DAMS

C-

There are a total of 3,358 state-regulated dams in Pennsylvania, including 768 high hazard potential dams (23 percent); 297 significant hazard potential dams (9 percent); and 2,293 low hazard potential dams (68 percent). High hazard potential dams are those whose failure would cause probable loss of human life and substantial property damage. Of the 776 high hazard potential dams in Pennsylvania, 518 (67 percent) are considered as "deficient." A "deficient" dam is any dam where the existing condition of the dam has been rated as less than satisfactory, a portion of which have deficiencies that if not corrected could result in the failure of the dam with subsequent loss of life or substantial property damage. The estimated cost to repair all Pennsylvania dams projected to be found deficient over the next five years is more than $1.4 billion. Due to the establishment of the Pennsylvania Department of Environmental Protection's (PADEP's) Dam Safety Program in the late 1970s and recent updates to the program in 2011, Pennsylvania has remained ahead of most states in dam safety. Pennsylvania's dam safety program, in terms of funding, staffing and efficacy, generally ranks well above national averages. For Pennsylvania dams, a grade of C- reflects the positive benefits of Pennsylvania's dam safety program, balanced against the high number of dams in need of repair, the $1.4 billion needed for repair and rehabilitation of deficient high hazard potential dams, and the significant threat a dam failure would pose to public health, safety and property, the environment and to local, county and state economies.

BACKGROUND

Compared to other parts of the U.S., Pennsylvania has ample surface water resources. Man-made reservoirs exist throughout the Commonwealth and provide substantial benefits to the public including: water supply, irrigation and industrial uses, flood control, hydroelectric power, fire protection, recreation, and navigation. However, Pennsylvania's dams are aging and deteriorating while downstream populations are increasing. The dams that impound these reservoirs represent a significant risk to public safety, local and regional economies and the environment if they are not well managed and maintained. This situation demands greater attention to and investment in measures that reduce risks to public safety and economic assets.

Historically, some of the worst disasters in the U.S. have resulted from dam failures. In 1889, more than 2,200 lives were lost when the South Fork Dam above Johnstown, Pennsylvania failed. During the 1970s, the failures of the Buffalo Creek Dam in West Virginia, Teton Dam in Idaho, and the Toccoa Falls Dam in Georgia resulted in a combined loss of 175 lives and more than $1 billion in damages.

These 1970s dam failures spurred the federal government into action and led to the enactment of PL 92-367 the National Dam Inspection Act of 1972. In 1978, the U.S. Army Corps of Engineers (USACE) began the national dam inspection program. In

1979, federal guidelines for dam safety were prepared and published by the Federal Emergency Management Agency (FEMA 93, 1979).

After the National Dam Inspection Program inspections were completed, Pennsylvania's Dam Safety Program (DSP) moved forward quickly, making $100 million in funding available for repairs through low-interest loans from the Water Facilities Loan Board and its successor, the Pennsylvania Infrastructure Investment Authority (PENNVEST), with an additional $140 million for upgrades financed by other sources. As a result, Pennsylvania's DSP made significant progress earlier than most states. However, the absence of a dam rehabilitation grant or loan program for dams other than those for public water supply limited the pace at which Pennsylvania's Dam Safety Division could address dam safety issues through the 1980s and early 1990s.

One of the underlying national problems at this time was that Pennsylvania did not have an established group with regulatory authority or experience on dam safety issues. To address this problem, Pennsylvania enacted the Dam Safety and Encroachments Act in 1978. The Department of Environmental Resources (DER), which was the predecessor to the Pennsylvania Department of Environmental Protection (PADEP), established the Bureau of Dams and Waterway Management (now known as the Bureau of Waterways Engineering and Wetlands) shortly thereafter. The Bureau operates one of the few state-level comprehensive flood protection programs in the U.S. and has an active dam removal program with approximately 25 dams removed per year. Dams are removed for a variety of reasons, including ecological, social and economic. Many dams no longer serve the function for which they were constructed. On average, it costs 3 to 5 times more to repair a dam than to remove it.

Pennsylvania Dam Safety regulations were significantly updated in 2011. A majority of the changes clarified existing regulations to reflect policy under which the program had been operating for many years. This assisted owners and engineers in understanding the regulations. The 2011 regulations provide four hazard potential categories, as opposed to three under the previous regulation. A requirement to provide financial responsibility (bond) for all existing hazard potential category 1 and 2 dams (high hazard potential and significant hazard potential) was added. Clarification of activities that constitute a dam permit action or an amendment to an existing permit was added. Additional details regarding structural stability requirements were added, specifically citing minimum acceptable factors of safety for relevant loading conditions. Incremental dam breach analysis was established as the preferred method to determine the acceptable spillway design flood for dams. Details for construction oversight, completion documentation, and reservoir filling/refilling rates were added. Outlet works requirements, including sizing and location of controls, were revised. Emergency Action Planning (EAP) criteria and details were revised and strengthened to better address revisions and plan updates. EAP updates are required every five years for Category 1 and 2 dams.

The federal government provided some assistance with program improvements through the National Dam Safety Act of 1996. This act was re-authorized as the National Dam

Safety and Security Act of 2002, and subsequently as the National Dam Safety Program Act in 2006. This provided funding through grants ranging from $6.5 million in 2007 to $9.2 million in 2011, for distribution among state dam safety programs. The Act expired in 2012 however, it is included in the Water Resources Reform & Development Act of 2013 (WRRDA) that is currently working its way through Congress. This funding would not available for dam repairs or upgrades. The National Dam Repair and Rehabilitation Act was introduced in both the House and Senate in previous legislative sessions and, if passed, would have provided grant funding to public dam owners.

CONDITIONS

There are a total of 3,358 state-regulated dams in Pennsylvania: including 768 high hazard potential dams (23 percent); 297 significant hazard potential dams (9 percent); and 2,293 low hazard potential dams (68 percent). Dam hazard rating refers strictly to the potential for downstream flooding and not the condition of the dam. High hazard potential dams are those whose failure would cause probable loss of human life and substantial property damage. Significant hazard potential dams are those whose failure would result in no probable loss of human life but can cause economic loss. Of the 768 high hazard potential dams in Pennsylvania, 518 (67 percent) are considered as "deficient". This represents a 41 percent increase in the number of deficient dams in Pennsylvania since 2010, when 367 were identified as deficient. This dramatic increase in the number of deficient dams in Pennsylvania is largely due to the inclusion of dams with poor maintenance, as well as reclassification of existing dams from a lower hazard potential classification to a high hazard potential classification due to an increase in the Population at Risk (PAR) resulting from population encroachment, updates to Pennsylvania's dam safety criteria, and increased inspection efforts by state dam safety officials. A "deficient" dam is defined as any dam where the existing condition of the dam has been rated as less than satisfactory, a portion of which have deficiencies that if not corrected could result in the partial or complete failure of the dam or any appurtenant structure or facility with subsequent loss of life or substantial property damage. Pennsylvania is continually finding new dams and reclassifying others as downstream conditions and development change.

While the estimated repair costs can vary significantly based upon a number of factors, estimated average repair costs can often range from $1.5 million to $4 million per dam. The total estimated cost for upgrading Pennsylvania's 518 deficient high hazard potential dams could likely exceed $1.4 billion. In addition, many of the structures that were upgraded in the early to mid-1980s may soon reach a point where additional upgrades and/or repairs are necessary to meet current state dam safety standards.

The National Inventory of Dams (NID) is a database which documents dams in the U.S. and its territories. The NID includes all high and significant hazard potential classification dams and all low hazard potential dams that meet specific height and reservoir storage requirements. The current NID, published in 2013, includes data on 87,359 U.S. dams. State Dam Safety Offices regulate 77 percent of the dams listed in

the NID. Pennsylvania currently has 1,552 dams included in the NID database, a summary of Pennsylvania dams included in the NID are as follows:

Hazard Potential	No. of Dams	Percentage of Total
High	819	53
Significant	342	22
Low	388	25
Undetermined	3	<1

Dams by Height	No. of Dams	Percentage of Total
<25 ft	837	55
26-50 ft	458	30
51-100 ft	175	11
>100 ft	68	4

Dams by Owner Type	No. of Dams	Percentage of Total
Privately Owned	959	62
Local Government	355	23
State Owned	155	10
Federal Owned	69	4
Public Utilities	14	<1

Primary Purpose	No. of Dams	Percentage of Total
Recreation	800	51
Water Supply	243	15
Flood Control	217	14
Other	87	6
Tailings	57	4
Fire Protection	43	3
Irrigation	29	2
Hydroelectric	23	2
Navigation	17	1
Fish and Wildlife	16	1
Unknown	13	<1
Debris Control	7	<1

Dam Type	No. of Dams	Percentage of Total
Earth	1353	87
Concrete	49	3

Gravity	47	3
Stone	34	2
Rockfill	25	2
Masonry	11	1
Timber Crib	10	1
Other	10	1
Unknown	6	<1
RCC	5	<1
Arch	1	<1
Buttress	1	<1

In Pennsylvania, approximately 48 percent of dams are greater than 50 years old and approximately 14 percent are greater than 100 years old.

With its early start on the investigation and rehabilitation of its seriously deficient dams, Pennsylvania remains ahead of most other states in terms of condition of dams statewide. A large number of Pennsylvania's high hazard dams have been upgraded to the current dam safety criteria. Pennsylvania ranks second nationally, behind only California, in terms of annual funding for dam safety—approximately $2.5 million in 2012. Pennsylvania ranks third nationally, behind only California and Texas, in terms of the number of full-time employees in their dam safety program with 27, including 8 full-time dam safety inspectors. Pennsylvania compares very favorably with the national average in terms of the number of regulated dams per full-time dam safety employee with 118 dams per full-time employee in Pennsylvania versus the national average of 192 dams per full time employee. Pennsylvania also compares favorably with the national average of regulated high hazard potential dams per full-time dam safety employee, each with about 28 high hazard potential dams per full-time dam safety employee.

Pennsylvania ranks well above the national average in terms of funding per state regulated dam with $735 per state regulated dam versus the national average of $518 per state regulated dam. However, it ranks below the national average in terms of funding per state regulated high hazard potential dam with approximately $3,200 per state regulated high hazard potential dam versus the national average of approximately $3,900 per state regulated high hazard potential dam.

Pennsylvania ranks well above the national average with approximately 91 percent of its high hazard potential dams having an Emergency Action Plan (EAP) compared to a national average of approximately 74 percent. Pennsylvania also ranks above the national average with approximately 54 percent of Pennsylvania's significant hazard potential dams having an Emergency Action Plan (EAP), compared to a national average of approximately 45 percent. An Emergency Action Plan is a formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize loss of life and property damage.

For these reasons, Pennsylvania dams have an assigned a grade C- for the condition of its dams. The grade for Pennsylvania's dams reflects in large part, the efficacy of its commitment to dam safety, including its recent (2011) updates to Pennsylvania's Dam Safety regulations, as well as the successful execution of its dam safety program. Despite the fact that Pennsylvania operates a model dam safety program, a grade of only a C- was assigned because there is still a great deal of dam safety work that remains to be done in the Commonwealth. Pennsylvania is one of the top ten states in the nation with the number of state regulated high hazard potential dams in need of repair. Regrettably, the number of dams identified as deficient is increasing at a faster rate than those being repaired.

POLICY OPTIONS

The main issue preventing the PADEP Division of Dam Safety from achieving its goals and many owners from improving their dams is a lack of funding for dam rehabilitation projects. In 2012, the Association of State Dam Safety Officials (ASDSO) estimates that approximately $54 billion is needed to rehabilitate dams across the nation, based on the current national inventory of non-federally owned dams. This statistic highlights the need for a national dam rehabilitation program, a goal that is the driving force behind the formation of the Dam Safety Coalition. This coalition is comprised of a number of national associations and agencies, including ASCE, ASDSO, the National Society of Professional Engineers, the National Watershed Coalition, and the U.S. Society on Dams. The Dam Safety Coalition supports the creation of a federal funding program to repair the nation's unsafe dams, addressing the critical issue of deteriorating dam structures that pose a severe threat to many communities throughout the country.

In addition to federal funding, the H2O PA Act was passed in 2008, establishing funding of up to $800 million for water infrastructure projects, including a minimum of $50 million for unsafe, high hazard potential dams and a minimum of $75 million for flood control projects of which a portion has been used to repair flood control dams. To date, approximately $90 million has been awarded for rehabilitation or removal of 24 of these dams.

RECOMMENDATIONS

The four Pennsylvania sections of ASCE recommend that the following measures be taken to promote dam safety within Pennsylvania:

- Passage of state legislation to provide additional funding for rehabilitation of Pennsylvania dams, which will be needed for leverage of any federal funding programs that may be enacted, and low-interest loans for private dam owners;

- Passage of the Dam Rehabilitation and Repair Act which was introduced in 2012 in the 112th Congress (2011-2013) but was not enacted. The Act would establish a program to provide grant assistance to states for the repair,

rehabilitation and maintenance of non-federal publicly-owned, non-Federal, high-hazard potential deficient dams; and

- Re-authorization and full funding of the National Dam Safety Program Act (P.L. 109-460).

SOURCES

- American Society of Civil Engineers (ASCE) Central PA, Lehigh Valley, Philadelphia, Pittsburgh, *2010 Report Card for Pennsylvania's Infrastructure*: May 2010. Available at: http://www.pareportcard.org/
- American Society of Civil Engineers (ASCE), *2013 Report Card for American's Infrastructure*: March 25, 2013. Available at: http://www.infrastructurereportcard.org/
- Association of State Dam Safety Officials (ASDSO), *State and Federal Oversight of Dam Safety Must Be Improved,* news media document, November 2008.
- Northeast Region Council for Safe Dams, Funding for Dam Rehabilitation – *Pennsylvania Dams Needs Statement.*
- Pennsylvania Department of Environmental Protection (PADEP), *Dam Safety and Encroachments Act* (1978).
- Pennsylvania Department of Environmental Protection (PADEP), *H2O PA Act* as it relates to Dam Rehabilitation Projects (July 2008).
- Pennsylvania Department of Environmental Protection (PADEP), *The Inspection, Maintenance and Operation of Dams in Pennsylvania* (1999).

ASCE POLICY STATEMENTS

- ASCE Policy Statement 470: *Dam Repair and Rehabilitation (PS 470)*
- ASCE Policy Statement 280: *Responsibility for Dam Safety (PS 280)*