



Ohio Department of Natural Resources  
**Division of Soil and Water Resources**  
**Fact Sheet**

Fact Sheet 95-37

## Dam Safety: Probable Maximum Flood

Uncontrolled flood waters are one of the most powerful and destructive forces in nature. Dams that are not designed to withstand major storms may be destroyed by them, increasing flood damage downstream. This damage is too often catastrophic. In order to protect lives and property downstream, the Ohio Administrative Code requires that dams be constructed to safely handle an appropriate percentage of the Probable Maximum Flood (PMF). This percentage varies according to the height of the dam, size of the impoundment, and extent and severity of damage possible upon failure. The requirements established in Ohio are similar to those used in other states, and historical records of significant storms and dam failures this century verify that the design criteria are reasonable.

### Definitions

The Probable Maximum Precipitation (PMP) is the greatest depth (amount) of precipitation, for a given storm duration, that is theoretically possible for a particular area and geographic location.

The Probable Maximum Flood (PMF) is the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in a particular drainage area.

### Historical Storms in Ohio and Dam Failures

Storms which have caused severe flooding and included precipitation amounts that reached a significant percentage of the PMP have occurred in Ohio this century. Flood waters from these storms caused the failure of dams and other structures. Many dam failures are considered disasters because they cause great harm, damage, or serious and sudden misfortune. Because of the rapid and unexpected manner in which dam failures can occur, they are judged to be as serious as earthquakes and tornadoes.

A storm approaching two thirds of the PMP struck north-central Ohio in the summer of 1969. Some small areas within the region were inundated with 14 inches of rain in 12 hours. Three large dams and many small farm-pond dams failed. Almost all the failures were caused by water overtopping the dams.

In 1990, severe flash floods destroyed eighty residences near the town of Shadyside in southeast Ohio. Twenty six people died. In this instance, the amount of precipitation did not constitute a high percentage of the PMP, yet the flood waters which resulted were deep and powerful.

The potential for damage due to dam failures is increasing along with the increase of residential and commercial development downstream of dams. In many cases, existing dams will need to be modified to keep downstream areas safe from disaster.

### Notable U.S. Dam Failures

Year	Name	Location	Deaths	Damage
1972	Buffalo Creek Dam	West Virginia	125	\$400 million
1972	Canyon Lake Dam	South Dakota	139	\$60 million
1976	Teton Dam	Idaho	11	\$400 million
1977	Taccoa Falls Dam	Georgia	39	\$30 million
1982	Lawn Lake Dam	Colorado	3	\$21 million
2006	Kaloko Dam	Hawaii	7	?
2008	Kingston Ash Impoundment	Tennessee	0	\$975 million

### Classification of Ohio Dams

Dams in Ohio are divided into four classes based on the storage volume of the impoundment, dam height and potential downstream hazard (how far downstream the residences are, etc.). These criteria were chosen because they affect the extent and severity of downstream damage possible upon failure. The percentage of the PMF that a dam must be designed to withstand depends upon its classification. Dams that could cause loss of human life if they fail must be designed to handle 100 percent of the PMF. More details about the classification system can be found in the Ohio Administrative Code and Fact Sheet No. 94-29.

### Development of the PMP

Scientists use both meteorological methods and historical records to determine the greatest amount of precipitation which is theoretically possible within a region. The historical data consists of point precipitation amounts measured at rain gages throughout the region being studied, or a region with very similar meteorologic and topographic characteristics. These rainfall data are subsequently maximized through "moisture maximization" and other numerical methods. Moisture maximization

*Continued on back!*

is a process in which the maximum possible atmospheric moisture for a region is applied to rainfall data from a historic storm. This process increases the rainfall depths, bringing them closer to their potential maximum.

Probable maximum precipitation amounts vary slightly throughout Ohio because of variations in topography and meteorology. The PMP is greatest in the southern portion of the state. Furthermore, not all storms have the same duration. Using the methods mentioned above, the PMP has been determined for different storm periods, generally ranging from six to seventy two hours.

**Development of the PMF**

The Probable Maximum Flood is the flood which is a direct result of the Probable Maximum Precipitation. However, drainage areas with the same PMP may have different PMFs. This is possible because the amount of flooding which results from a given rainfall amount depends upon the characteristics of the drainage basin.

For this reason, the PMF, not the PMP, must be used as a design criterion for a dam. Some important characteristics include soil type, land use, size and shape of the watershed, and average watershed slope. Both the volume and rate of runoff are affected. For example, water will run off of steep slopes more quickly than gentle ones. More water will infiltrate sandy soils than clay.

Any other questions, comments concerns, or fact sheet requests, should be directed to:

Ohio Department of Natural Resources  
 Division of Soil and Water Resources  
 Dam Safety Engineering Program  
 2045 Morse Road  
 Columbus, Ohio 43229-6693  
 Voice: (614) 265-6731 Fax: (614) 447-9503  
 E-mail: dswc@dnr.state.oh.us  
 Website: <http://ohiodnr.gov/soilandwater>  
**Emergency 24hr hotline: 614-799-9538**

**All-season Probable Maximum Precipitation (in inches) for 6-hour duration, 10-square mile area.**



*Adapted from HMR-51, National Weather Service, 1978.*

