Massachusetts Infrastructure Investment Coalition

Infrastructure Status Report: Massachusetts Dams

From the Legacy of the Industrial Revolution to a Future of Global Climate Change

May 2010 Volume 1, Number 1

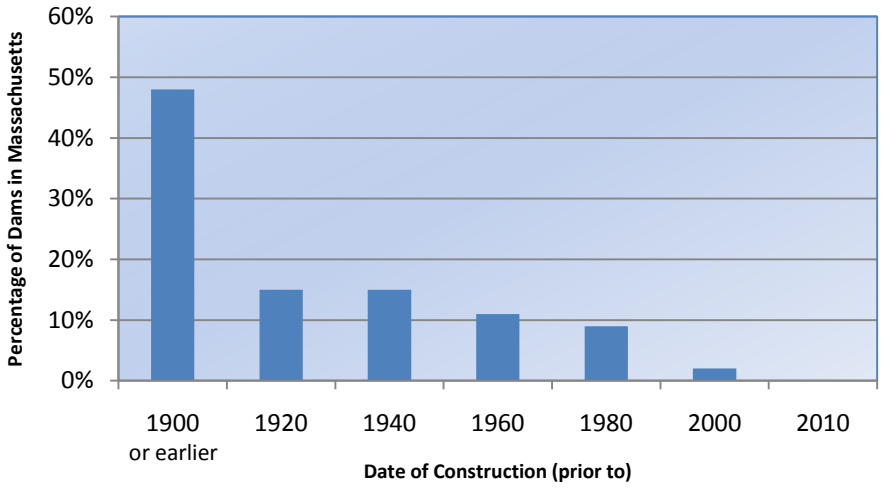
Dam Facts and Terminology:

- ✓ *There are over 2,900 dams in Massachusetts*
- ✓ *Of these, more than 1,680 dams are judged to pose some level of risk to human life and/or public or private property.*
- ✓ *Each owner is responsible for inspecting and maintaining his or her own dam.*
- ✓ *More than 56% of the dams in Massachusetts are privately owned.*
- ✓ *The Commonwealth (primarily the Dept. of Conservation and Recreation) owns and is directly responsible for 387 dams.*
- ✓ *Municipalities own and are responsible for 870 dams.*
- ✓ *The Federal government is only responsible for the small number of structures directly constructed by the US Army Corps of Engineers*
- ✓ *More than 48% of dams in Massachusetts were constructed in 1900 or earlier. Many are relics of the Industrial Revolution, some date to the Colonial era.*
- ✓ *More than a quarter of all jurisdictional dams in Massachusetts are rated as in Poor or Unsafe Condition.*
- ✓ *More than 35 percent of dams owned by the Commonwealth of Massachusetts are rated as in Poor or Unsafe Condition.*

From the massive Quabbin Reservoir to the small mill ponds impounded on virtually every brook and stream in the Commonwealth, the fabric of life in Massachusetts is built around man-made impoundments. There are dams in every city and town of the Commonwealth, from the Cape and Islands to the Berkshires. Some dams are publicly owned but a surprising number are private property. Some are used for water supply, some for hydropower, some provide recreation, and some have outlived their usefulness. But all dams share the common characteristic that they pose a potential threat to downstream life and property if they are not properly designed, constructed, operated, maintained, and monitored. The condition of many of the dams in Massachusetts is Poor or even Unsafe, and the condition of many more will continue to degrade in the coming years if action is not taken to repair and rehabilitate these critical components of the Commonwealth's infrastructure.

Some people view dams in much the same way as they view the pyramids of Egypt, structures from another era which have always been here and always will remain. While dams in Massachusetts are not as ancient as the pyramids, it is true that many are quite old. Of the structures for which there are data, **more than half of the dams in Massachusetts are more than 100 years old** (see **Figure 1**).

Figure 1 -
Distribution of Dams by Date of Construction



But unlike the pyramids, these dams do not exist in the dry warm climate of the desert. The forces of water, ice, rust, and wear all act on our dams… stones move, concrete cracks, soil erodes, wood rots. Dams, like any machine, need a certain level of maintenance. When dams do not receive adequate maintenance, their condition can deteriorate. Even when an owner is diligent, shear age can take its toll.

More than one quarter of the jurisdictional dams in Massachusetts are judged to be in Poor Condition or worse. This includes up to 40 dams which have been determined to be in UNSAFE Condition, of which more than half are of Significant or High Hazard. The failure of many of these dams would result in loss of life and millions of dollars in property damage.

The condition of a dam is determined during an inspection by a Registered Professional Engineer experienced with dam safety issues. The condition rating of the structure is judged based on a number of factors which could affect the ability of the dam to safely impound water and might potentially lead to the failure of the dam. Indicators of potential safety issues at a dam can include the following:

- Cracked Concrete
- Displaced Alignment
- Lost Masonry
- Inoperable Outlets
- Inappropriate Vegetation (inclu
- Cloudy Seepage
- Sloughing Embankment Slopes
- Eroded Soil
- Inadequate Spillway Capacity

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Dam Facts and Terminology:

Dam:

Generically, any artificial barrier, including appurtenant works, which impounds or diverts water.

Condition:

A means of rating the overall state of a dam and its potential risk of failure based upon all aspects of the dam including structural integrity, operational procedures, maintenance, and compliance with design standards. In Massachusetts, dams may be rated as being in one of five condition categories:

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.*

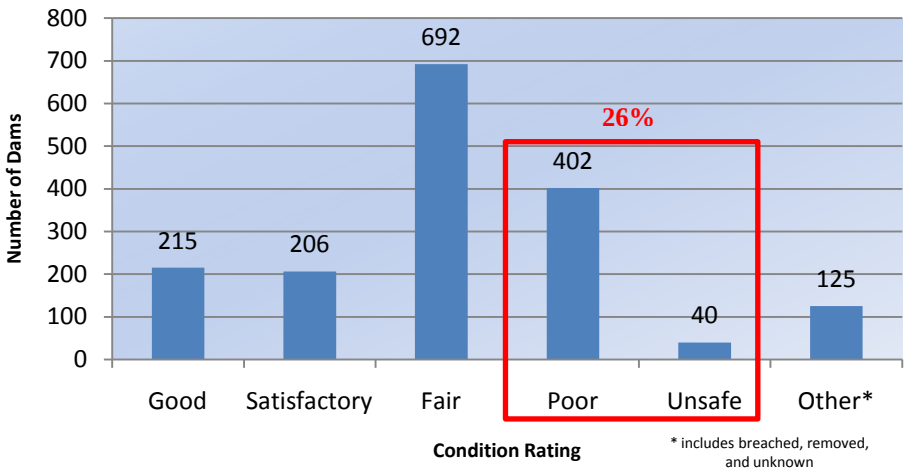
Good: *No existing or potential deficiencies recognized. Safe performance is expected under all loading including SDF.*

All sidebar definitions as per 302 CMR 10.03

Since 2004, every dam owner in the Commonwealth has been responsible for engaging a qualified professional engineer to prepare a Phase 1 dam inspection at the expense of the owner. The inspecting engineer is responsible for assigning one of five potential condition ratings, from Good to Unsafe (see sidebar):

The results of this inspection are then transmitted to the Office of Dam Safety at the Department of Conservation and Recreation (DCR). The Office of Dam Safety is then responsible for ordering additional action when warranted by the condition of the dam and as necessary to protect the public safety. However, it is the dam owner who is responsible for funding and implementing any necessary repairs. **Figure 2** presents data from the Office of Dam Safety regarding the distribution of condition of the jurisdictional dams in Massachusetts.

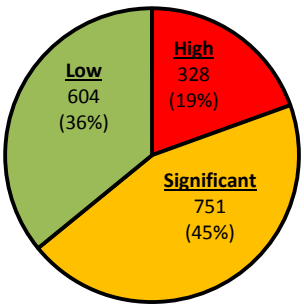
Figure 2 -
Condition Ratings of Jurisdictional Dams



Among the dams directly owned and operated by the Commonwealth of Massachusetts, 109 dams or more than 35 percent are currently in Poor or Unsafe condition.

Dam Hazard Classification is an indicator of the potential risk to downstream life and property which is posed by a dam in the event of a hypothetical failure. The Hazard Classification of a dam is an intrinsic characteristic which is determined by an engineering analysis of the impacts of downstream flooding which would result from the sudden breach of the dam. Hazard classification is independent of the condition of the dam. Hazard creep occurs as development encroaches into the downstream floodplain and more structures and people are put at risk. **Figure 3** shows the distribution of Hazard Classifications of the dams in the Massachusetts inventory. This represents a total of 1,683 structures. There are also an additional 1,226 dams in Massachusetts which are considered "Non-Jurisdictional" due to size or other factors.

Figure 3
Distribution of Dams by Hazard Classification



Non-Jurisdictional Dams:

Any appurtenant works which temporarily impound or divert water used on agricultural lands (as defined by M.G.L. c. 131, § 40) and/or Any barrier or appurtenant works which is small sized or low hazard and is used on agricultural lands and/or any barrier which is not in excess of six feet in height, regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of 15 acre feet, regardless of height.

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Dam Facts and Terminology:

***Hazard Potential Classification**:*

The rating for a dam based on the potential consequences of failure. The rating is based on potential for loss of life and damage to property that failure of that dam could cause downstream of the dam. The hazard potential classification for a dam also is based on the incremental adverse consequences of failure, and has no relationship to the current structural integrity, operational status, flood routing capability, or safety condition of the dam or its appurtenances.

***High (Class I):** 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 (Class II):** 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 (Class III):** Dams located where failure may cause minimal property damage to others. Loss of life is not expected.*

Size:

The size classification system for dams is based on the height of the dam and storage capacity of a dam. In Massachusetts, jurisdictional dams fall into one of three size categories:

***Small:** Structure with a height between 6 and 15 feet and a storage capacity of 15 to 50 acre-feet.*

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

***Large:** Structure with a height greater than 40 feet or a storage capacity greater than 1,000 acre-feet.*

The Size of a dam is determined based on its height or the amount of water stored in the impoundment. While not directly related to Hazard, it is clear that a larger dam is more likely to generate a more intense flood were it to fail. **Figure 4** shows the distribution of the Size classifications of Massachusetts dams.

It is sometimes assumed that the government owns all dams. This is far from the case. Over 56% of all dams in Massachusetts are privately owned, by corporations or even private citizens. These private owners have the same responsibilities for the care, monitoring, and upkeep as do government owners, but often with significantly less resources available to them. Another 30% of dams are owned by cities, towns, water districts, etc. Even for governmental agencies, the cost of repairing a dam, which is often in the millions of dollars, can be a hardship. **Figure 5** shows the distribution of the ownership of all 2,909 Massachusetts dams.

One very specific issue which must be addressed at many dams is the capability of the dams to survive extreme flood events. All dams must have a spillway of sufficient size to safely pass flood flows through or around the dam structure. A recent analysis of the inventory of dams managed by the Department of Conservation and Recreation indicated that almost half of the Commonwealth's dams have spillways which are incapable of accommodating even 50% of the appropriate spillway design flood. The problem will grow worse as global climate change leads to more extreme weather events and floods increase in both size and frequency.

Figure 4
Distribution of Dams by Size Classification

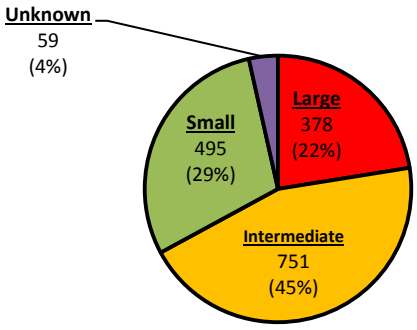
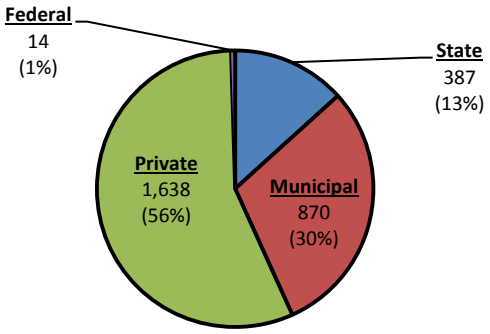


Figure 5
Distribution of Dams by Owner Type



Without dams, our state and local governments could not provide some of the most basic services which the citizens of the Massachusetts rely on every day… water supply, fire protection, flood protection. The impoundments created by dams also serve important functions in providing recreational benefits, protecting habitat, and enhancing property values. Some dams serve to generate hydroelectricity, a clean source of domestic renewable power. While hydropower generation is not feasible at all dams, the US Secretary of Energy has estimated that, nationwide, an additional 70,000 megawatts of electrical power could be generated simply by retrofitting hydropower at many of the country's existing dams.

Of course, some dams no longer serve a useful purpose and may even have negative impacts on the environment. In such cases, dam removal is a viable option for both eliminating potential public safety threats and restoring important habitat. Dam removal is an important option when considering how to address safety deficiencies at a dam, but even this option comes at a cost. Experience has shown that removing even a small dam can cost $250,000 or more. And ironically, obtaining the environmental permits for removing a dam can be a long and expensive process due to the need to address concerns about flooding, loss of wetland and aquatic habitat, sediment quality, abutter impacts, and other issues.

We have the knowledge and skills to maintain and improve this important part of the Commonwealth's critical infrastructure. The work of rehabilitating and improving Massachusetts' dams can be done by Massachusetts engineers and Massachusetts contractors for the benefit of the people of Massachusetts. But like all such work, adequate funding is required. State government can play an important role in this effort in two ways: 1) by allocating appropriate funds for operating, maintaining, and repairing its own dams; and 2) by making grants and/or low interest loans available to municipal and private dam owners to help rehabilitate or remove their structures. Working together, we can preserve the historic legacy of our dams, provide for our current needs, and ensure a safe future for all the people of the Commonwealth.

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The **Massachusetts Infrastructure Investment Coalition** is identifying the long-term needs for infrastructure investments to support economic development and improve the quality of life for the citizens of Massachusetts. The Dams Status Report was prepared to provide information about the investment requirements for Massachusetts dam facilities and collection systems. The coalition is currently preparing status reports for other infrastructure elements including: **Aviation, Bridges, Dams, Drinking Water, Energy, Government Facilities, Hazardous Waste, Homeland Security, Housing, Navigable Waterways, Ports and Harbors, Roadways, Schools, Transit (Rapid/Bus/Commuter Rail), Telecommunications and Wastewater.** These reports are available at www.engineers.org/resources/news.htm.

Infrastructure Investment Coalition

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Aviation – Bridges – Dams – Drinking Water – Energy – Government Buildings - Hazardous Waste – Homeland Security – Housing - Navigable Waterways – Ports and Harbors – Railroads (Freight) – Roadways - Schools – Transit (Rapid/Bus/Commuter Rail) – Telecommunications - Wastewater

The Massachusetts Infrastructure Investment Coalition is supported by:

- A Better City
- American Planning Association/Massachusetts Chapter
- American Council of Engineering Companies of Massachusetts
  - American Public Works Association of New England
- Associated Builders and Contractors of Massachusetts
- Associated General Contractors of Massachusetts
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