Connecticut Department of Environmental Protection

Arthur J. Rocque, Jr.
Commissioner

Guidelines for Inspection and Maintenance of Dams

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Department of Environmental Protection
Bureau of Water Management
Inland Water Resources Division
(860) 424-3706

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Finally, I would like to acknowledge the contribution of David Majachier. Nearly a decade ago, while working for the Dam Safety Section, he envisioned what I hope we have accomplished with this manual. With great appreciation and respect, this manual is dedicated to David.

Ann Kuzyk
Project Manager

Guidelines for
Inspection and Maintenance of Dams

Prepared for

Connecticut Department of Environmental Protection
Bureau of Water Management
Inland Water Resources Division

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A. INTRODUCTION

Purpose and Scope

Dams are barriers typically constructed across a stream channel to impound water. Dams are man-made structures requiring routine inspection and maintenance. Several dams fail every year due to lack of maintenance, and in most cases failure could have been prevented.

This manual was developed to assist and encourage the many owners of small dams in Connecticut to inspect and maintain their dams on a regular basis. It is intended to be a useful guide for owners to refer to while performing these activities. By inspecting a dam on a regular basis, and becoming familiar with the structure, the owner can recognize important changes more readily over time.

A number of inspection and maintenance practices for various types of dams are covered, although an emphasis has been placed on earth and earth/masonry structures since they are the most common types of small dams in Connecticut.

Importance of Dam Maintenance and Inspection

Impact of Dam Failure: Dam failure may result in the loss of life, property and income. The loss or significant lowering of a pond or lake impounded by a dam may cause hardship for those dependent on it for their livelihood or water supply. The loss of a dam may also alter existing wetlands and eliminate recreational opportunities for swimming, fishing and boating. The

Dam Failure

likelihood of future residential and commercial development occurring both downstream of dams and adjacent to impoundments means that the potential for such losses will continue to grow over time. Adhering to the maintenance and inspection guidelines of this manual is not only an important endeavor for dam owners but also a legal requirement.

Regular Inspection: Regular inspection is vital to the proper care and maintenance of dams. A regular inspection program is essential in preserving the integrity of a dam and avoiding costly repairs. Dams are subject to erosion, corrosion, and deterioration by wind, rain, ice and temperature. Water passing over, under and through dams can weaken these structures over time. A regular inspection program should start just after construction is completed and continue throughout the life of a dam.

B. DAM SAFETY REGULATIONS, OWNER RESPONSIBILITY AND LIABILITY

DEP Dam Safety Program Overview

The Dam Safety Section of the Inland Water Resources Division of the Connecticut Department of Environmental Protection (DEP) is responsible for administering and enforcing Connecticut's dam safety laws. The existing statutes require that permits be obtained to construct, repair or alter dams, dikes and similar structures and that existing dams, dikes and similar structures be registered and periodically inspected to assure that their continued operation and use does not constitute a hazard to life, health or property.

Pertinent Statutes and Regulations

The dam safety statutes are codified in Sections 22a-401 through 22a-411 of the Connecticut General Statutes (CGS). Sections 22a-409-1 through 22a-409-2 of the Regulations of Connecticut State Agencies (RCSA) govern the registration and safety inspection of dams in Connecticut. A copy of these statutes and regulations are available from the Dam Safety Section of the Inland Water Resources Division of the DEP by calling (860) 424-3706.

How Dams are Classified

DEP assigns dams to one of five classes according to their hazard potential:

a. Class AA: negligible hazard potential dam which, if it were to fail, would result in no measurable damage to roadways, land and structures, and negligible economic loss.

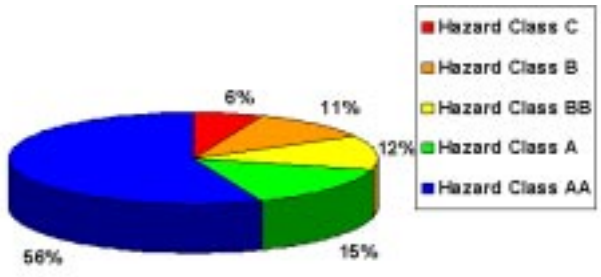
b. Class A: low hazard potential dam which, if it were to fail, would result in damage to agricultural land, damage to unimproved roadways, or minimal economic loss.

c. Class BB: moderate hazard potential dam which, if it were to fail, would result in damage to normally unoccupied storage structures, damage to low volume roadways, or moderate economic loss.

d. Class B: significant hazard potential dam which, if it were to fail, would result in possible loss of life; minor damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.; damage to or interruption of the use or service of utilities; damage to primary roadways and railroads; or significant economic loss.

e. Class C: high hazard potential dam which, if it were to fail, would result in the probable loss of life; major damage to habitable structures, residences, hospitals, convalescent homes, schools, etc.; damage to main highways; or great economic loss.

The classification of a dam can change due to changes in downstream development. As shown in the chart below, 83% of dams in Connecticut fall within the negligible to moderate hazardous categories while only 17% fall within the significant and high hazard categories.



Connecticut Dams by Hazard Class

Operation and Maintenance Plan Requirements

DEP typically requires owners of Class B and C hazard classification dams to prepare individual Operation & Maintenance Manuals for their dams, while owners of Class A and BB dams are not routinely required to do so. The DEP created this manual in order to help the owners of Class A and BB dams inspect and maintain these lower hazard structures. In addition, this manual may also serve as a starting point for the preparation of individual Operation & Maintenance Manuals for Class B and C dams.

Inspection Requirements

DEP is charged with periodically inspecting all dams subject to the jurisdiction of the Commissioner. These are dams which by breaking away would cause property damage or loss of life. Information regarding the inspection process is contained in 22a-409-2 of the RCSA.

Hazard Class	Inspection Frequency
AA	At least once
A	Every 10 years
BB	Every 7 years
B	Every 5 years
C	Every 2 Years

Periodic DEP Inspections

Responsibility and Liability

Owners of dams are legally responsible for the operation and maintenance of their structures. Negligence by dam owners in fulfilling their responsibilities can negatively impact downstream and adjacent residents and properties.

Section 22a-409-2(j) of the RCSA outlines owner responsibilities including:

a. Inspection of the dam to assure no unsafe conditions are developing, e.g., due to weather, animal activity, vandalism.

b. Notification to DEP of any major damage such as overtopping by flood waters, erosion of the spillway discharge channel, new seepage, settling, cracking or movement of the embankment.

c. Maintenance of structure and adjacent area to remain free of brush and tree growth.

d. Written records of all inspections and maintenance activities undertaken.

Dam owners are encouraged to visit and inspect their dam frequently in order to become familiar with its features and current condition. This allows important changes to be detected quickly.

Dam owners may consider obtaining insurance to provide coverage in the event of damages and claims resulting from a dam failure. Contact your homeowners insurance agent for more information.

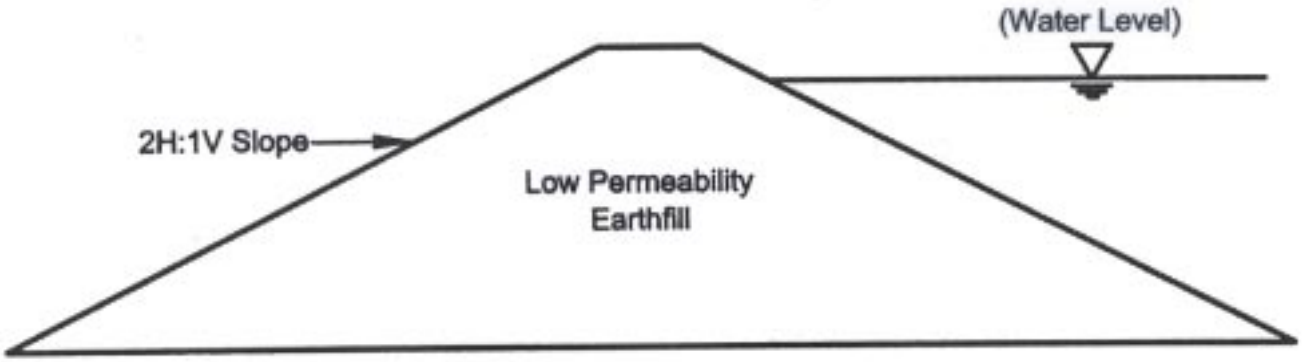
C. TYPES OF DAMS AND COMPONENTS

Various materials are used for dam construction including earth, timber, rock, concrete and steel. Most dams in Connecticut are constructed of earth or combinations of earth and other materials. Dams are provided with spillways to safely pass a broad range of flows over, around or through the dam. Dams often have a drain or similar mechanism to control water levels in the impoundment for maintenance or emergency purposes.

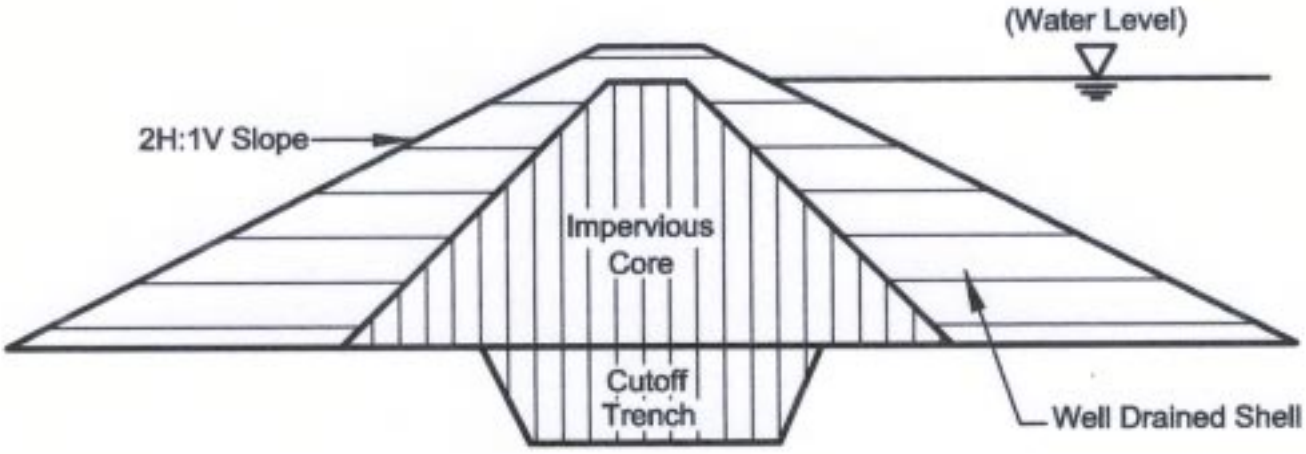
Some typical dam configurations are described below:

a. Earthfill Dam: in which more than 50% of the volume consists of soil. This type of dam is often referred to as an Embankment Dam.

b. Zone Embankment Dam: composed of zones of selected materials having different degrees of permeability.



Earthfill Dam



Zone Embankment Dam with Cutoff Trench

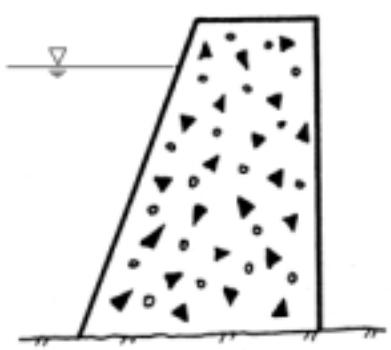
c. Masonry Dam: constructed mostly of shaped stone, brick or concrete blocks that may or may not be joined by mortar.

d. Rubble Dam: constructed of unshaped coarse stone or fragments of stones, not placed in courses, that may or may not be joined by mortar.

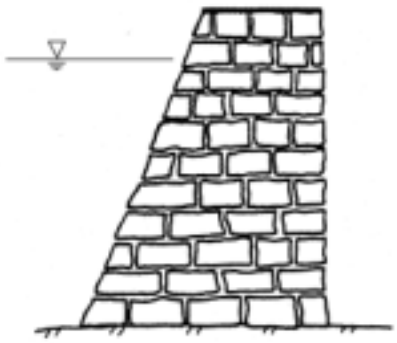
e. Masonry Wall/Earthfill Dams: consisting of earth embankment with one or two masonry rubble rock faces; walls on downstream and/or upstream faces are generally vertical.

f. Concrete Dam: constructed primarily of cast-in-place concrete.

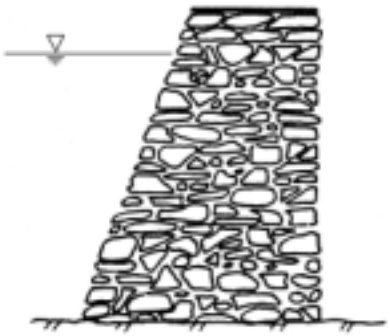
g. Concrete Wall/Earthfill Dam: consisting of earth embankment with one concrete wall, generally vertical and on the upstream face.



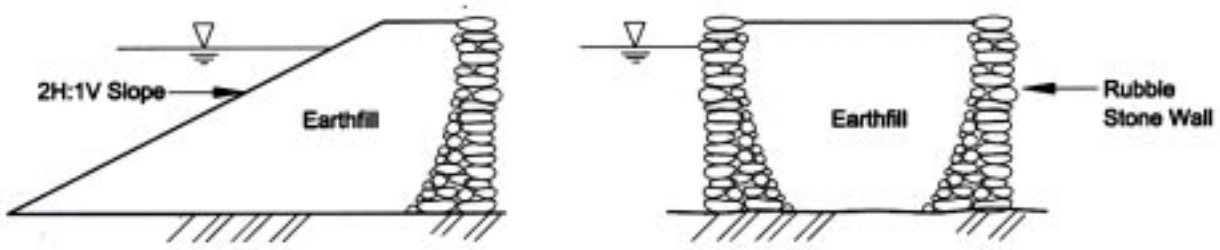
Concrete Dam



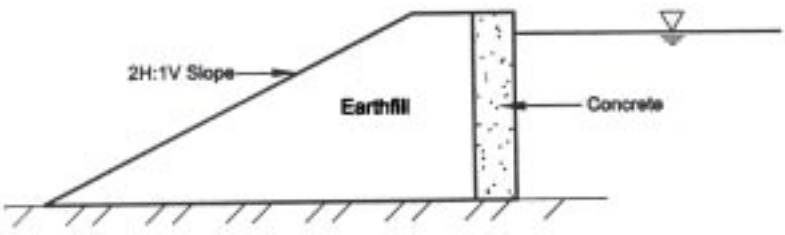
Masonry Dam



Rubble Dam

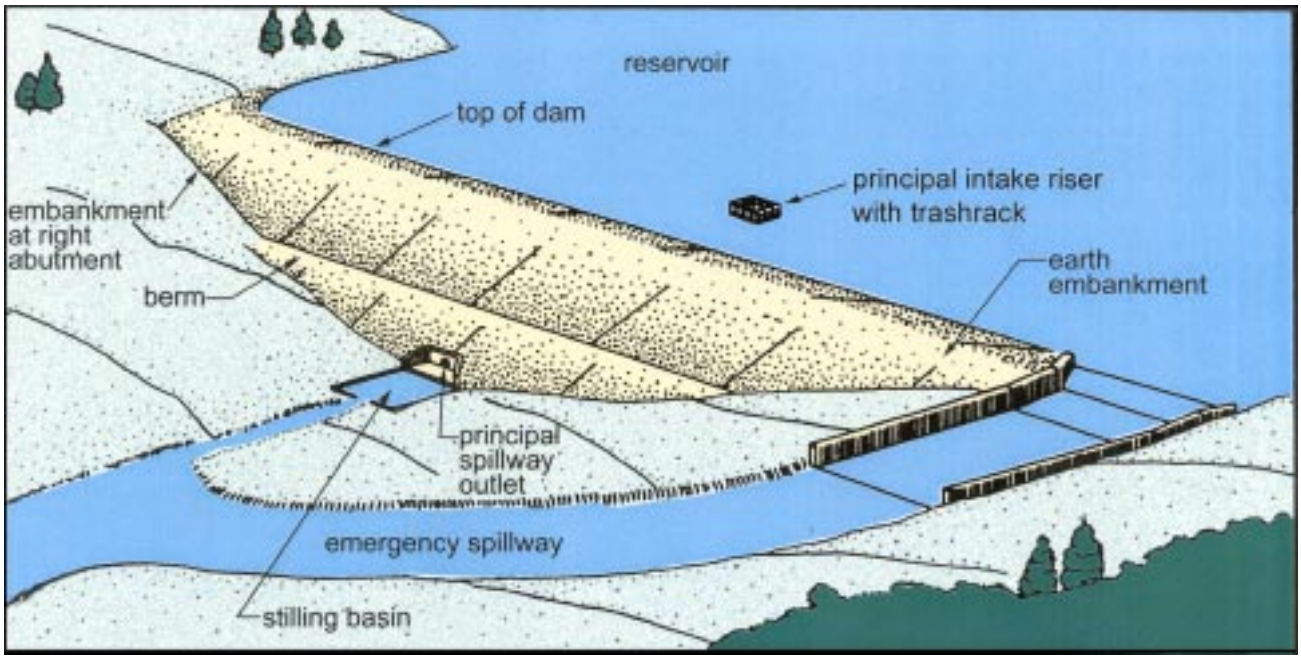


Masonry Wall//Earthfill Dams

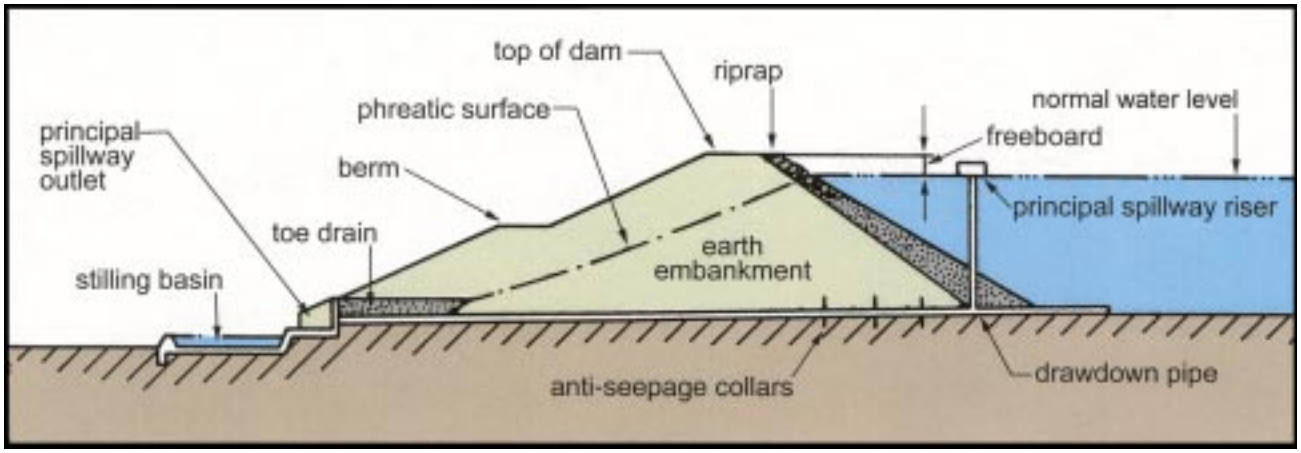


Concrete Wall/Earthfill Dam

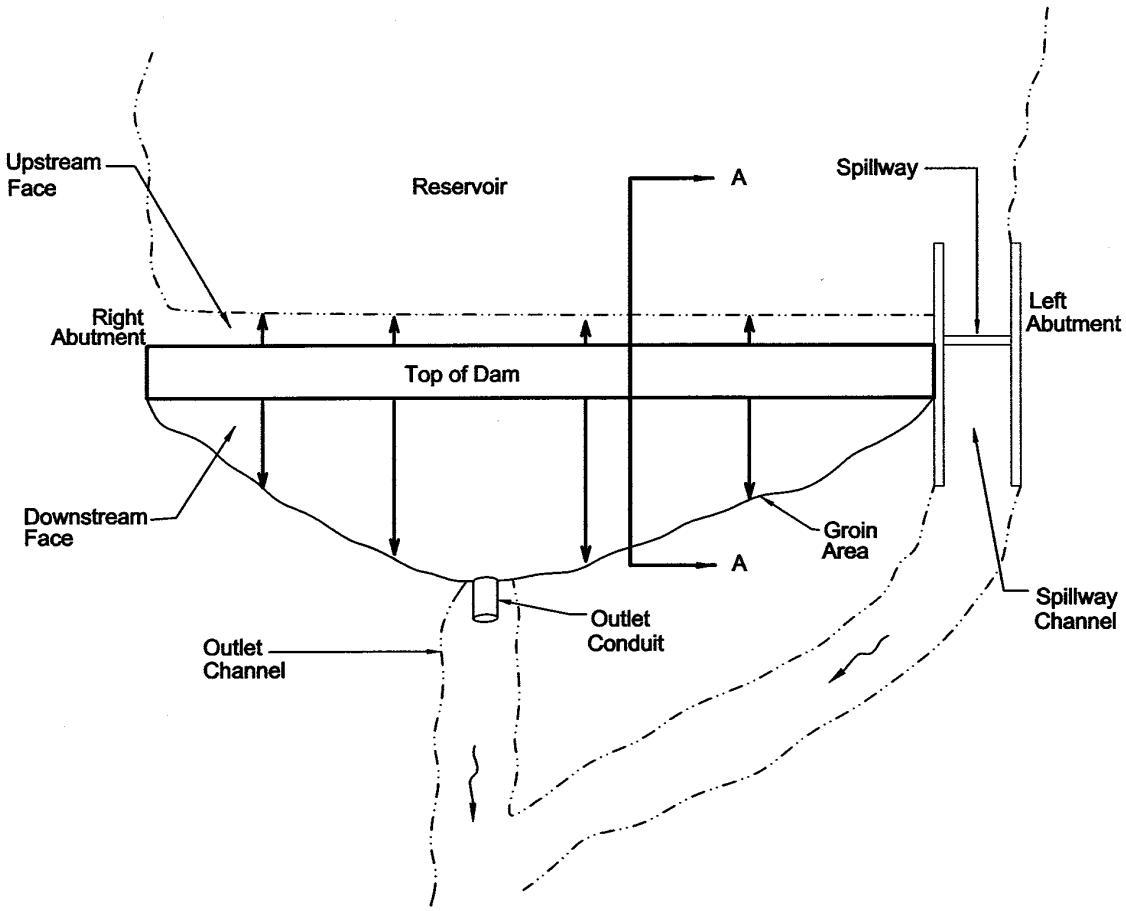
The common components of a typical earthfill dam are illustrated below. Descriptions of some common dam components are also given below.



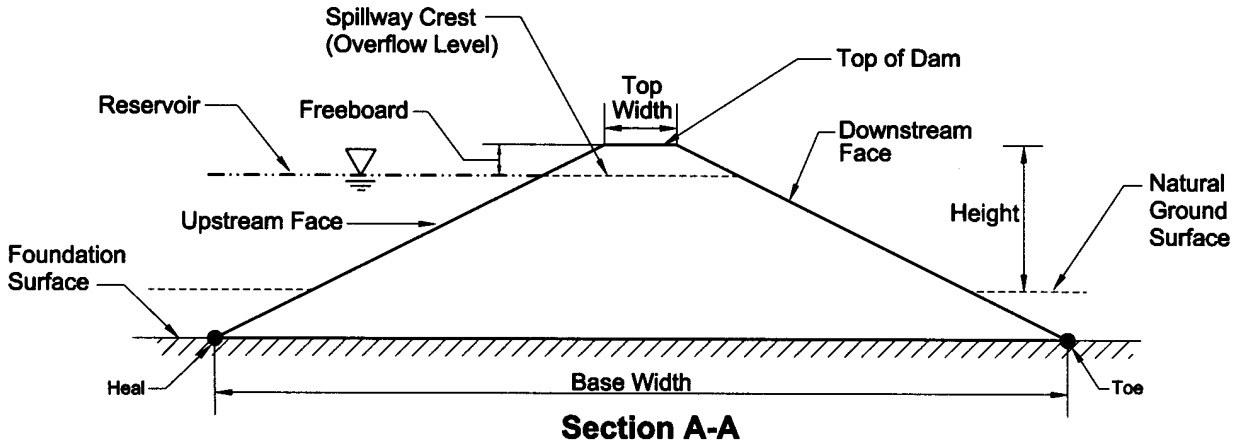
Earthfill Dam



Section Through Dam



Plan View



Section A-A

Embankment Dam Nomenclature

Embankment

The embankment is the primary part of the dam. It is the section which impounds and resists the forces of the water. A homogeneous embankment is composed of essentially the same material throughout, while a zoned embankment has different materials, such as clay or rock, incorporated into some areas. Seepage through the dam embankment may be collected and controlled by an internal drainage system such as a toe drain or foundation drain.

Spillway

Well Maintained Embankment

Spillways

The principal spillway establishes the normal water level of the pond or lake. The function of the principal spillway is to allow normal flow to pass the dam in a safe and non-erosive manner. An emergency spillway is an auxiliary spillway designed to pass flood flows greater than the principal spillway's capacity in order to prevent the dam from overtopping during extreme storms. Spillways must be resistant to erosion because their failure may be as significant as an embankment failure and may well lead to dam failure. Because flows in spillways may reach high velocities, a stilling basin or plunge pool is often used to prevent erosion.

Intake/Outlet Structures

Also referred to as drawdown facilities, these structures help control impoundment levels and drain a reservoir for normal maintenance or emergency purposes. Most drawdown facilities consist of a pipe through the dam with a valve which may be operated as needed. The dam spillway and drawdown structures may be built in close proximity to one another, and an outlet structure may be incorporated into the principal spillway structure.

Intake Structure

Masonry and Rubble Walls

Many masonry and rubble-wall-faced earth dams exist in Connecticut. In some instances properly graded gravel was placed immediately behind the wall to provide a drainage outlet for any seepage moving through the earthfill. Spillway and spillway training walls have also been constructed with masonry/rubble walls. Evidence of any seepage, subsidence or undercutting of these walls is best observed with the impoundment at spillway crest elevation to assess whether the crest is level. The structure should then be viewed with no flow over the spillway to assess the degree and location of seepage/leakage and the presence of scour or undercutting erosion at the toe.

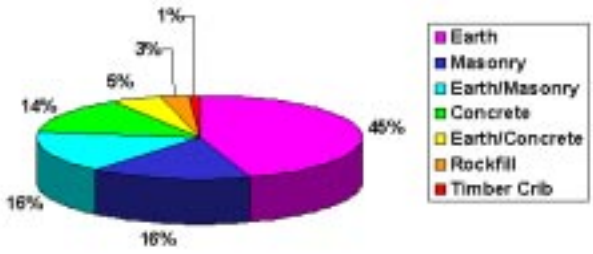
Rubble Wall

Miscellaneous Safety and Access Features

Fences, handrails, gates, access roads, bridges and warning signs serve to improve access and personal safety. Fences also discourage vandalism.

Relative Numbers for Types of Dams

As shown in the chart below, 77 percent of Connecticut dams in the negligible to moderate hazard categories are constructed primarily of earth, masonry or a combination of these materials.



Construction of Types AA, A and BB Dams in Connecticut

D. TYPES OF FAILURE

Dam failures usually result from poor design, improper construction, inadequate maintenance, or a combination of the above. Although the manner in which a dam fails and the particular causes of failure are often varied and complex, failures can generally be grouped into the following three types:

Seepage/Piping

All earth dams have seepage due to water movement through the dam and its foundation, however, the rate of seepage must be controlled. Uncontrolled seepage can progressively erode soil from the embankment or its foundation in an upstream direction towards the reservoir and develop a flow conduit (pipe) to the reservoir. This phenomenon is known as "piping." Uncontrolled seepage may also weaken the soil and lead to a structural failure. Common causes of seepage/piping include rodent activity, tree roots and poor construction.

Overtopping/Erosion

Overtopping failures result from the erosive action of the uncontrolled flow of water over, around or adjacent to the dam. Earth embankments are not designed to be overtopped and therefore are particularly susceptible to erosion. Surface erosion may reduce the embankment cross-section, saturate an earth embankment and lead to a structural failure. General causes of overtopping include inadequate spillway size and/or spillway blockage by debris.

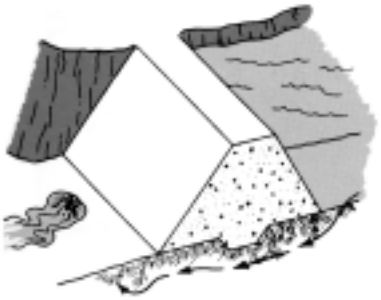
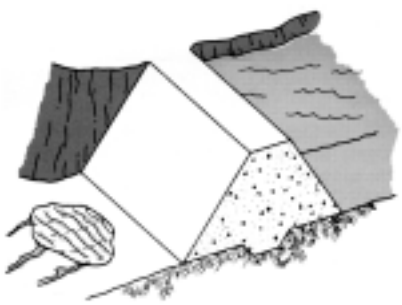
Dam Failure

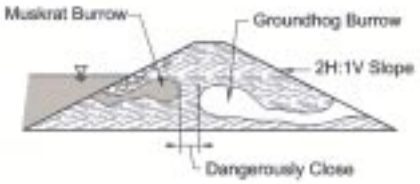
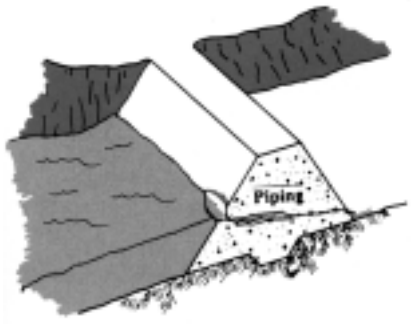
Structural

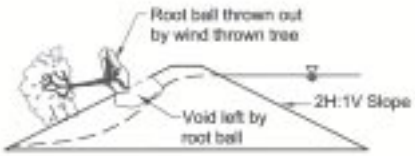
Structural failures can occur in the dam itself or its foundation. Structural failure of a spillway, drawdown facility, concrete wall or other appurtenance can lead to a total dam failure. Cracking, settlement and slides are common signs of structural failure which often result from uneven settlement of foundation materials and/or poor workmanship during construction.

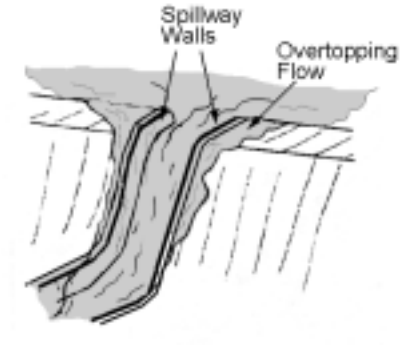
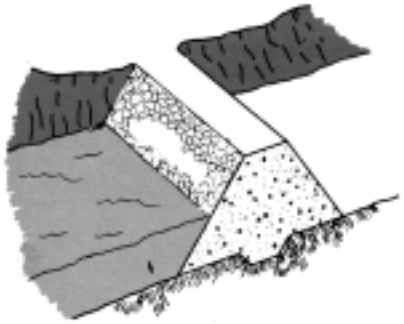
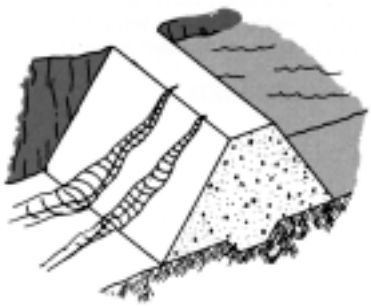
Problems, Consequences, Recommended Actions

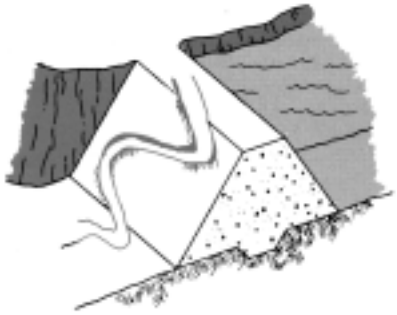
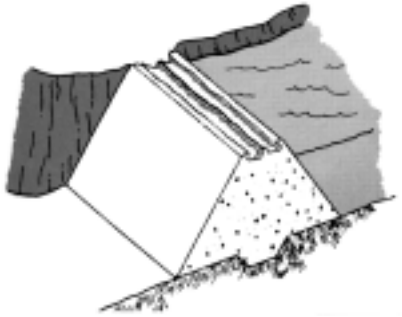
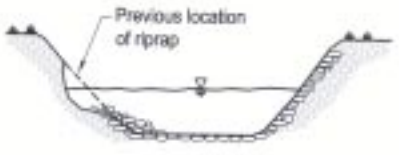
Various observable problems, their possible consequences, and recommended actions are grouped below by failure type.

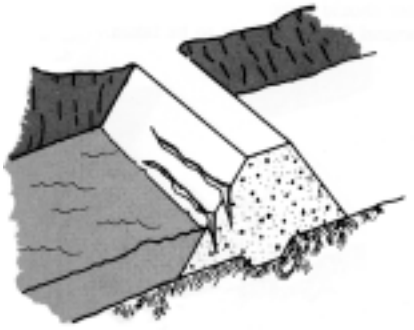
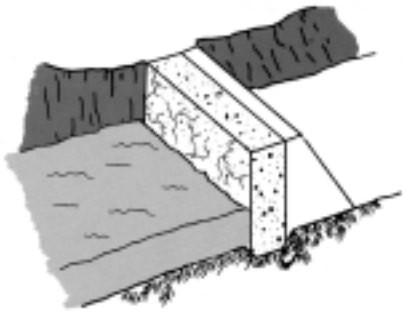
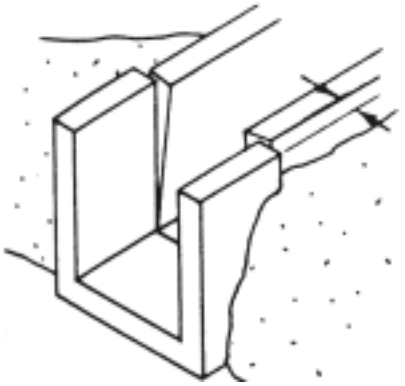
SEEPAGE/PIPING PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Seepage Water Exiting at Abutment Contact 	Can lead to erosion of embankment materials and failure of the dam.	Study leakage area to determine quantity of flow and extent of saturation. Stake out the saturated area and monitor for growth or shrinkage. Inspect frequently for slides. Water level in the impoundment may be lowered to increase embankment safety. A QUALIFIED ENGINEER should inspect the conditions and recommend further actions to be taken.
Seepage Water Exiting as a Boil in the Foundation 	Continuous flows can lead to piping erosion of the foundation and failure of the dam.	Examine boil for transportation of foundation materials, evidenced by discoloration. If soil particles are moving downstream, create a sand bag or earth dike around the boil. This is a temporary control measure. The pressure created by the water level within the dike may control flow velocities and prevent further erosion. If erosion continues, lower the reservoir level. A QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken. CONTACT DEP DAM SAFETY PERSONNEL.
Spongy Condition at Toe of Dam 	Condition shows excessive seepage in the area. If control layer of turf is destroyed, rapid piping erosion of foundation materials could result in failure of the dam. Marked change in vegetation may be present.	Carefully inspect the area for outflow quantity and any transported material. A QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken. CONTACT DEP DAM SAFETY PERSONNEL.

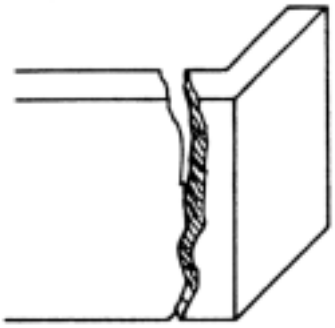
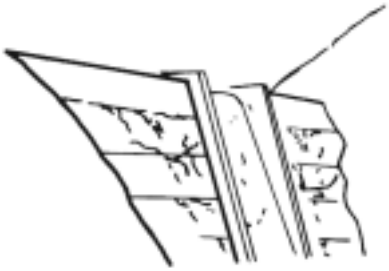
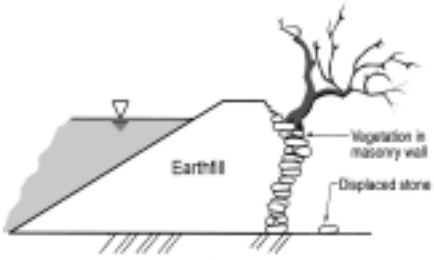
SEEPAGE/PIPING PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Rodent Activity 	Can reduce length of seepage path and lead to piping erosion failure. If rodent tunnel exists through most of the dam, it can lead to failure of the dam.	Control rodents to prevent more damage. Determine exact location of digging and extent of tunneling. Remove rodents and backfill existing holes.
Seepage Water Exiting From a Point Adjacent to the Outlet 	Continued flows can lead to rapid erosion of embankment materials and failure of the dam.	Investigate the area by probing and/or carefully shoveling to see if the cause can be determined. Determine if leakage water is carrying soil particles evidenced by discoloration. Determine quantity of flow. If flow increases, or is carrying embankment materials, reservoir level should be lowered until leakage stops. A QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken. CONTACT DEP DAM SAFETY PERSONNEL.
Sinkhole 	Piping erosion can empty a reservoir through a small hole or can lead to dam failure as soil pipes erode. Dirty water at the exit indicates erosion.	Inspect other parts of the dam for seepage or more sinkholes. Identify exact cause of sinkholes. Check seepage and leakage outflows for dirty water. A QUALIFIED ENGINEER should inspect the conditions and recommend further actions to be taken. CONTACT DEP DAM SAFETY PERSONNEL.

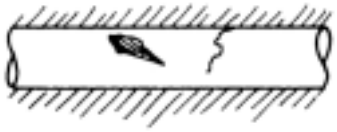
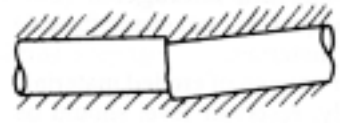
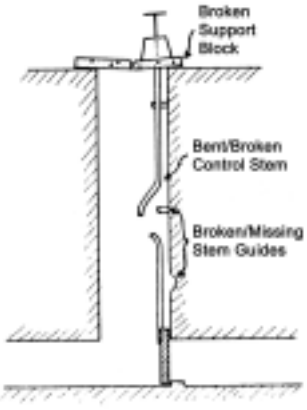
SEEPAGE/PIPING PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Trees /Brush  	Large tree roots can create seepage paths. Brush can obscure visual inspection and harbor rodents. Decaying root systems can provide seepage paths. Wind thrown tree can create void in dam.	Remove all trees and shrubs on and within 25 feet of the embankment. Properly backfill void with compacted material. A QUALIFIED ENGINEER may be required; CONTACT DEP DAM SAFETY PERSONNEL.

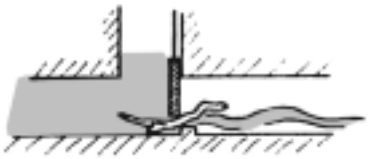
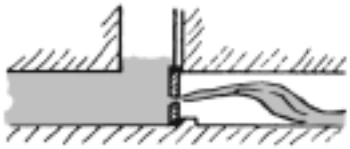
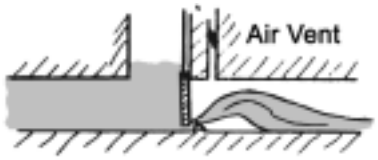
OVERTOPPING/EROSION PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Blocked/Inadequately Sized Spillway 	May reduce discharge capacity and cause overflow of spillway and/or dam overtopping. Dam, if overtopped frequently, can erode and/or fail.	Remove debris blockage (e.g. beaver dams) regularly. Measure quantity of flow depth in spillway for various rain events. Control vegetative growth in spillway channel. Install log boom or trash rack in front of spillway entrance to intercept floating debris. A QUALIFIED ENGINEER should inspect the conditions and recommend further actions to be taken.
Broken Down or Missing Riprap 	Wave action against unprotected areas decreases embankment width. Soil is eroded away which allows riprap to settle, providing less protection and decreased embankment width.	Re-establish normal slope. Place bedding and competent riprap. ENGINEER REQUIRED for design of bedding and riprap.
Erosion 	Erosion can lead to eventual deterioration of the downstream slope and failure of the structure. Can reduce available freeboard and/or cross-sectional area of dam. Can result in a hazardous condition if due to overtopping.	Protect eroded areas with riprap. Compacted soil and re-establishing turf may be adequate if the problem is detected early. If gully was caused by overtopping, provide adequate spillway designed by a QUALIFIED ENGINEER.

OVERTOPPING/EROSION PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Pedestrian/Vehicle Traffic 	Creates areas bare of erosion protection and causes erosion channels. Allows water to stand and makes area susceptible to drying cracks.	Prohibit access using fence, signs. Repair erosion protection with riprap or grass. If access is needed or required, provide a formal access way designed to prevent erosion.
Ruts/Puddling Along Crest 	Allows standing water to collect and saturate crest of dam. Vehicles can get stuck.	Regrade and recompact crest to provide proper drainage to upstream slope. Install gravel or road base material to accommodate traffic.
Missing/Deteriorated Riprap Channel Lining 	Erosive action displaces channel lining and washes sediment downstream.	Install properly graded riprap in channel lining with filter material to prevent soil from being washed out through spaces in the riprap.

STRUCTURAL PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Large Cracks, Slide, Slump or Slip 	Large cracks indicate onset of massive slide or settlement caused by foundation failure. A series of slides can lead to obstruction of the outlet or failure of the dam. If massive slide cuts through crest or upstream slope, reducing free-board and cross section, structural collapse or overtopping can result.	Measure extent and displacement of slide. If continued movement is seen, begin lowering water level until movement stops. A QUALI-FIED ENGINEER should inspect the condition and recommend further action. CONTACT DAM SAFETY PERSONNEL.
Cracked or Deteriorated Concrete Face 	Ice action may further weaken or displace concrete by freezing and thawing.	Determine cause. Either patch with grout or contact engineer for permanent repair method. If damage is extensive, a QUALI-FIED ENGINEER should inspect the conditions and recommend further actions to be taken.
Wall Displacement/Open Joints 	Minor displacement will create eddies and turbulence in the flow, causing erosion of the soil behind the wall. Erosion of foundation material may weaken support and cause further displacement. Major displacement will cause severe cracks and eventual failure of the structure.	Reconstruct displaced structure. Water-stops should be used at joints where feasible. Consult a QUALIFIED ENGINEER before actions are taken.

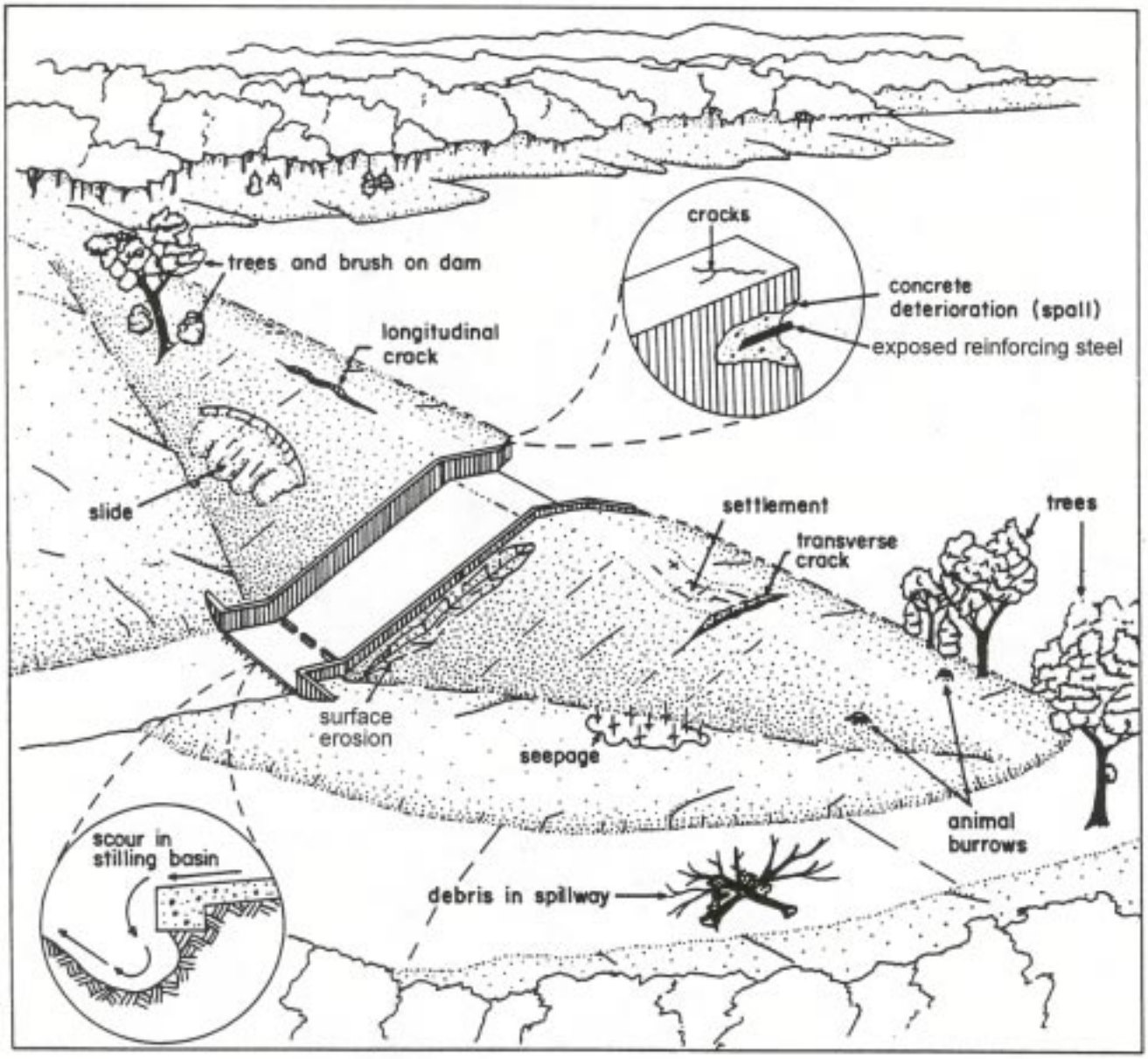
STRUCTURAL PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Large Cracks 	Disturbance in flow patterns; erosion of foundation and backfill; eventual collapse of structure. May allow entrance of water which could cause freeze and thaw damage and further weaken structure.	Cracks without large displacement may be repaired by patching, in which case surrounding areas should be cleaned or cut out before patching. Installation of weep holes or other actions may be needed. A QUALIFIED ENGINEER should inspect the condition and recommend such further actions.
Leakage Through Joints or Cracks 	Can cause walls to tip over. Flows through concrete can lead to rapid deterioration from weathering. If the spillway is located within the embankment, rapid erosion can lead to failure of the dam.	Check area behind wall for puddling of surface water. Check and clean drain outfalls, flush lines, and weep holes. If condition persists a QUALIFIED ENGINEER should inspect the condition and recommend further actions to be taken.
Tree Growth in Masonry Walls 	Can weaken or disintegrate wall by dislodging masonry or rubble stone.	Control excessive brush through regular routine maintenance (removal). Remove large trees, stumps and roots under the direction of a QUALIFIED ENGINEER.

STRUCTURAL PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Leaning/Bulging Masonry Walls 	Freezing/thawing of silty/clayey soils push (lean) masonry walls out of vertical alignment. Missing stones can weaken wall and lead to wall failure.	Monitor movement over time. Replace lost or unsuitable soils behind wall or brace downstream face with riprap or washed stone. Replace missing stones, choke and/or chink gaps in wall. Depending upon extent of displacement/condition, a QUALIFIED ENGINEER may be required. CONTACT DEP DAM SAFETY PERSONNEL.
Outlet Pipe Damage: **Hole, Crack**  **Joint Offset** 	Provides passageway for water to exit or enter pipe, resulting in erosion of internal materials of the dam.	Check for evidence of water either entering or exiting pipe. Tap pipe in vicinity of damaged area, listening for hollow sound which indicates a void has formed along the outside of the conduit. If a progressive failure is suspected, request advice from a QUALIFIED ENGINEER. CONTACT DEP DAM SAFETY PERSONNEL.
Control Works 	Loss of support for control stem. Stem may buckle and break under even normal use, resulting in loss of control.	Use of the system should be minimized or discontinued. If the outlet system has a second control valve, consider using it to regulate releases until repairs can be made.

STRUCTURAL PROBLEM	POSSIBLE CONSEQUENCES	RECOMMENDED ACTIONS
Valve Leakage:		
Debris Stuck Under Gate 	Gate will not close. Gate or stem may be damaged in effort to close gate.	Raise and lower gate slowly until debris is loosened and floats past valve. When reservoir is lowered, repair or replace trashrack.
Cracked Gate Leaf 	Gate leaf may fail completely, evacuating reservoir.	Use valve only in fully open or closed position. Minimize use of valve until leaf can be repaired or replaced.
Damaged Gate Seat or Guides 	Leakage and loss of support for gate leaf. Gate may bind in guides and become inoperable.	Minimize use of valve until guides/ seats can be repaired. Check to see if air vent pipe exists and is unobstructed.

E. PREVENTIVE MAINTENANCE

Because dams are subject to deterioration over time, and seemingly minor deficiencies can quickly develop into major problems, all dam components and appurtenances should be inspected and maintained regularly. Routine maintenance recommendations are provided below by dam component.



Typical Deficiencies

Embankment

Recommended routine maintenance procedures and frequencies include:

a. Vegetation Control - twice per year

- Mow grass to maintain visibility of dam surfaces and remove woody vegetation from within 25 feet of all dam components
- Maintain a healthy stand of grass to prevent erosion and growth of woody vegetation

b. Rodent Control - as required

- Fumigate burrow
- Trap or eradicate rodent
- Fill entire burrow with fill material

Rodent Burrow

c. Minor Embankment and Erosion Repair - as required

- Restore damaged/eroded areas with soil that is free from vegetation, organic matter, trash, large rock
- Place and compact in thin (i.e., 6-inch) layers
- Install topsoil and seed

d. Erosion Protection - as required

- Install rock, vegetation or other material (concrete or asphalt) where erosion protection is missing, damaged or otherwise required

Spillways

Recommended routine maintenance procedures and frequencies include:

a. Vegetation Control (for grass lined emergency spillways)

- Mow grass twice per year
- Maintain a healthy stand of grass to prevent erosion
- Remove woody vegetation annually

b. Minor Earthwork and Erosion Repair - as required

- Replace missing soil with new soil that contains no vegetation, organic matter, trash or large rocks
- Place and compact in thin (i.e., 6-inch) layers
- Install topsoil and seed

c. Erosion Protection - as required

- Install rock, riprap, vegetation or other material (e.g., concrete or asphalt) where erosion protection is missing, damaged or otherwise required
- Check downstream spillway channel for evidence of excessive siltation or erosion

d. Concrete/Stone/Masonry Repair - as required

- Consult DEP Dam Safety personnel and/or a professional engineer to determine appropriate repair

e. Beaver Dam Removal - as required

- Remove beaver flowage debris from spillway

Beaver Dam in Spillway

Intake/Outlet Structures

Recommended routine maintenance procedures and frequencies include:

a. Trashrack - after every major storm

- Remove accumulated debris
- Repair rusted or broken sections as needed

b. Mechanical - once per year

- Cycle (open and close) outlet gate valves through full operating range
- Lubricate mechanisms per manufacturer's recommendation
- Paint or grease ferrous metal surfaces as needed
- Align stem guides or brackets

c. Internal Conduit - once per year

- Check for undermining or seepage around the outlet end
- Check for corrosion or other deterioration of conduit material
- Should deficiencies be detected, obtain immediate professional guidance before attempting repairs

d. Concrete Features - once per year

- Check for misalignment, cracks, spalls, scaling, exposed steel rebar, rust stains
- Consult with DEP Dam Safety Personnel or a consultant engineer before attempting repairs

Concrete Intake Structure

Masonry and Rubble Walls

Recommended routine maintenance procedures and frequencies include:

a. Vegetation Control - twice per year

- Remove woody vegetation within 25 feet of masonry dam structures
- Cut trees growing in masonry walls flush with face of masonry

b. Missing Stones - as required

- Replace missing or misaligned capstones in spillway
- Replace missing stone masonry in downstream and upstream walls
- Do not mortar up or seal off the spaces or openings between the stones on the downstream face of masonry or rubble walls without first consulting a qualified engineer

Leak in Masonry Wall

Miscellaneous Safety and Access Features

Recommended routine maintenance procedures and frequencies include:

a. Maintain vehicular and pedestrian access features to allow future inspection and maintenance - once per year.

b. Check fences, locks and signs for damage - once per year.

Walkway, Hand Railing

Fence and Signage

F. MAINTENANCE SUMMARY AND SCHEDULE TABLE

This maintenance summary and schedule is intended to provide the owner with a quick reference of the recommended frequency intervals for inspecting and performing routine maintenance on the components of a dam.

Component	**Maintenance Activity**	**Frequency**
Embankment	Vegetation control Rodent control Minor earthwork, erosion repair Erosion protection	Twice per year, minimum Check once per year, perform as required Check once per year, perform as required As required
Principal Spillway	Vegetation control Minor earthwork, erosion repair Erosion protection Concrete repair	Twice per year Check twice per year, perform as required Check twice per year, perform as required As required
Emergency Spillway	Vegetation control Minor earthwork, erosion repair Erosion protection Concrete repair	Twice per year Check twice per year Check twice per year As required
Intake/Outlet Structures	Trashrack cleaning Mechanical operation Internal conduit inspection Concrete features inspection	After every major storm Once per year Once per year Once per year
Masonry Walls	Vegetation control Missing stones	Twice per year As required
Miscellaneous Safety and Access Features	Vehicle/pedestrian access route(s) maintenance Fences, locks, signs inspection	Once per year Once per year

G. INSPECTION CHECKLIST

Regular dam inspection and the review of inspection records are essential in assessing the need for carrying out dam repairs. By inspecting a dam on a regular basis, the owner can recognize changes in the structure over time. Very often the existence of a problem is not as important as its rate of development or a sudden change in its condition or extent.

The dam owner should keep records of all (routine and special) inspections in the form of notes, photographs and/or sketches. The inspection checklist found in the Appendix of this manual is intended to help the owner perform routine inspections in a consistent, efficient manner.

Each dam registered in the State of Connecticut has an assigned identification number unique to that dam. Contact the DEP Dam Safety Section to obtain the appropriate identification number for your dam.

H. REPAIR ASSISTANCE AND EMERGENCY INFORMATION

When a Permit May Be Required

The DEP Bureau of Water Management, Inland Water Resources Division, regulates the construction, alteration, repair or removal of dams, dikes, reservoirs and similar structures. This authority is derived from Sections 22a-401 through 22a-411 of the CGS. Consequently, any person or agency proposing to construct a dam, dike, reservoir or similar structure, or proposing to repair, alter or remove such a structure, must first obtain either a permit under CGS Section 22a-403 or 22a-411 from the DEP, or obtain a determination from DEP that such a permit is not required for the proposed activity. Pursuant to CGS Section 22a-401, DEP regulates dams "which, by breaking away or otherwise, may endanger life or property." Dams whose failure does not endanger downstream life or property may not be regulated by DEP, but by the local inland wetlands or conservation commission where such dam is located.

Routine maintenance activities that do **not** require a construction permit from the DEP Dam Safety Section typically include the following:

- Grass mowing
- Cutting of brush or trees from the dam or adjacent areas
- Removal of debris and sediment from spillway intake areas and channels
- Restoration of minor eroded areas by placing topsoil, seed and mulch
- Minor patching of concrete structures
- Eradication of rodents and filling rodent holes
- Maintenance of drain valves (exercise, grease, adjust, repair valve stem and operators)

The local inland wetlands or conservation commission should be contacted prior to undertaking these types of activities to determine what, if any, local agency permits may be required.

Repair activities that **do** require a construction permit from the DEP Dam Safety Section typically include work of a more intrusive nature such as:

- Removal of tree roots and stumps and repair to earth embankments
- Reconstruction of severely deteriorated concrete structures or stone masonry walls
- Repair or replacement of damaged/deteriorated low level outlet pipes, conduits, valves
- Installation of drainage systems to control embankment or foundation seepage/leakage
- Flattening of embankment slopes
- Reconstruction of spillway, outlet control structure, walls

The DEP normally requires a dam construction permit for those repairs, alterations, or modifications to existing dams which, if improperly constructed, would adversely impact the structural integrity of the dam. Similarly, other proposed work which may affect the integrity of a dam, such as excavation adjacent to the dam, may require a DEP dam construction permit. DEP's review of permit applications under CGS Section 22a-403 evaluates the structural and engineering aspects of the proposed dam repair, modification or alternation. In addition, the potential impact of the proposed construction on the environment, the safety of persons and property, and inland wetlands and watercourses are considered. The DEP must also determine the need for providing fish passage at the site in accordance with CGS Section 26-136.

Before obtaining a permit, plans and specifications by a licensed professional engineer must be submitted to the DEP Dam Safety Section of the Inland Water Resources Division for approval. After a permit is issued, a professional engineer familiar with dam construction (ideally the design engineer) must inspect the construction, certify completion of the work and prepare "as-built" plans of the structure. Following DEP approval of the permitted construction, a "Certificate of Approval" is issued to the owner of the dam in accordance with CGS Section 22a-405. The Owner must file the certificate on the land records of the town or towns in which the dam is located. The Certificate of Approval may contain specific terms and conditions regarding the dam's inspection and operation which are intended to protect life and property.

When to Contact a Professional Engineer

Regular dam inspection and prudent operation and maintenance by the owner will help identify and solve minor problems early and reduce the potential for

dam failure. However, since each dam is unique, this manual cannot begin to cover every possible condition/deficiency which may develop. The importance of contacting a qualified engineer when significant deficiencies are detected cannot be overemphasized.

A dam inspection by a qualified engineer provides a thorough, systematic evaluation of the condition of the dam. Such inspections should, at a minimum, be performed during construction of a new dam, modifications to an existing dam, and whenever potentially significant defects are first observed including:

- Earth slides in the embankment
- Uncontrolled seepage from dam, foundation boil
- Severe erosion of spillways or discharge channels
- Seepage around pipes
- Concrete deterioration (cracks, joint displacement)
- Pipe joint separation or damage
- Surface cracking
- Irregular settlement
- Sinkholes

A professional engineer may be located by checking the yellow pages section of the local telephone directory under the headings "professional engineers," "consulting engineers" or "civil engineers." Confirm that the engineer has experience with, and is qualified to inspect, dams.

Emergency Operation Plan

Dam owners have historically been held liable for damages which occur as a result of dam failure. Owners therefore bear responsibility for reducing the potential hazard posed by their dams to downstream residents and property. Accordingly, the DEP requires that owners of Class B and C potential hazard dams prepare and implement an Emergency Operation Plan (EOP).

Guidelines for EOP preparation include three essential components:

1) An identification of the area inundated by a dam failure;

2) An established procedure for monitoring the dam during periods of heavy rainfall and runoff; and

3) A formalized warning system to alert the appropriate local emergency management officials charged with warning or evacuation responsibilities.

Usually, the owners of Class BB and A hazard potential dams are not required to prepare an EOP for their dams. However, the DEP encourages dam owners who wish to prepare an EOP to do so in accordance with the aforementioned guidelines. The guidelines are available from the DEP Inland Water Resources Division's Dam Safety Section.

Even if an EOP has not been prepared for a dam, it is still prudent for the owner to inspect the dam whenever a "flood watch" or "flood warning" alert is issued by the National Weather Service for the county where the dam is located. It is also a good idea to inspect the dam immediately following a very heavy rainfall. A written record of these special dam inspections should be maintained.

Local Emergency Management Role

If any of the following four conditions are observed during a flood watch or warning, the dam owner should notify the appropriate local emergency management agency that conditions at the dam may justify the evacuation of specific areas or closing certain roads due to the potential for flooding. Only local emergency management agencies have the authority to order the evacuation of residences or close roads.

a. Dam is overtopping or nearly overtopping.

b. Internal piping erosion of soil from the embankment or foundation has developed and caused a rapid increase in seepage, a muddy discharge near the downstream embankment toe, sinkholes appearing on or near the embankment, or a significant whirlpool (eddy) in the reservoir.

c. A large slide or slough develops in the upstream or downstream embankment slope which threatens to

breach the embankment and release the impounded water.

d. The sudden movement or failure of an appurtenant structure threatens the complete failure of the dam and release of its impoundment.

The dam owner is responsible for notifying, at a minimum, one local emergency management office or department. The local agency contacted should then notify other appropriate local agencies. The owner must contact the local government ahead of time to find out which telephone number(s) to call during or after normal business hours in the event of an emergency at the dam.

Emergency Telephone Numbers

The following agencies typically have responsibility to act in response to an impending dam failure. A space is provided next to these agencies for the dam owner to fill in the appropriate contact information:

a. Town/City Chief Executive:

b. Local Police Department:

c. Local Emergency Management Director:

d. State Office of Emergency Management:
(860) 566-3180

e. DEP Flood Emergency Operations Center:
(860) 424-3706 or (860) 424-3019

f. DEP Communications Center:
(860) 424-3333 - after normal business hours

g. State Police (Nearest Barracks):

GLOSSARY OF TERMS

ABUTMENT - The natural ground that borders on either end of the dam structure. Right and left abutments are those on respective sides of the dam when an observer looks downstream.

ANTI-SEEPAGE COLLAR - A projecting collar of concrete or other material built around the outside of a tunnel or conduit within an embankment dam, to reduce the seepage potential along the outer surface of the conduit.

APPURTENANCE - Any structure or mechanism other than the dam itself which is associated with the dam's operation.

AS-BUILT DRAWINGS - Plans or drawings portraying the actual dimensions and conditions of a dam, dike, or levee as it was built. Field conditions and material availability during construction often require changes from the original design drawings.

BLANKET DRAIN - A drainage layer of sand or gravel placed directly over the foundation material to allow for the safe release of seepage flow.

BOIL - A disturbance in the surface layer of soil caused by water escaping under pressure from behind a water retaining structure such as a dam or levee. The boil may be accompanied by deposition of soil particles (usually sand) in the form of a conical-shaped mound (miniature "volcano") around the area where the water escapes.

BREACH - A break or opening in a dam which releases impoundment water either deliberately or accidentally.

CHOKE OR CHINK - Placement of stones on the upstream or downstream face (respectively) of a stone masonry or rubble wall.

CONDUIT - A closed channel to convey the discharge through or under a dam, typically a pipe.

CONSTRUCTION JOINT - The interface between two successive placements of concrete where bonding, not permanent separation, is intended.

CONTRACTION JOINT - A joint constructed such that shrinkage of the concrete would cause a crack.

CORE - A zone of material of low permeability, within an embankment, the purpose of which is to reduce the quantity of seepage through the dam.

CORE WALL - A wall of substantial thickness built of impervious materials, usually of concrete or asphaltic concrete, within an embankment to prevent leakage.

CORROSION - The chemical attack on a metal by its environment. Corrosion is a reaction in which metal is oxidized.

CREST - The crown of an overflow section of the dam. In the United States, the term "crest of dam" is often used when "top of dam" is intended. To avoid confusion, the terms crest of spillway and top of dam should be used for referring to the overflow section and dam proper, respectively.

CUTOFF - A relatively impervious barrier of soil, concrete, or steel constructed either to minimize the flow of water through pervious or weathered zones of a dams foundation or to direct flow around such zones. May be a trench filled with impervious material or a wall of impervious material built into the foundation.

DAM - Any barrier which is capable of impounding or controlling the flow of water, including but not limited to stormwater retention or detention dams, flood control structures, dikes and incompletely breached dams.

DRAINAGE LAYER OR BLANKET - A layer of pervious material in a dam to relieve pore pressures or to facilitate drainage of the fill.

DRAINAGE WELL - Vertical wells or boreholes downstream of, or in the downstream berm of, an embankment to collect and control seepage through or under the dam and so reduce water pressure. A line of such wells forms a drainage curtain.

DRAWDOWN - The resultant lowering of water-surface level due to release of water from the reservoir.

DROP INLET SPILLWAY - A spillway consisting of a vertical pipe or conduit in the impoundment connected to a near horizontal pipe which passes through the dam and discharges downstream of the dam.

EMBANKMENT - Fill material, usually earth or rock, placed with sloping sides and usually longer than high.

EMERGENCY SPILLWAY - See Spillway.

ENERGY DISSIPATER - Any device constructed in a waterway to reduce the energy of fast-flowing water.

EROSION - Wear or scouring caused by the abrasive action of moving water.

FACE - The external surface limits of a structure, e.g., the face of a wall or dam.

FAILURE - An incident resulting in the uncontrolled release of water from an operating dam.

FILTER - A bank or zone of granular material that is incorporated in a dam and is graded (either naturally or by selection) to allow seepage to enter the filter without causing the migration of fill material from zones adjacent to the filter.

FLOOD - A general and temporary condition of partial or complete inundation of normally dry land areas.

FLOOD PLAIN - An area adjoining a body of water or natural stream that has been or may be covered by flood water.

FOUNDATION OF DAM - The natural material on which the dam structure is placed.

FREEBOARD - The vertical dimension between the top of the dam at its lowest point and the reservoir water surface elevation.

GRAVITY DAM - A dam constructed of concrete or masonry, which relies on its own weight for stability.

GROIN AREA - The area at the intersection of either the upstream or downstream slope of an embankment and the valley wall or abutment.

GROUT - A thin cement or chemical mortar used to fill voids, fractures, or joints in masonry, rock, sand and gravel, and other materials. As a verb, it refers to filling voids with grout.

GULLY - Rainfall erosion of earthen embankment slopes. Also may be caused in part by vehicular traffic or foot traffic.

HEEL OF DAM - The junction of the upstream face of a gravity dam with the foundation surface. In the case of an embankment dam the junction is referred to as the upstream toe of the dam.

HEIGHT OF DAM - The vertical distance measured from the downstream toe of the dam at its lowest point to the elevation of the top of the dam.

HOMOGENEOUS EARTHFILL - An embankment type construction of more or less uniform earth materials throughout, except for possible inclusion of internal drains or blanket drains. The term is used to differentiate from a zoned earthfill embankment.

INTAKE - Any structure in a reservoir, dam, or river through which water can be drawn from the impoundment or river to a discharge point.

INTERNAL EROSION - See Piping.

INUNDATION MAP - A map delineating the area that would be inundated in the event of a dam failure.

LEAKAGE - Uncontrolled loss of water by flow thorough a hole or crack.

LOW-LEVEL OUTLET - A low-level reservoir outlet, valve and pipe system through the dam generally used for lowering reservoir water level.

MAXIMUM WATER LEVEL - The maximum water level, including the flood surcharge, the dam is designed to withstand.

NORMAL WATER LEVEL (NORMAL POOL)- For a reservoir with a fixed overflow spillway crest, it is the lowest level of that crest.

OBSERVATION WELL - Small-diameter perforated vertical tube installed within an embankment. Used to measure the height of the internal water surface in the embankment at the location of the well.

ONE-HUNDRED YEAR (100-YEAR) RETURN FREQUENCY FLOOD - The flood magnitude with one percent chance of being exceeded in any given year. A 100-year rainfall event is currently said to occur when seven inches of precipitation falls in a 24-hour period.

OUTLET - An opening through which water can be freely discharged from a reservoir to a downstream channel.

OWNER - Any person or entity holding legal title to a dam or water obstruction.

PERMEABILITY - A material property which defines the material's capacity to transmit water.

PERVIOUS ZONE - A part of the cross section of an embankment dam comprising material of high permeability.

PHREATIC SURFACE - The upper surface of seepage in an embankment. All the soil below this surface will be saturated when the steady-state seepage condition has been reached.

PIPING - Progressive erosion and removal of soil by concentrated seepage flows through a dam, dike, or levee, its foundation, or its abutments. As material is eroded, the area of the "pipe" increases and the quantity and velocity of flow increase; these changes in turn result in the erosion of more material. The process continues at a progressively faster rate. Dam failure can result if the piping cannot be brought under control.

RELIEF WELL - See Drainage Well.

RESERVOIR - An impoundment of water created by a dam.

RILL - See Gully.

RIPRAP - A layer of large stone, broken rock, or precast blocks placed in random fashion on the slope of an embankment dam, on a reservoir shore or in a channel as a protection against erosive flows, waves and ice.

SCALING - The peeling away of a concrete surface.

SEEPAGE - The slow percolation of water through a dam, its foundation, or abutment. A small amount of seepage will normally occur in any dam or embankment that retains water.

SEEPAGE COLLAR - A projecting collar, usually of concrete, built around the outside of a pipe, tunnel, or conduit, under an embankment dam, to lengthen the seepage path along the outer surface of the conduit. Sometimes referred to as "anti-seepage collar."

SLIDE - The movement of a mass of earth or tailings down a slope. In embankments and abutments, this involves the separation of a portion of the slope from the surrounding material.

SLOPE PROTECTION - The armoring of the embankment slope against wave action and erosion, usually done by the installation of riprap.

SLOUGH - The separation from the surrounding material and downhill movement of a small portion of an earth slope. Usually this refers to a shallow earth slide.

SPALLING - Breaking (or erosion) of small fragments from the surface of concrete, masonry or stone under the action of weather or erosive forces.

SPILLWAY - A structure over or through a dam by which normal or flood flows are discharged. If the flow is controlled by gates, it is considered a controlled spillway; if the elevation of the spillway crest is the only control, it is considered an uncontrolled spillway. A principal spillway conveys normal flows; an emergency spillway is used to convey more infrequent flood flow.

SPILLWAY CHANNEL - A channel conveying water from the spillway crest to the water course.

SPILLWAY DESIGN FLOOD - The rainfall and run-off event used to design a dam's spillway capacity. The current DEP recommended minimum spillway design is the run off associated with the 100-year return frequency flood with an additional foot of freeboard.

STILLING BASIN - An energy-dissipating device at the outlet of a spillway to dissipate the high velocity (energy) of the flowing water, in order to protect the spillway structure and avoid serious erosion of the outlet channel and subsequent undermining.

STOP LOGS - Large logs, timbers, metal panels or steel beams, placed on top of each other with their ends held in guides on each side of a channel or conduit, to provide means of controlling or stopping the flow of water. Sometimes referred to as weir boards.

STORAGE - The retention of water or delay of runoff either by planned operation, as in a reservoir, or by temporary filling of overflow areas, as in the progression of a flood through a natural stream channel.

TAILWATER LEVEL - The level of water in the discharge channel immediately downstream of the dam.

TOE OF DAM - The base portion of a dam which intersects with natural ground at the downstream side.

TOP OF DAM - The elevation of the uppermost surface of a dam.

TRASHRACK - A device located at the intake of a conduit inlet or waterway to prevent entrance of some floating or submerged debris.

UPLIFT - The upward pressure in the pores of a material or on the base of a structure.

UPSTREAM BLANKET - An impervious layer placed on the reservoir floor upstream of a dam. In the case of an embankment, this blanket may be connected to the impermeable zone of the embankment.

VALVE - A device fitted to a pipeline or orifice to control or stop flow.

WEEP HOLE - A small pipe opening into structures such as concrete abutments, downstream mortared stone wall or concrete aprons to relieve any buildup of water pressure from seepage or groundwater.

WEIR - A type of spillway in which flow is constricted and caused to fall over a crest. Sometimes specially designed weirs are used to measure flow amounts.

ZONED EARTHFILL - An earthfill-type embankment, the cross section of which is composed of zones of selected materials having different degrees of porosity, permeability and density.

DAM INSPECTION CHECKLIST

DAM NAME: _____

OWNER: _____

DAM I.D. No.: _____ **INSPECTOR :** _____

Directions: Mark an "X" in the YES or NO column. If an item does not apply, write "NA." If possible, identify any changes since the last inspection in Section 11 - Other Comments/Observations.

DATE:										
WEATHER:										
TEMPERATURE:										
ITEM	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**	**YES**	**NO**
1. TOP OF DAM										
a. Any visual settlements?										
b. Misalignment?										
c. Cracking?										
2. UPSTREAM SLOPE										
a. Adequate grass cover?										
b. Any erosion?										
c. Are trees growing on slope?										
d. Longitudinal cracks?										
e. Transverse cracks?										
f. Adequate riprap protection?										
g. Any stone deterioration?										
h. Visual depressions or bulges?										
i. Visual settlements?										
j. Debris or trash present?										
3. DOWNSTREAM SLOPE										
a. Adequate grass cover?										
b. Any erosion?										
c. Are trees growing on slope ?										
d. Longitudinal cracks?										

DAM INSPECTION CHECKLIST (Cont.)

DATE:										
ITEM	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
e. Transverse cracks?										
f. Visual depressions or bulges?										
g. Visual settlements?										
h. Is the toe drain dry?										
i. Are the drainage wells flowing?										
j. Are boils present at the toe?										
k. Is seepage present?										
l. Soft or spongy zones present?										
m. Are foundation toe drain pipes:										
(1) Broken, bent, or missing?										
(2) Corroded or rusted?										
(3) Obstructed?										
(4) Is discharge carrying sediment?										
4. ABUTMENT CONTACTS										
a. Any erosion?										
b. Visual differential movement?										
c. Any cracks noted?										
d. Is seepage present?										
5. PRINCIPAL SPILLWAY INLET										
a. Do concrete surfaces show:										
(1) Spalling?										
(2) Cracking?										
(3) Erosion?										
(4) Scaling?										
(5) Exposed rebar?										
b. Do the joints show:										
(1) Displacement or offset?										

DAM INSPECTION CHECKLIST (Cont.)

ITEM / DATE:										
	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
(2) Loss of joint material?										
(3) Leakage?										
c. Metal appurtenances:										
(1) Rust present?										
(2) Broken components?										
(3) Anchor system secure?										
d. Trashrack operational?										
6. PRINCIPAL SPILLWAY CONDUIT										
a. Is the conduit concrete?										
b. Do concrete surfaces show:										
(1) Spalling?										
(2) Cracking?										
(3) Erosion?										
(4) Scaling?										
(5) Exposed rebar?										
c. Do the joints show:										
(1) Displacement or offset?										
(2) Loss of joint material?										
(3) Leakage?										
d. Is the conduit metal?										
(1) Rust present?										
(2) Protective coatings adequate?										
(3) Is the conduit misaligned?										
e. Is there seepage around the conduit?										
7. STILLING BASIN										
a. Do concrete surfaces show:										
(1) Spalling?										

DAM INSPECTION CHECKLIST (Cont.)

ITEM / DATE:										
	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
(2) Cracking?										
(3) Erosion?										
(4) Scaling?										
(5) Exposed rebar?										
b. Do the joints show:										
(1) Displacement or offset?										
(2) Loss of joint material?										
(3) Leakage?										
c. Do energy dissipaters or riprap areas show:										
(1) Signs of deterioration?										
(2) Accumulated debris?										
d. Is the channel:										
(1) Eroding?										
(2) Sloughing?										
(3) Obstructed?										
e. Is discharged water:										
(1) Undercutting the outlet?										
(2) Eroding the embankment?										
8. EMERGENCY SPILLWAY										
a. Does spillway concrete show:										
(1) Spalling?										
(2) Cracking?										
(3) Erosion?										
(4) Scaling?										
(5) Exposed rebar?										
b. Do the joints show:										
(1) Displacement or offset?										

DAM INSPECTION CHECKLIST (Cont.)

DATE:										
ITEM	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO
(2) Loss of joint material?										
(3) Leakage?										
c. Is the spillway in rock or soil? (circle one)										
(1) Are slopes eroding?										
(2) Are slopes sloughing?										
d. Is the discharge channel:										
(1) Eroding or back cutting?										
(2) Obstructed?										
(3) Is vegetative cover adequate?										
e. Has discharged water:										
(1) Eroded the embankment?										
(2) Undercut the outlet?										
f. Is the weir in good condition?										
9. VALVES/GATES										
a. Are the valves/gates:										
(1) Broken or bent?										
(2) Corroded or rusted?										
(3) Periodically maintained?										
(4) Operational?										
b. Is there a low level valve?										
c. Is the low level valve operational?										
10. AREA DOWNSTREAM										
a. Recent downstream development?										
b. Seepage or wetness?										

DAM INSPECTION CHECKLIST (Cont.)

11. OTHER COMMENTS/OBSERVATIONS (Include Date):

DAM INSPECTION CHECKLIST (Cont.)

12. SKETCHES:

DAM INSPECTION CHECKLIST (Cont.)

12. SKETCHES: