyses

***[This section should identify those studies that should be completed to evaluate concerns and/or comply with current regulations. These studies and analyses could include but are not limited to the following: Underwater Inspection; H&H analyses; Stability Analysis; Dam Break Analysis; Operations and Maintenance (O&M) Manual; Emergency Action Plan (EAP); Downstream Hazard Assessment and Seepage Evaluation.]***

## 3.3 Recurrent Maintenance Recommendations

***[This section should discuss those activities that should be undertaken on a regular or yearly basis. Typically, these activities are recurrent maintenance level activities that can be undertaken by the dam owner/caretaker and do not require engineering design or permitting.]***

## 3.4 Minor Repair Recommendations

***[This section should discuss recommended studies or activities to improve the overall condition of the dam that do not alter the current design of the dam. These recommendations may require design by a professional engineer and construction by a contractor experienced in dam repair. A Chapter 253 permit may be required. Within this section the rationale for the recommended repairs or maintenance activity should be provided to assist the owner/caretaker.]***

## 3.5 Remedial Modifications Recommendations

***[This section should include recommended modifications to the dam that alter the current configuration or design of the dam that are necessary to meet stability, seepage or safety concerns as well as comply with current state requirements. These recommendations will require design by a professional engineer and construction by a contractor experienced in dam repair. A Chapter 253 permit will likely be required.]***

## 3.6 Alternatives

***[This section should include a discussion of practical alternatives to the recommendations presented above. Examples include, but are not limited to, alternative armoring approaches, alternative spillway configurations, or alternative stabilizations. Possibilities of dam removal should be considered. Advantages and disadvantages should be discussed to assist the owner/caretaker in evaluating the information presented herein.]***

## 3.7 Opinion of Probable Construction Costs

***[Provide Opinions of Probable Cost for implementing the recommendations and alternatives. This information should be based upon published estimating guides, current market pricing, and manufacturer information where applicable. Where possible, an indication of engineering and permitting effort should be incorporated. As all opinions are based upon purely conceptual data, opinions should include construction contingencies. Opinions of probable cost should be presented for all activities recommended or described in Sections 3.2 through 3.6.]***

FIGURES

**FIGURES INSTRUCTION PAGE:**

***Figures should include:***

1. ***Locus Plan - Dam and Impoundment Area:***
   * ***A color locus map developed from USGS Quad sheet or GIS mapping that depicts the location of the dam, the entire impoundment, and the general area of the dam. The plan should include a scale, north arrow and be presented with a title block that indicates the dam name, National ID No., town, USGS quadrangle, the source of the map, and the Latitude/Longitude point location of the dam. The recommended size for this figure is 8.5 x 11.***
2. ***Aerial Photograph – Dam and Impoundment Area:***
   * ***A color (if available) or black and white highest available resolution ortho-photo locus map that depicts the location of the dam, the entire impoundment, and the general area of the dam. The plan should include a scale, north arrow, and be presented with a title block that indicates the dam name, National ID No., town, the source of the map, and the Latitude/Longitude point location of the dam. The recommended size for this figure is 8.5 x 11.***
3. ***Drainage area:***

* ***A color locus map developed from USGS Quad sheet that depicts the location of the dam, the entire drainage area delineated on the map. The plan should include a scale, north arrow and be presented with a title block that indicates the dam name, National ID No., drainage area in square miles, town, USGS quadrangle, the source of the map, and the Latitude/Longitude point location of the dam. The recommended size for this figure is 8.5 x 11.***

***4. Dam and Area Downstream from Dam:***

* ***A color locus map developed from USGS Quad sheet that depicts the location of the dam, the area several miles downstream from the dam likely to be affected by a dam breach. The plan should include a scale, north arrow and be presented with a title block that indicates the dam name, National ID No., town, USGS quadrangle, the source of the map, and the Latitude/Longitude point location of the dam. The recommended size for this figure is 8.5 x 11.***

***5. Dam Site Sketch or Plan (with photo locations/orientation):***

* ***Site plan based upon construction plans or information gathered during the inspection. Plan should include a scale, north arrow, an indication of flow direction, depiction of photo locations and orientation (for clarity a separate figure showing photo locations and orientations can be provided in Appendix A) and provide sufficient detail to identify the dam components and features. The size of this figure should be adjusted in order to provide a plan of appropriate scale to show relevant site features.***

APPENDIX A

Photographs

**PHOTOGRAPHS INSTRUCTION PAGE:**

***All photographs shall be color photographs. Photographs shall be clear and include scale references where applicable. Photographs shall include, but not be limited to the following:***

1. ***Overview of dam from upstream***
2. ***Overview of dam from downstream***
3. ***Overview of upstream face from right abutment***
4. ***Overview of upstream face from left abutment***
5. ***Overview of dam crest from right abutment***
6. ***Overview of dam crest from left abutment***
7. ***Overview of downstream face from right abutment***
8. ***Overview of downstream face from left abutment***
9. ***Overview of spillway from upstream***
10. ***Overview of spillway from downstream (tailrace or channel area)***
11. ***Overview of right training wall***
12. ***Overview of left training wall***
13. ***Overview of weir***
14. ***Overview of stilling basin***
15. ***Overview of downstream channel***
16. ***Overview of gatehouse exterior***
17. ***Overview of gatehouse interior***
18. ***Overview of operators***
19. ***Outlet inlets and discharge points***
20. ***Overview of reservoir***
21. ***Areas of specific deficiencies (e.g., cracks, erosion, displacement, seeps, deterioration, etc.)***
22. ***Photos of any Potential Public Safety Issues at dam***

***Each photograph shall include a caption indicating the subject of the photograph as well as highlighting any specific deficiencies pictured. All photographs shall be presented with no more than two (2) photos per page. Photo location and orientation shall be indicated on the site plan included in the section entitled “Figures”. Alternatively, for clarity, a separate figure can be provided in this appendix to show figure locations.***

APPENDIX B

Inspection Checklist

**DAM SAFETY INSPECTION CHECKLIST INSTRUCTION PAGE**

The checklist (Excel file) includes sections applicable to a variety of dam structure types. Carefully follow the instructions on the first tab of the checklist. Complete those pages pertaining to each structure and omit pages that are not relevant or mark them “Not Applicable.” The Checklist must be signed by the inspecting engineer and a clean, neat copy included in the final inspection report. Use the checklist to generate the Dam Evaluation Summary Detail Sheet (should immediately follow the Executive Summary) and Table 1.1 (should immediately follow Section 1.0).

|  |  |
| --- | --- |
| **E1: DESIGN METHODOLOGY** | **E7: LOW-LEVEL OUTLET DISCHARGE CAPACITY** |
| 1. Unknown Design – no design records available | 1. No low-level outlet, no provisions (e.g., pumps, siphons) for emptying pond |
| 2. No design or post-design analyses | 2. No operable outlet, plans for emptying pond, but no equipment |
| 3. No analyses, but dam features appear suitable | 3. Outlet with insufficient drawdown capacity, pumping equipment available |
| 4. Design or post-design analyses show dam meets most criteria | 4. Operable gate with sufficient drawdown capacity |
| 5. State of the art design – design records available & dam meets all criteria | 5. Operable gate with capacity greater than necessary |
| **E2: LEVEL OF MAINTENANCE** | **E8: LOW-LEVEL OUTLET PHYSICAL CONDITION** |
| 1. Dam in disrepair, no evidence of maintenance, no O&M manual | 1. Outlet inoperative needs replacement, non-existent or inaccessible |
| 2. Dam in poor level of upkeep, very little maintenance, no O&M manual | 2. Outlet inoperative needs repair |
| 3. Dam in fair level of upkeep, some maintenance, and standard procedures | 3. Outlet operable but needs repair |
| 4. Adequate level of maintenance and standard procedures | 4. Outlet operable but needs maintenance |
| 5. Dam well maintained, detailed maintenance plan that is executed | 5. Outlet and operator operable and well maintained |
| **E3: EMERGENCY ACTION PLAN** | **E9: SPILLWAY DESIGN FLOOD CAPACITY** |
| 1. No plan or idea of what to do in the event of an emergency | 1. 0 - 50% of the SDF or unknown |
| 2. Some idea but no written plan | 2. 51- 90% of the SDF |
| 3. No formal plan but well thought out | 3. 91- 100% of the SDF |
| 4. Available written plan that needs updating | 4. >100% of the SDF with actions required by caretaker (e.g., open outlet) |
| 5. Detailed, updated written plan available, filed with MADCR, annual training | 5. >100% of the SDF with no actions required by caretaker |
| **E4: EMBANKMENT SEEPAGE (Embankment, Foundation & Abutments)** | **E10: OVERALL PHYSICAL CONDITION OF THE DAM** |
| 1. Severe piping and/or seepage with no monitoring | 1. *UNSAFE* – Major structural, operational, and maintenance deficiencies |
| 2. Evidence of monitored piping and seepage | exist under normal operating conditions |
| 3. No piping but monitored seepage | 2*. POOR* - Significant structural, operation and maintenance deficiencies |
| 4. Minor seepage or high volumes of seepage with filtered collection | are clearly recognized for normal loading conditions |
| 5. No seepage or minor seepage with filtered collection | 3. *FAIR* - Significant operational and maintenance deficiencies, no structural |
| **E5: EMBANKMENT CONDITION (see Note 1)** | deficiencies. Potential deficiencies exist under unusual loading conditions |
| 1. Severe erosion and/or large trees | that may realistically occur. Can be used when uncertainties exist as to |
| 2. Significant erosion or significant woody vegetation | critical parameters |
| 3. Brush and exposed embankment soils, or moderate erosion | 4. *SATISFACTORY* - Minor operational and maintenance deficiencies. |
| 4. Unmaintained grass, rodent activity and maintainable erosion | Infrequent hydrologic events would probably result in deficiencies. |
| 5. Well maintained, healthy uniform grass cover | 5. *GOOD* - No existing or potential deficiencies recognized. Safe performance |
| **E6: CONCRETE CONDITION (see Note 2)** | is expected under all loading including SDF |
| 1. Major cracks, misalignment, discontinuities causing leaks, seepage or | **E11: ESTIMATED REPAIR COST** |
| stability concerns | Estimation of the total cost to address all identified structural, operational, |
| 2. Cracks with misalignment inclusive of transverse cracks with no mis- | maintenance deficiencies. Cost shall be developed utilizing standard |
| alignment but with potential for significant structural degradation | estimating guides and procedures |
| 3. Significant longitudinal cracking and minor transverse cracking |  |
| 4. Spalling and minor surface cracking |  |
| 5. No apparent deficiencies |  |

***Guidelines and Notes for Evaluations***

Each of the evaluation categories has 5 rating levels. In general, the rating levels in each category are intended to reflect the following conditions:

1. Unsafe

2. Poor

3. Fair

4. Satisfactory

5. Good

E10-Overall Safety Rating Guideline

Unless the inspecting engineer presents compelling data, analyses, and observations that justify a higher rating, E10-Overall Safety Rating of the Dam shall not be higher than the lowest ranking in these high importance categories:

-E4-Seepage,

-E5-Embankment Condition (for embankment dams), and

-E6-Concrete Condition (for dams where concrete structures retain water).

Note 1 - Embankment Condition Factor of Safety Criteria

In addition to the inspection conditions listed, the embankment condition rating should consider the slope stability Factor of Safety (FS) according to the following guidelines for downstream (D/S) and upstream slopes (U/S).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Normal Pool** | **SDF** | **Seismic** | **Rapid Drawdown** |
| **Rating** | **D/S & U/S FS** | **D/S FS** | **D/S & U/S FS** | **U/S FS** |
| 1 | <1.3 | <1.1 | <1.0 | <1.0 |
| 2 | <1.5 | <1.4 | <1.0 | <1.1 |
| 3 | >1.5 | <1.5 | <1.1 | <1.2 |
| 4 | >1.5 | >1.5 | >1.1 | >1.2 |
| 5 | >1.5 | >1.5 | >1.1 | >1.2 |

In the absence of stability analyses, use the following factors to evaluate the stability component of the embankment rating. The inspecting engineer will need to consider all factors in combination as the exact combination of conditions listed will rarely occur. For slopes, > indicates “steeper than.”

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rating** | **Slopes** | **Seepage** | **Material** | **Compaction** |
| 1 | >2H:1V | >5' above toe | SP, ML\*, SM\* | Loose or unknown |
| 2 | >2.5H:1V | >2' above toe | ML\*\*, MH | Loose or unknown |
| 3 | >3H:1V | at toe | SM\*\*, SW, CH | Likely compacted |
| 4 | <3H:1V | DS of toe | SC, CL | Compacted |
| 5 | <3H:1V | None | Suitably Zoned | Compacted |

ML\* - Non-plastic silt or any silt or clay susceptible to dispersion

ML\*\* - Silt with some plasticity (non-dispersive)

SM\* - Uniform silty fine sand

SM\*\* - Widely graded silty sand

Note 2 - Concrete Condition Factor of Safety Criteria

In addition to the inspection conditions listed, ratings should consider the sliding stability Factors of Safety (FS) for any concrete structures that retain water according to the following guidelines.

FS Criteria for Dams with Limited Structure and Foundation Information and Testing

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rating** | **Normal Pool FS** | **SDF FS** | **Ice Loading FS** | **Seismic FS** |
| 1 | <2.0 | <1.3 | <1.3 | <1.0 |
| 2 | <3.0 | <2.0 | <2.0 | <1.3 |
| 3 | >3.0 | >2.0 | >2.0 | <1.5 |
| 4 | >3.0 | >2.0 | >2.0 | >1.5 |
| 5 | >3.0 | >2.0 | >2.0 | >1.5 |

FS Criteria for Dams with Well Defined Structure and Foundation Information and Testing

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rating** | **Normal Pool FS** | **SDF FS** | **Ice Loading FS** | **Seismic FS** |
| 1 | <1.5 | <1.3 | <1.3 | <1.0 |
| 2 | <2.0 | <1.7 | <1.7 | <1.0 |
| 3 | <3.0 | <2.0 | <2.0 | <1.1 |
| 4 | >3.0 | >2.0 | >2.0 | <1.3 |
| 5 | >3.0 | >2.0 | >2.0 | >1.3 |

***See Appendix D for a complete listing of dam orientation and terminology definitions.***

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

Height of Dam – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the crest of the dam.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

APPENDIX C

Previous Reports and References

PREVIOUS REPORTS AND REFERENCES

*[A list of previous reports and references should be presented in chronological order (most recent to oldest) utilizing standard bibliographic procedures. Reports and references pertaining specifically to the dam should be separated from technical bibliographic entries utilized for research purposes during the development of the report.]*

The following is a list of reports that were located during the file review or were referenced in previous reports.

1. ***Historic Report 1 title, report prepared by [Insert Name], city/town, date of preparation.***
2. ***Historic Plan 1 title, Sheet No., plans prepared by [Insert Name], city town, date of preparation.***

The following references were utilized during the preparation of this report and the development of the recommendations presented herein.

1. ***Author, “Technical Reference 1 Title”, Publisher, City, copyright date.***

APPENDIX D

Definitions

**COMMON DAM SAFETY DEFINITIONS**

For a comprehensive list of dam engineering terminology and definitions refer to 302 CMR10.00 Dam Safety, or other reference published by FERC, Dept. of the Interior Bureau of Reclamation, or FEMA. Please note should discrepancies between definitions exist, those definitions included within 302 CMR 10.00 govern for dams located within the Commonwealth of Massachusetts.

**Orientation**

Upstream – Shall mean the side of the dam that borders the impoundment.

Downstream – Shall mean the high side of the dam, the side opposite the upstream side.

Right – Shall mean the area to the right when looking in the downstream direction.

Left – Shall mean the area to the left when looking in the downstream direction.

**Dam Components**

Dam – Shall mean any artificial barrier, including appurtenant works, which impounds or diverts water.

Embankment – Shall mean the fill material, usually earth or rock, placed with sloping sides, such that it forms a permanent barrier that impounds water.

Crest – Shall mean the top of the dam, usually provides a road or path across the dam.

Abutment – Shall mean that part of a valley side against which a dam is constructed. An artificial abutment is sometimes constructed as a concrete gravity section, to take the thrust of an arch dam where there is no suitable natural abutment.

Appurtenant Works – Shall mean structures, either in dams or separate therefrom, including but not be limited to, spillways; reservoirs and their rims; low-level outlet works; and water conduits including tunnels, pipelines, or penstocks, either through the dams or their abutments.

Spillway – Shall mean a structure over or through which water flows are discharged. If the flow is controlled by gates or boards, it is a controlled spillway; if the fixed elevation of the spillway crest controls the level of the impoundment, it is an uncontrolled spillway.

**Size Classification**

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

Large – structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.

Intermediate – structure with a height between 15 and 40 feet or a storage capacity of 50 to 1,000 acre-feet.

Small – structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.

Non-Jurisdictional – structure less than 6 feet in height or having a storage capacity of less than 15 acre-feet.

**Hazard Classification**

(as listed in Commonwealth of Massachusetts, 302 CMR 10.00 *Dam Safety*)

High Hazard (Class I) – Shall mean dams located where failure will likely cause loss of life and serious damage to home(s), industrial or commercial facilities, important public utilities, main highway(s) or railroad(s).

Significant Hazard (Class II) – Shall mean dams located where failure may cause loss of life and damage to home(s), industrial or commercial facilities, secondary highway(s) or railroad(s) or cause the interruption of the use or service of relatively important facilities.

Low Hazard (Class III) – Dams located where failure may cause minimal property damage to others. Loss of life is not expected.

**General**

EAP – Emergency Action Plan – Shall mean a predetermined (and properly documented) plan of action to be taken to reduce the potential for property damage and/or loss of life in an area affected by an impending dam failure.

O&M Manual – Operations and Maintenance Manual; Document identifying routine maintenance and operational procedures under normal and storm conditions.

Normal Pool – Shall mean the elevation of the impoundment during normal operating conditions.

Acre-foot – Shall mean a unit of volumetric measure that would cover one acre to a depth of one foot. It is equal to 43,560 cubic feet. One million U.S. gallons = 3.068 acre-feet.

Height of Dam (Structural Height) – Shall mean the vertical distance from the lowest portion of the natural ground, including any stream channel, along the downstream toe of the dam to the lowest point on the crest of the dam.

Hydraulic Height – means the height to which water rises behind a dam and the difference between the lowest point in the original streambed at the axis of the dam and the maximum controllable water surface.

Maximum Water Storage Elevation – means the maximum elevation of water surface which can be contained by the dam without overtopping the embankment section.

Spillway Design Flood (SDF) – Shall mean the flood used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

Maximum Storage Capacity – The volume of water contained in the impoundment at maximum water storage elevation.

Normal Storage Capacity – The volume of water contained in the impoundment at normal water storage elevation.

**Condition Rating**

Unsafe – Major structural\*, operational, and maintenance deficiencies exist under normal operating conditions.

Poor – Significant structural\*, operation and maintenance deficiencies are clearly recognized for normal loading conditions.

Fair – Significant operational and maintenance deficiencies, no structural deficiencies. Potential deficiencies exist under unusual loading conditions that may realistically occur. Can be used when uncertainties exist as to critical parameters.

Satisfactory– Minor operational and maintenance deficiencies. Infrequent hydrologic events would probably result in deficiencies.

Good – No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.

\* Structural deficiencies include but are not limited to the following:

* Excessive uncontrolled seepage (e.g., upwelling of water, evidence of fines movement, flowing water, erosion, etc.)
* Missing riprap with resulting erosion of slope
* Sinkholes, particularly behind retaining walls and above outlet pipes, possibly indicating loss of soil due to piping, rather than animal burrows
* Excessive vegetation and tree growth, particularly if it obscures features of the dam and the dam cannot be fully inspected
* Deterioration of concrete structures (e.g., exposed rebar, tilted walls, large cracks with or without seepage, excessive spalling, etc.)
* Inoperable outlets (gates and valves that have not been operated for many years or are broken)