

FLOODS

THE AWESOME POWER

NATIONAL WEATHER SERVICE



U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
NOAA's National Weather Service
May 2010

NOAA/PA 200467



FEMA

FLOODS

THE AWESOME POWER

"Water is the life blood of this planet. Virtually every business has a water imperative: Manufacturing, agriculture, and energy production rely on a steady supply of water. And yet, it is floods and droughts that cause more U.S. societal losses than any other type of severe weather natural disaster. Floods claim nearly 100 lives each year, exceeding any other severe weather phenomenon. The average annual flood damages exceeds \$7 billion. Flood fighting and mitigation can cost hundreds of millions per event."

— Jack Hayes, NOAA Assistant Administrator for Weather Services

Why Should I Be Concerned About Flooding?

This preparedness guide explains flood-related hazards and suggests lifesaving actions you can take. With this information you can recognize a flood potential, develop a plan, and be ready when threatening weather approaches. Remember... your safety is up to YOU!

In the long term, floods kill more people in the United States than other types of severe weather. In recent years, only heat related fatalities surpassed flood fatalities. Floods can roll boulders the size of cars, tear out trees, destroy buildings and bridges, and pose a significant threat to human lives.

Online Resources

Additional flash flood/flood-related safety information can be obtained at:

American Red Cross
<http://www.redcross.org/>

Federal Emergency Management Agency
<http://www.fema.gov/>

U.S. Geological Survey
<http://www.usgs.gov/>

National Weather Service
<http://www.nws.noaa.gov/>

Photo: Jim Rackwitz, St. Louis Post-Dispatch ▶
River flooding due to excessive rain.



Photo: Steve Allen Photography ▶
River flooding due to ice jam.



What Are Flash Floods?

A flash flood is a rapid rise of water along a stream or low-lying urban area. Flash flood damage and most fatalities tend to occur in areas immediately adjacent to a stream or arroyo, due to a combination of heavy rain, dam break, levee failure, rapid snowmelt, and ice jams. Additionally, heavy rain falling on steep terrain can weaken soil and cause debris flow, damaging homes, roads, and property.

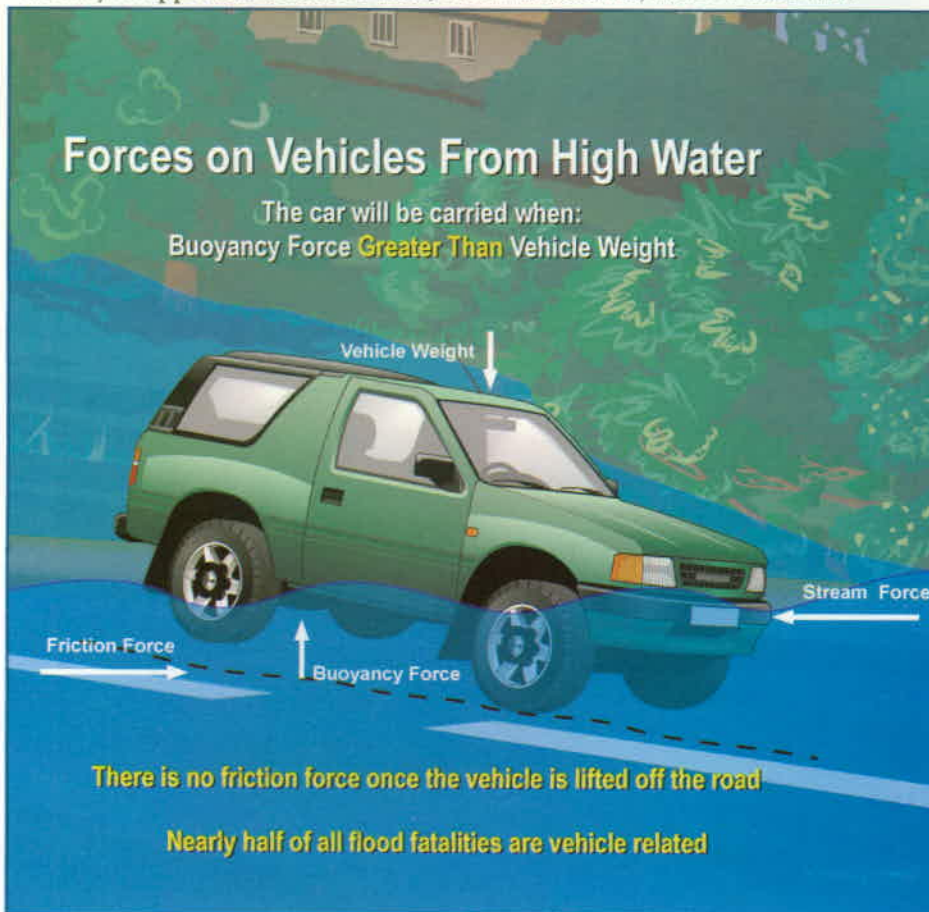
Flash floods can be produced when slow moving or multiple thunderstorms occur over the same area. When storms move faster, flash flooding is less likely since less rain accumulates over a particular area.

Flash Flood Risk in Your Car, Truck, or Sport Utility Vehicle (SUV)

Nearly half of all flood fatalities occur in vehicles. Most motorists can lose control of their vehicle in as little as six inches of moving water. Vehicles can be swept away in 18-24 inches of water.

Water can erode the road bed, creating unsafe driving conditions. Underpasses can fill rapidly with water, while the adjacent roadway remains clear. Many flash floods occur at night when flooded roads are difficult to see.

When you approach a flooded road, **TURN AROUND, DON'T DROWN!**



Warning Sign



This Federal Highway Administration compliant Warning Sign should be permanently deployed at locations where the incident of flooding is high, the onset of flooding is rapid, and/or where flooding occurs in isolated locations. For details on producing this FHWA sign, go to:

<http://mutcd.fhwa.dot.gov/SHSm/warning.pdf>
Select W8-13 for template of Warning Sign.

Incident Sign



This Federal Highway Administration compliant Incident Sign should be temporarily deployed by emergency personnel on an as needed, event driven basis. For details on producing this FHWA sign, go to:

<http://mutcd.fhwa.dot.gov/SHSm/warning.pdf>
Select W11-12 for template of Incident Sign.

FLOODS

THE AWESOME POWER

LISTEN FOR ROARING SOUND UPSTREAM AS FLOOD WATERS COULD BE HEADED YOUR WAY!

LOOK FOR RAPIDLY RISING WATER AND/OR WATER TURNING MUDDY!

REMEMBER TO CLIMB TO SAFETY IF YOU HEAR OR SEE SIGNS OF A FLOOD!



Photo: Steve Allen Photography, ▶

Waitsfield, VT

Road damage as a result of flash flooding.

Where You Are Determines Your Flash Flood/Flood Risk

Rainfall over mountains and steep hills produce rapid runoff and quick stream response. Rocks and clay soils do not allow much water to infiltrate the ground. Steep narrow valleys generate rapid flowing waters that can rise quickly to a considerable depth. Saturated soil also can lead rapidly to flash flooding.

Very intense rainfall can produce flooding even on dry soil. In the West, most canyons and "small streams" are not easily recognizable as a source of danger. Canyons can be scoured with sudden walls of water 10-15 feet high (e.g., Antelope Canyon, Arizona, August 1997, 11 fatalities).

Additionally, high risk locations include low water crossings, recent burn areas in mountains, and urban areas from pavement and roofs which concentrate rainfall runoff.

Flash Flood Risks at Home, Work, or School

Since many flash floods occur along small streams, you can determine your risk by knowing your proximity to streams. Flooding can be caused by rain falling several miles upstream and then moving downstream rapidly.

Densely populated areas have a high risk for flash floods. The construction of buildings, highways, driveways, and parking lots increases runoff by reducing the amount of rain absorbed by the ground. This runoff increases the flash flood potential. Sometimes, streams through cities and towns are routed underground into storm drains. During periods of heavy rainfall, storm drains may become overwhelmed and flood roads and buildings. Low spots, such as underpasses, underground parking garages, and basements can become death traps.

Embankments, known as levees, are built along rivers and are used to prevent high water from flooding bordering land. In 1993, many levees failed along the Mississippi River, resulting in devastating flash floods.

Dam failures have played a deadly role in the history of flash flooding. The United States has about 76,000 dams, and about 80 percent of those are of earthfill construction. Be aware of any dams upstream of your location. Earthen dams are more easily compromised by heavy rainfall than are concrete structures. Water flowing over an earthen dam can cause the dam to weaken or fail, sending a destructive wall of water downstream.

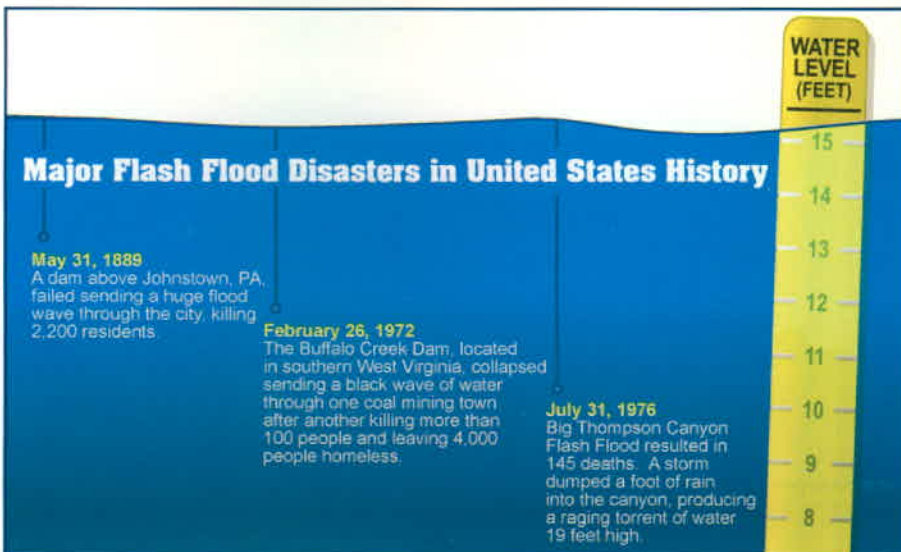
Flash Flood Risk to Recreation (Camping, Hiking, Boating, Fishing)

Many people enjoy hiking, fishing, or camping along streams and rivers. Listen to weather forecasts and keep away from streams if thunderstorms have happened or have been predicted upstream from where you are. A creek only 6 inches deep in mountainous areas can swell to a 10-foot deep raging river in less than an hour if a thunderstorm inundates the area with intense rainfall.

When thunderstorms are in the area, stay alert for rapidly changing conditions. You may notice the stream start to rise quickly and become muddy. You may hear a roaring sound upstream that may be a flood wave moving rapidly toward you. Head immediately for higher ground. Don't be swept away by the rising water. There are dangers associated with fast-moving water, but with common sense and some preparation, outdoor enthusiasts can enjoy a safe day along a stream or river.



◀ Photo Credit: Distinctive AFWS Designs, Inc. Upper Marlboro, MD



◀ Source: National Weather Service

FLOODS

THE AWESOME POWER

PERSISTENT THUNDERSTORMS OVER THE SAME GEOGRAPHICAL AREA CAN LEAD TO RIVER FLOODING.

What Are River Floods?

A flood is the inundation of a normally dry area caused by an increased water level in an established river. River flooding is often caused by:

- Excessive rain from tropical systems making landfall.
- Persistent thunderstorms over the same geographical area for extended periods of time.
- Combined rainfall and snowmelt.
- Ice jam.

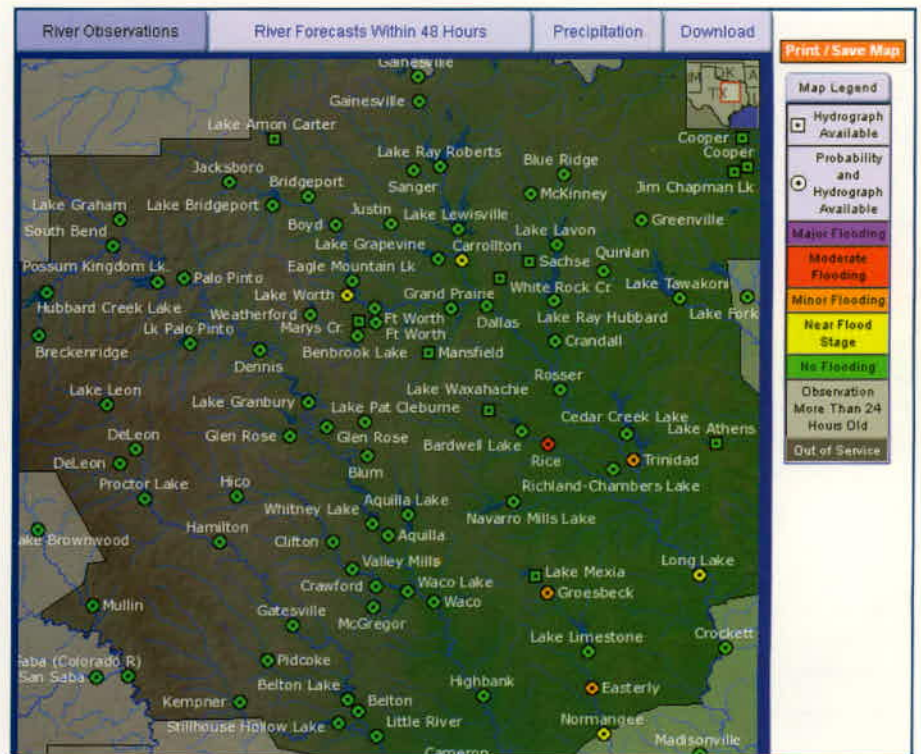
Graphical depiction of NWS **Severity Categories.**

Flood Severity Category

Minor Flooding – minimal or no property damage, but possibly some public threat.

Moderate Flooding – some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations.

Major Flooding – extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.



Flood Severity Category

Once a river reaches flood stage, the flood severity categories used by the National Weather Service include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat.

The impacts of floods vary locally. For each of the more than 4,000 NWS river forecast locations across the country, flood levels associated with each of the NWS flood severity categories are established in cooperation with local public officials. Increasing river levels above flood stage constitute minor, moderate, and major flooding. Impacts vary from one river location to another because a certain river stage (height) above flood stage in one location may have an entirely different impact than the same level above flood stage at another location.

FLOODS ARE LONG TERM
EVENTS AND MAY LAST
DAYS, WEEKS, OR LONGER!

Tropical Cyclones and their Remnants

Floods are often produced by hurricanes, tropical storms, and tropical depressions. A tropical cyclone's worst impact may be the inland flooding associated with torrential rains.

When these storms move inland, they are typically accompanied by very heavy rain. If the decaying storms move slowly over land, they can produce rainfall amounts of 20 to 40 inches over several days. Widespread flash flooding and river flooding can result from these slow-moving storms.

A hurricane also can produce a deadly storm surge that inundates coastal areas as it makes landfall. Storm surge is water pushed on shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the average water level 15 feet or more.

Hurricane Katrina was an extraordinarily powerful and deadly hurricane that carved a wide swath of catastrophic damage and inflicted large loss of life. It was the costliest and one of the five deadliest hurricanes to ever strike the United States. Known fatalities resulting from rainfall inland flooding, storm surge, and other severe weather approached 2,000 people.



▲ Photo: Harris County Flood Control District, Houston, Texas

Major flooding from Tropical Storm Allison in Houston, Texas, June 2001.

“Some of the Nations worst floods occur as a result of heavy rainfall from tropical cyclones well after landfall.”

Bill Read – National Hurricane Center Director

1994 Hurricane Gordon 1,122 deaths in Puerto Rico Primarily a tropical storm, Gordon produced heavy rain. U.S. property damage was \$400 million.	1999 Hurricane Floyd 56 deaths Floyd brought intense rains and record flooding to the eastern United States. Of the 56 people who perished, 50 drowned from inland flooding. Damages exceeded \$6 billion.	2001 Tropical Storm Allison 44 deaths Allison flooded the coastal sections from Texas to New England. More than 3 feet of rain was reported along the Gulf Coast. Damages exceeded \$5 billion	2008 Hurricane Ike 47 deaths Ike caused damage from Texas to the Great Lakes. More than two million homes and businesses lost power. Damages exceeded \$24 billion.
--	---	---	--



FLOODS

THE AWESOME POWER

Stay Informed



"The NOAA Weather Radio All Hazards (NWR) is a nationwide network of radio stations broadcasting NOAA's NWS forecasts, weather warnings and watches, as well as other emergency information 24 hours a day from the nearest National Weather Service office.

The Advanced Hydrologic Prediction Service (AHPS)

The NWS Service provides a gateway of improved river flood forecasting and water information through the Advanced Hydrologic Prediction Service (AHPS). This information assists users, including community leaders and emergency managers, in making life savings and cost savings decisions about evacuating people and moving property before a flood occurs.

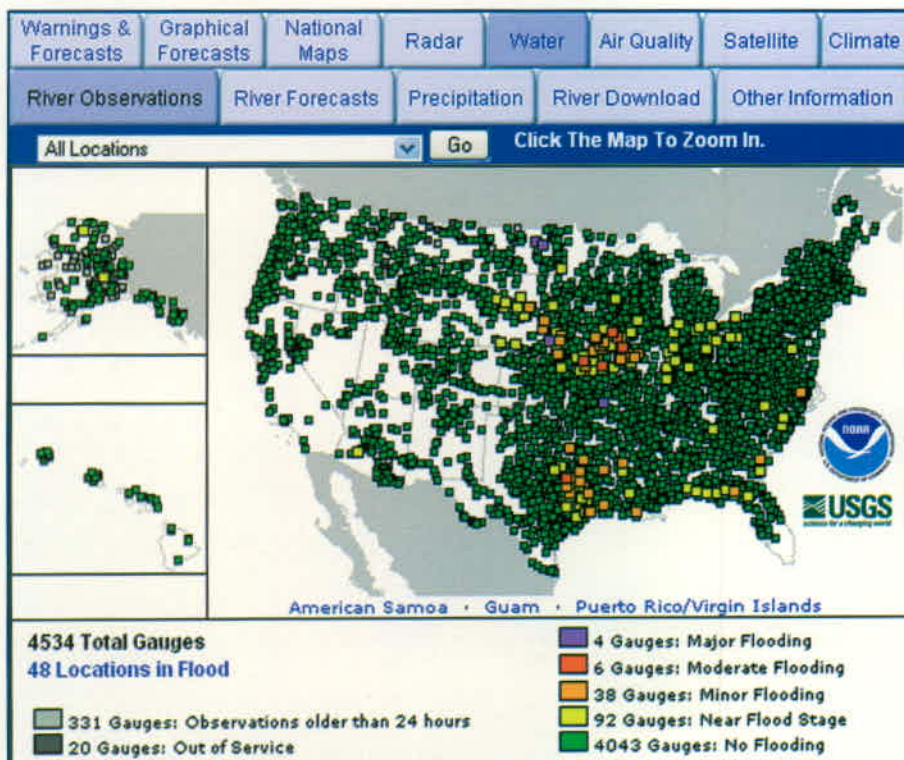
Major themes:

- Short-term through long-term forecasts (from minutes to months including probabilistic products for risk management decisions).
- Real-time flood forecast maps depicting a real extent of flooding.
- More timely and accurate flash flood warnings through the use of enhanced flash flood decision assistance tools.

According to the National Hydrologic Warning Council report, "Use and Benefits of the National Weather Service River and Flood Forecasts," through AHPS, once fully implemented throughout the United States, will provide more than \$750 million in economic benefits each year.

Additional information can be obtained at: water.weather.gov

► Source: National Weather Service
AHPS Weather Display

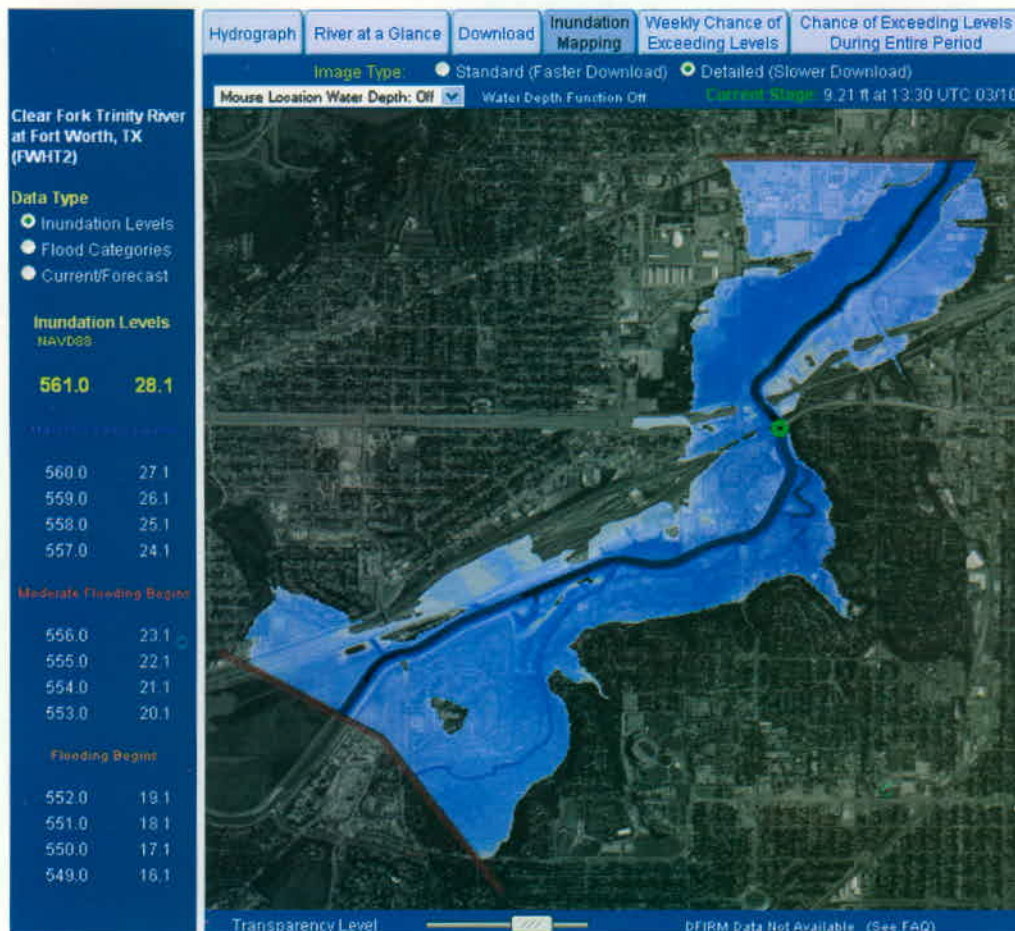


Flood status at all NWS forecast locations.

Flood Inundation Mapping Decision Support Tool

The NWS AHPS provides an on-line capability for the development of flood forecast inundation maps to help community decision-makers better plan for flooding and take measures to reduce flood losses. Flood forecast mapping provides a comprehensive view of the extent of flooding, the depths of flood waters, and the potential areas impacted by forecast flooding. This capability, in combination with the NWS river forecast, allows emergency managers to foresee the communities and infrastructures subject to flooding. It provides an understanding of how long flooding could inundate community resources. Emergency managers can also download flood forecast maps into their Geographic Information System to further enhance local flood operational plans. This tool was designed to assist emergency officials to make effective decisions to evacuate people, strategically pre-position resources, and relocate capital assets, thereby resulting in savings of life and property. In working with community leaders, this capability will be expanded across the Nation.

Examples of operational flood forecast maps can be accessed via water.weather.gov. To see if there are flood forecast inundation maps for your community, scroll to the bottom of the web page to "inundation mapping locations".



FLOODS

THE AWESOME POWER



TO HELP AMERICA PREPARE FOR THE RAVAGES OF FLASH FLOODS AND FLOODS, THE NATIONAL WEATHER SERVICE HAS DESIGNED STORMREADY, TO ARM AMERICA'S COMMUNITIES WITH THE COMMUNICATION AND SAFETY SKILLS NECESSARY TO SAVE LIVES AND PROPERTY.

MORE INFORMATION IS AVAILABLE AT:
WWW.NWS.NOAA.GOV/STORMREADY

What My Community Can Do

- Provide river and rainfall readings to emergency managers and the National Weather Service.
- Establish early warning procedures.
- Create and operate a Local Flood Warning System to identify areas vulnerable to flooding.
- Produce and follow the flood emergency plans.

Contact your local emergency management agency or local National Weather Service office for further information on Local Flood Warning Systems, or visit:

nws.noaa.gov/oh/docs/alfws-handbook

Photo: FEMA, ▶

StormReady®

StormReady® is a nationwide preparedness program that uses a grassroots approach to help communities develop the planning and communications infrastructure to handle all types of severe weather - from tornadoes to floods. StormReady® is a NWS partnership with Emergency Management that provides clear-cut guidelines on how to improve their communities' hazardous weather operations. Please visit the StormReady® web page at: www.stormready.noaa.gov.

National Flood Insurance Program

Since standard homeowners insurance doesn't cover flooding, it's important to have protection from the floods associated with hurricanes, tropical storms, heavy rains and other conditions that impact the U.S.

In 1968, Congress created the National Flood Insurance Program (NFIP) to help provide a means for property owners to financially protect themselves. The NFIP offers flood insurance to homeowners, renters, and business owners if their community participates in the NFIP. Participating communities agree to adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding.

To find out more about the NFIP, visit FloodSmart.gov. Call 1-888-435-6637 to find an agent in your area.



Streamgage Data Saves Lives

NWS forecasters rely on a network of almost 10,000 streamgages to monitor the height of rivers and streams across the Nation. This information provides present river conditions and is the initial information needed to develop a river forecast. Most of the streamgages are maintained by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the Department of Agriculture. Some streamgages are read manually by dedicated volunteer observers. If you would like to volunteer as a cooperative observer, visit the web site at: www.nws.noaa.gov/om/coop/become.htm

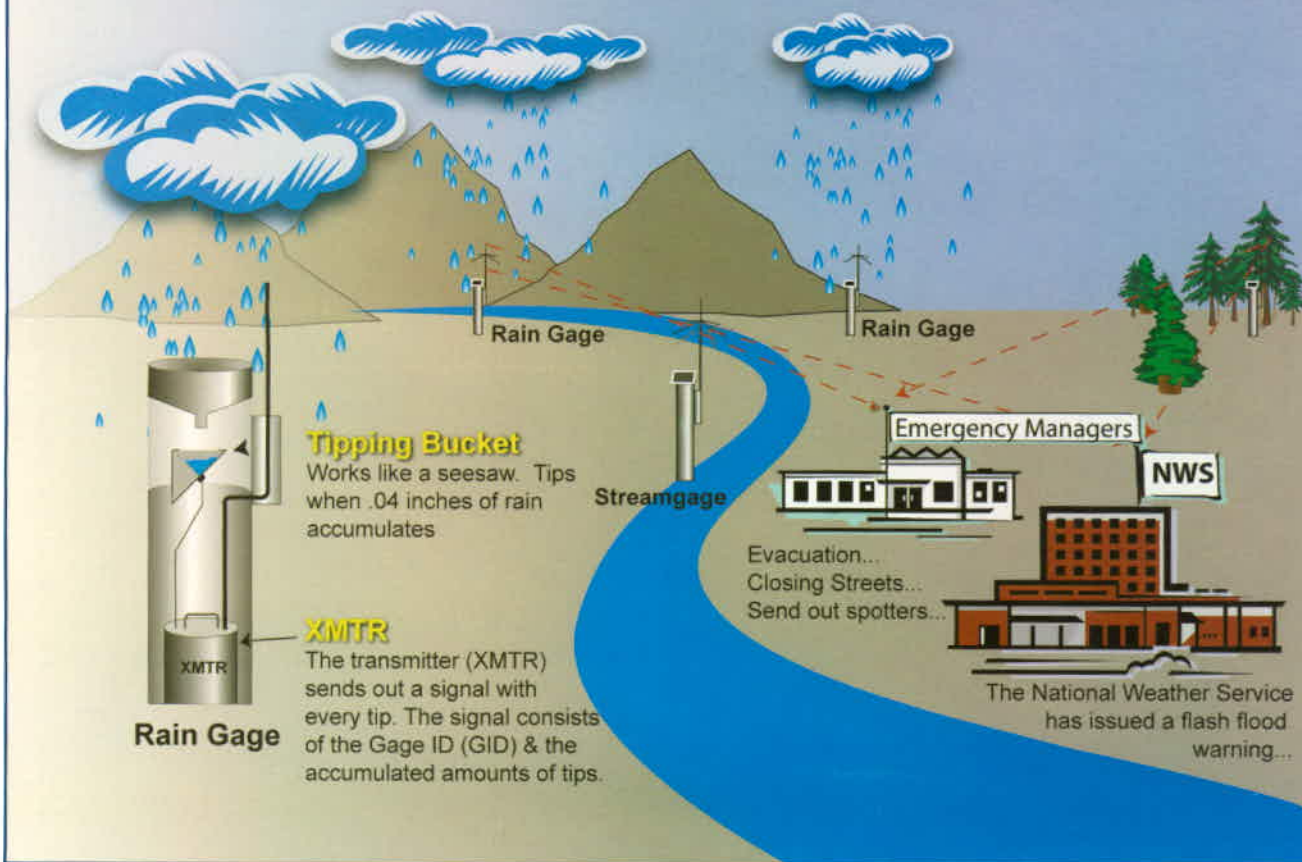
Local Flood Warning Systems

The hydrology program manager at your local NWS office offers expert help in setting up a Local Flood Warning System, including assisting in establishing rainfall and river stage alarm thresholds and enhancing warning plans. Besides providing community leaders with helpful information, the data from a LFWS can also benefit issuance of flood and flash flood warnings. Nonprofit organizations, like the National Hydrologic Warning Council (www.hydrologicwarning.org), are dedicated to helping community officials become aware of ways to improve their operations through the use of real-time flood warning systems.

NATIONAL WEATHER SERVICE FORECASTERS
RELY ON A NETWORK OF ALMOST 10,000
STREAMGAGES TO MONITOR THE HEIGHT OF
RIVERS AND STREAMS ACROSS THE NATION

Local Flood Warning System

Gages collect rain and river data that is transmitted to NWS and Emergency Managers



FLOODS

THE AWESOME POWER



What You Can Do Before the Flood...

When you receive a Flood Watch:

- A Watch is issued when flooding is possible within the watch area. When a flood watch is issued, you should be aware of potential flood hazards. Everyone in a Watch area should be ready to respond and act quickly.
- Have an evacuation plan in place BEFORE flooding occurs. Flooded roads may cut off your escape route. Head for higher ground before the water becomes too deep. Remember—just six inches of rapidly flowing water can knock you off your feet. For information on how or what to do if you are advised to evacuate, visit the American Red Cross web page at: www.redcross.org
- Know your flood risk and the elevation above which flooding occurs. Do streams or rivers near you flood easily? If so, be prepared to move to a safe place. Know your evacuation routes.
- Find out if you are located in a high, medium, or low flood risk area. Check with your city or county government to find out if your community is participating in the National Flood Insurance Program. Start with the Building or Planning Department to review the Flood Insurance Rate Maps, published by the Federal Emergency Management Agency..
- Discuss flood plans with your family. Everyone should know what to do in case all family members are not together. Discussing flood plans ahead of time helps reduce fear and anxiety and lets everyone know how to respond.
- Determine if the roads you normally travel to reach your home or job will be flooded during a storm. If so, look for alternative routes to use during flooding.
- Keep a NOAA Weather Radio All Hazards, a battery-powered portable radio, emergency cooking equipment, and flashlights in working order with extra batteries.
- Have a professional install check-valves in plumbing to prevent flood waters from backing up into the drains of your home.
- Keep your automobile fueled; if electric power is cut off, gas stations may not be able to operate pumps for days.
- Store drinking water in food-grade containers. Water service may be interrupted.
- Keep a stock of food requiring little cooking and no refrigeration; electric power may be interrupted.
- Keep first-aid supplies and prescription medicines on hand.

What You Can Do During the Flood...

When you receive a Flood Warning:

- If advised to evacuate, do so immediately! Families should use only one vehicle to avoid getting separated and reduce traffic jams. Move to a safe area before access is cut off by flood water. Continue listening to NOAA Weather Radio All Hazards, radio or television for information concerning the flooding.
- Don't drive if you don't have to.
- Never try to walk, swim, drive, or play in flood water. You may not be able to see how fast the flood water is moving or see holes or submerged debris.
- Do not camp or park your vehicle along streams and washes, particularly during threatening conditions.
- Be especially cautious at night when it is harder to recognize flood dangers.
- Do not attempt to drive through a flooded road. The depth of water is not always obvious. The road bed may be washed out under the water, and you could be stranded or trapped.
- Do not drive around a barricade. Barricades are there for your protection. Turn around and go another way!
- Children should NEVER play around high water, storm drains, viaducts, or arroyos. It is very easy to be swept away by fast-moving water.
- If you come upon a flowing stream where water is above your ankles, STOP! Turn around and go another way. Climb to higher ground. If it is moving swiftly, even water six inches deep can knock you off your feet. Many people are swept away wading through flood waters, resulting in injury or death.



▲ Photo: Federal Emergency Management Agency

What You Can Do After the Flood...

- Get necessary medical care at the nearest hospital. The American Red Cross can help by providing shelters, food, water, and first aid, as well as helping you meet your immediate disaster-caused needs.
- Do not visit disaster areas. Your presence might hamper rescue and other emergency operations.
- If the power is out, use flashlights, not candles.
- Use flashlights, not lanterns, torches, or matches, to examine buildings. Flammables may be inside.
- Report broken utility lines to appropriate authorities.
- Boil drinking water before using. Wells should be pumped out and the water tested for purity before drinking. If in doubt, call your local public health authority.
- If fresh or canned food has come in contact with flood waters, throw it out.
- Take steps to reduce your risk of future floods. Make sure to follow local building codes and ordinances when rebuilding, and use flood-resistant materials and techniques to protect yourself and your property from future flood damage.

FLOODS

THE AWESOME POWER

DO NOT VISIT DISASTER AREAS FOLLOWING A FLOOD. YOUR PRESENCE MAY HAMPER URGENT EMERGENCY RESPONSE AND RESCUE OPERATIONS.

Myth OR Fact

MYTH

Tornadoes kill more people each year than any other severe weather event.

MYTH

Flash floods mainly occur in the eastern United States.

MYTH

Flash floods occur only along flowing streams.

MYTH

Flash floods occur mainly in the late afternoon and evening.

MYTH

Homeowners insurance policies cover flooding.

MYTH

You can't buy flood insurance if your property has been flooded.

MYTH

Larger vehicles, such as SUVs and pickups, are safe to drive through flood waters.

FACT

Generally, each year, more deaths occur due to flooding than from any other severe weather related hazard.

FACT

Flash floods occur in all 50 states, including Alaska and Hawaii.

FACT

Flash floods can occur in dry arroyos and urban areas where no streams are present.

FACT

Many flash floods occur at night.

FACT

Unfortunately, many homeowners do not find out until it is too late that their policies do not cover flooding. Contact your insurance company or agent to buy flood insurance.

FACT

You are still eligible to purchase flood insurance after your home, apartment, or business has been flooded, provided your community is participating in the National Flood Insurance Program.

FACT

Two feet of flowing water can carry away most vehicles including SUVs and pickups.

Do You Have a Family Disaster Plan?

I. Gather Information About Hazards

Contact your local NWS office, emergency management office, and American Red Cross chapter. Find out what types of disasters could occur and what you should do. Learn about your community's methods of warning people and evacuation plans. Ask your insurance agent about flood insurance. Find out what you can do to protect your home from the effects of natural hazards that could occur where you live. Meet with your family to create a plan.

Discuss the information you have gathered. Pick two places to meet: a spot outside your home for an emergency such as a fire, and a place away from your neighborhood in case you can't return home. Choose an out-of-town family member or friend as your family check-in contact for everyone to call if the family gets separated, and a backup out-of-neighborhood friend in case the first one does not answer. Discuss what you would do and how to do it if advised to evacuate.

II. Implement Your Plan

- Post emergency telephone numbers by phones and in address lists each person carries with them. Include cell phone numbers of family and contact-points.
- Install safety features in your home, such as smoke alarms and fire extinguishers.
- Inspect your home for potential hazards such as items that can move, fall, break, or catch fire, and correct them.
- Make physical changes that will make your home less vulnerable; install check-valves and hurricane shutters; strap the hot water heater to wall studs.
- Have your family learn basic safety skills such as CPR/Automated External Defibrillator (AED) and first aid; how to use a fire extinguisher; and how and when to turn off water, gas, and electricity at the main switches and valves. Know how to operate a NOAA Weather Radio All Hazards.
- Teach children how and when to call 9-1-1 or your local Emergency Medical Services number.
- Keep emergency supplies in your home sufficient for three days to a week, if your area has ever lost basic water, electricity and gas service for a week or longer. Assemble a disaster supplies kit with things you will need if you have to evacuate. Store these supplies in sturdy, easy-to-carry containers such as backpacks or duffel bags.
- Keep important family documents in a waterproof and fire-resistant container.
- Keep a smaller emergency kit with seasonal supplies, tools, and clothes in the trunk of your car.
- Each person who has a cell phone should carry it and keep it turned on to receive calls in any emergency situation.

III. Prepare a Disaster Supplies Kit to Include:

- At least a 3-day water supply (one gallon per person per day)
- Food that won't spoil
- One change of clothing and footwear per person
- One blanket or sleeping bag per person
- First aid kit
- Prescription medicines
- Emergency tools
- Battery-powered NOAA Weather Radio All Hazards
- Portable radio
- Flashlight with extra batteries
- Extra set of car keys
- Cash and credit card
- Special items for infant, elderly, and disabled family members
- Map of local area

Community Preparedness Plans

After you have developed a personal/family safety plan, find out about your community safety plan. Each community prone to a flash flood/flood should develop a safety plan. Local officials should have detailed information for your immediate area. Please listen and follow their recommendations before, during, and after a storm.

The best way to prevent loss of life is to design and build communities where roads remain usable and undamaged during floods, and where homes and businesses are protected. While this may not always be possible, it is a goal we hope every community strives to reach.

Protect yourself, your home, your family, and your financial future.



ARC 4493
NOAA/PA 200467