

# FLOOD WARNING SYSTEM DOES YOUR COMMUNITY NEED ONE ?

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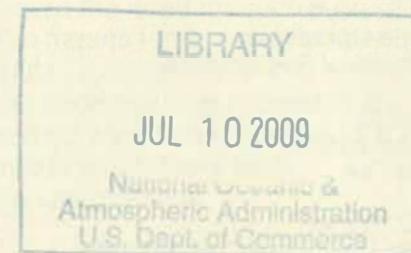
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# the concept

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The basic concept of a local flood warning program is simple. Rainfall amounts or stream levels upstream of an area are measured and the information is used to predict whether a flood is about to occur, when it will arrive, and how severe it will be. Organizations and individuals are then warned so that they can protect themselves and their property. The basic parts of a flood warning program are:

1. The warning system, consisting of the equipment, people, and procedures for recognizing an impending flood and disseminating warnings;
2. A prepared plan of actions to be taken before and during the flood; and
3. Arrangements for maintenance and updating of equipment and plans.

The several parts must, of course, be tailored to the community's circumstances. Several hundred cities and counties in the United States already have such systems.

Local flood warning programs can work extremely well. Those now in use have been credited with saving scores of lives and preventing millions of dollars of damage. They are most valuable where flooding occurs very quickly following heavy rains. Local flood warning systems also have been credited with preventing unnecessary evacuations and other over-reactions in cases when floods threatened but did not occur.

The cost of a local flood warning program depends largely on the type of equipment used in the warning system. Some excellent systems now in use cost communities relatively little to set up and maintain. The most effective warning systems usually involve a cooperative effort of local officials and the National Weather Service.

Thousands of communities in the United States which are threatened by floods still lack the elementary protection of a flood warning program despite the relatively low cost for their development and the simplicity of their operation. The most frequently encountered reason for their absence is local officials' lack of information about the need for such a program and the means for its establishment. In particular, local officials who are unfamiliar with flood warning programs are often concerned about their cost and the potential for liabilities from erroneous forecasts.

These concerns are not generally shared by community officials who are experienced in operation of flood warning systems. Their concerns focus instead on the need for wider participation in the program to maximize the benefits obtained.

This pamphlet provides basic information on establishing of local flood warning programs. More detailed information is available from the nearest office of the National Weather Service.

*"Several lives would have  
definitely been lost if there had  
been no warning."*

*City of Cooburn*

*"There was enough time to  
warn people and . . . conse-  
quently, not a single life was  
lost."*

*City of Appalachia*

## **safety**

*"People were evacuated  
earlier with far less danger,  
and many homeowners were  
able to move [furnishings] out  
of harm's way."*

*Susquehanna River Basin  
Commission*

*"As a result [of warning], there  
was no life loss even though  
the flood was a disastrous  
one."*

*Big Stone Gap*

# why are local flood warning programs needed?

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About 25,000 locations in the United States have documented flood problems. The National Weather Service presently makes specific forecasts of floods at about 2,200 locations. The detailed information on rainfall and streamflow which is needed to forecast floods at many of the remaining locations is not available. As a result, such areas can only be given generalized forecasts in the form of flash flood watches and warnings, small stream flood statements, or urban flood statements. Because of this, communities face the problem of deciding whether to assume a flood will occur and react accordingly or ignore the warning and risk being caught unprepared. The first course of action leads to frequent over-reaction and the second courts disaster. In addition, flash floods may occur so quickly that effective action requires almost immediate local recognition and response to the threat.

While relying on the regular National Weather Service program for generalized information, communities can reduce the risk by establishing a local flood warning program. Timely collection of more detailed information on local rainfall and/or stream levels allows more accurate and reliable predictions of floods for small watersheds by either the National Weather Service or some local agency. Prediction of floods locally, either by a National Weather Service office in the area or by a community agency, reduces problems with communications and usually enables more frequent updating of predictions.

Advance knowledge about an impending flood can be used in a variety of ways to improve safety. Some of the more common actions taken include:

- Warning low-lying areas to evacuate;
- Scheduling closure of schools and transportation of students;
- Curtailing electric and gas service to prevent fire and explosions;

- Providing evacuation assistance to invalids, convalescents and others requiring help;
- Establishing traffic controls to facilitate evacuation and prevent inadvertent travel into hazardous areas;
- Dispersing fire and rescue services for continued protection.

When enough time is made available by a local flood warning system, it can also often be put to use in a number of ways to reduce property damage. Common actions of this type include:

- Moving public vehicles and equipment from low areas;
- Relocating or stacking contents of private structures;
- Shutting down motors and pumps to prevent damage;
- Initiating flood fighting efforts; and
- Establishing security to prevent looting.

*"... all of the merchants who had made the effort [to respond to warnings] had saved almost 100 percent of their stock."*

*Ellicott City Business Association*

*"People were able to save a large amount of personal property ..."*

*Big Stone Gap*

# reduced private losses

*"... tremendously productive as a means of reducing flood damages ..."*

*U.S. Bureau of Reclamation,  
Chachuma Dam Operations*

*"As a result [of warnings], there were millions of dollars of savings."*

*City of Coeburn*

*"Savings due to the system are up to untold millions."*

*New Braunfels City Manager*

# who should consider a local flood warning program?

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Consideration should be given to establishment of a flood warning program by any community that:

- Has experienced a flood;
- Is enrolled in the National Flood Insurance Program;
- Is protected from flooding by a levee, floodwall, or a reservoir; or
- Is located near a stream other than a major river.

Assistance in evaluating the flood hazard is available from the Corps of Engineers, National Weather Service, Soil Conservation Service and U.S. Geological Survey. Assistance in evaluating the usefulness of a flood warning program in dealing with the hazard is available from the National Weather Service. This involves no cost or commitment of any type from the community.

*"Estimated cost savings was \$7,000-8,000 [at a water pumping plant]. More importantly . . . they could put the plant back into operation faster."*

*Susquehanna River Basin  
Commission*

*"The reduction of safety problems and property damages also reduce the public costs for cleanup, rescue, decontamination of water mains and other items."*

*Howard County Civil Defense Office*

*"At least \$25,000 in negative costs were saved on a recent weekend by not overreacting to a potential flooding situation."*

*Wise County Civil Defense Office*

## **reduced public costs**

*"For a flood like the one in 1977, the warning system saves \$200,000-300,000 of public property losses."*

*City of Appalachia*

*". . . the opportunity to move city equipment before a flood would result in a reduction of damages of about 1 million."*

*New Braunfels Civil Defense Agency*



# creating a local flood warning system

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All components of a local flood warning program are important. However, delays and confusion in developing such programs usually center on the equipment, people, and procedures for recognizing an impending flood and disseminating warnings. The effectiveness with which these components come together to make up the flood warning program is vital to the success of the overall program.

The flood warning system can be divided into three main parts for:

a) collecting the basic information on rainfall and/or stream levels; b) making the flood predictions; and c) disseminating the warnings.

*Collecting Information* The simplest and least expensive way to collect rainfall and stream level information is using volunteers who take readings with inexpensive equipment and telephone or radio the information to some central location. A more expensive way which has some special advantages is use of sophisticated gages which can report automatically by either telephone or radio. A variety of equipment for both sorts of systems are available. The use of

the more expensive automated equipment may be necessary where observers are lacking or to improve the timeliness of warnings. This is especially true in rugged terrain.

Large amounts of data are not always necessary. For small streams with few tributaries, one or two rainfall observers suitably situated in the watershed or knowledge of upstream water levels at one point may be all that is required. Accurate forecasting for larger streams may require information from many points, depending on the number and size of tributaries.

*Making Flood Predictions* Most local flood warning systems use a table or chart for making the flood prediction. The table or chart relates flood stages at the forecast point to either average rainfall over the upstream area or water depth at some upstream point. Preparing the prediction only requires looking at the table or chart and reading the appropriate value. Some systems provide predictions in terms of the number of feet above flood stage while others result in a qualitative prediction of slight, moderate or severe flooding. When the flood crest will occur

can also be determined from the basic information.

Such simple systems are surprisingly accurate when adequate data are available. The necessary charts or tables are usually developed without charge by the National Weather Service. The agency will provide training in their use.

*Disseminating Warnings* Warnings must be delivered with a high degree of reliability to be effective. Radio and television have the obvious drawback of not reaching many people in the late night and early morning hours. For this reason, local flood warning systems usually depend on the use of civil defense sirens and the use of sirens and public address systems on fire and police vehicles to warn the public. The principal steps in developing the procedure for warning dissemination are: a) deciding what areas are to be warned at each stage of predicted flooding; and b) assigning responsibility for carrying out the warning. If desired, the basic procedure can be supplemented by arrangements to provide very early alerts to local officials, emergency services agencies, schools, hospitals and others needing additional time for preparation.

*"... very reliable ..."*

*City of Lompoc*

*"System accuracy has proved  
excellent."*

*Santa Barbara Flood Control and  
Water Conservation District*

# **accuracy & reliability**

*"Experience with the warning  
system has shown it to be so  
reliable and accurate that it  
can be depended on totally."*

*City of Coeburn*

*"Accuracy of the system is on  
the button."*

*Dauphin County Civil Defense*

# examples of local flood warning systems

The several hundred local flood warning programs in operation around the country vary widely in the details of their operation, their cost and what they provide.

Some basic programs are built around a single flash flood alarm which only serves

to alert local officials that an upstream rise in stream level has occurred. Others incorporate flood prediction systems so sophisticated that they also serve as tools for water management in complex river basins.

The five flood warning systems briefly described in the following table illustrate the diversity possible in approaches to warning.

Location	Technique for Prediction	Equipment	Original Cost to Local Governments	Annual Cost to Local Governments	Approximate Warning Time Provided	Accuracy of Predictions	Date System Installed
Wise County, Virginia	Use rainfall to predict flood levels. Use river gages to confirm predictions.	15 rain gages and 8 river gages read by volunteers.	\$1,000	\$100	4 hr.	"within inches"	1971
Swatara Creek, Pennsylvania	Use rainfall to predict flood level at one upstream point. Use crest-stage relationship to predict flood levels for lower points.	6 rain gages read by volunteers and 10 river gages (for system calibration).	—0—	—0—	from 2-3 hrs. at upper end to 10-15 hrs. at lower end of Creeka	2 feet	1976
Howard County, Maryland	Use flash flood alarms to alert system. Use crest-stage relationships to predict flood levels. Use precipitation information to determine if water levels will continue to rise.	4 flash flood alarms, 20 river gages, and 9 precipitation gages.	\$6,000 <sup>2</sup>	\$5,224 <sup>2</sup>	6-8 hr. fora Ellicott Citya	½ foot	1975
New Braunfels, Texas	Use rainfall to predict flood levels.	10 rain gages.	\$100	\$250	½ hr.	2 feet	1972
Santa Ynez Watershed, California	Use computerized rainfall-runoff model plus information on reservoir releases to predict flows.	10 automatic rain gages, 3 reservoir level gages, 10 gages on reservoir gates, 1 river gage, and 2 computers.	Approximately \$35,000	\$1,000	8-12 hrs.a	"excellent"	1969

<sup>1</sup>As reported by operators of the warning system. Accuracy customarily improves with experience in system operation. Degrees of accuracy implied are not to be expected in newly established systems.

<sup>2</sup>Costs for purchase of 2 flash flood alarms and operation of 4 flash flood alarms. Remaining two flash flood alarms were donated by NWS.

Warning systems  
of local flood  
examples

*"... the investment is returned  
a thousand fold."*

*Santa Barbara Flood Control and  
Water Conservation District*

# investment of public funds

*"Hundreds of thousands of  
dollars can be saved for a few  
pennies ..."*

*City of Appalachia*

*"... a return of 1,000 times  
over is no exaggeration."*

*New Braunfels Civil Defense Agency*

*"... any community with a  
flood problem should find the  
money somewhere and put in  
a warning system."*

*New Braunfels Fire Department*

# costs for local flood warning systems

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Local flood warning systems based on rainfall reports from volunteer observers involve practically no costs for the sponsoring communities. Necessary equipment and training is usually furnished by the National Weather Service. The major local requirements are to involve volunteer observers and appoint a local coordinator to collect the rainfall reports and issue the flood predictions. If few people live in the area from which rainfall data is needed, volunteer observers can be augmented with automatic gages at a cost of \$1,000-3,000 each, depending on the type selected.

Systems based on upstream water levels can also be inexpensive if river gage readings are provided by volunteers,

police or other mobile radio units. River gages generally cost \$25-50 for materials and require only a few hours for installation. If gages are painted on bridge piers, material costs become negligible. As in the case of collecting rainfall data, observers can be augmented with automatic gages. Suitable gages are available in the range of \$1,500-3,000 each.

More sophisticated local flood warning systems are available for those situations which require them. Systems can be established which are fully automated and computerized, operated by radio, and tied into the National Weather Service to take advantage of information available from radar and satellites. These types of systems are more expensive with costs in the vicinity of \$15,000 for a set of 3 or 4

radio operated gages, \$12,000-20,000 for computer equipment and significant other costs for installation and calibration of the system.

Operation and maintenance costs also vary according to the type of system used. For simple systems, costs may be limited to replacement of an occasional rain gage which is broken or a river gage which is washed away. Radio operated precipitation gages require periodic servicing, including replacement of batteries. Other types of automatic gages involve power line or telephone line charges which vary according to the distance to the gage location. The fully automated and computerized systems are, of course, more expensive to operate and maintain than simpler systems.

Isaac for local  
gaining profit  
systems

*"The system is so popular with the public that official observers sometimes have to wait their turn to read the gages."*

*Wise County Civil Defense Office*

*"Merchants would rather have the flood warning system than any insurance on their business."*

*Ellicott City Business Association*

# public acceptance

*"They [City Council] are now pushing for similar systems for other types of disasters."*

*Big Stone Gap*

*"... enables giving apprehensive people better answers about what to expect."*

*New Braunfels Police Department*

*"Important side benefits of the system are the sense of security provided to county residents and their confidence that local government is taking action to protect them."*

*Howard County Civil Defense Office*

# legal aspects

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The legal aspects which most frequently concern local officials considering the establishment of a flood warning system are the availability of authority necessary to undertake such an activity and the prospect of liabilities arising from erroneous forecasts. However, neither of these aspects poses a serious problem in practice.

*Authority* General purpose governments in most states have broad responsibilities for protective services derived from the State's constitutional power to promote health, safety and general welfare. Local governments can therefore generally engage in warning and preparedness if they choose to do so, subject to

approval of the council, board or other local legislative body.

The most important question concerning authority is usually whether the local government can acquire and operate sites and equipment outside its boundaries for the monitoring of rainfall and stream levels. Analysis of laws for a specific location are necessary to assure this authority is available. However, this type of authority is generally available to municipal corporations. It is frequently used, for example, in connection with parks and water supply facilities.

*Liability* Undue concern over liability arising from operation of a flood warning system is usually unfounded. Liabilities are more likely to arise if a community

fails to take seriously its responsibility to anticipate and protect against floods. Proper warnings and actions to protect school children, hospital patients and others in public care reduce the risk of liability.

Of course, liability could arise from negligence in operation of a warning system. That is the case with most activities which communities undertake. Few communities would choose to do without the protection of a flood warning system to avoid that small risk. One court has held that there is no liability even with negligence, so long as warnings are addressed to the general public rather than specific individuals.

legal  
subjects

*"No problems . . . of any type  
have arisen from operation of  
the system and none are  
anticipated . . ."*

*Santa Barbara Flood Control and  
Water Conservation District*

*"No difficulties whatsoever . . .  
have arisen in connection with  
the distribution of warnings."*

*City of Lompoc*

# easy operation

*"Another benefit of the  
[system] is the elimination of  
chaos and 65 to 85 percent of  
the mistakes which are made  
when it's necessary to act  
without enough time to think."*

*New Braunfels Police Department*



# getting more information

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If you want a copy of the complete report, *Information for Local Officials on Flood Warning Systems*, write NWS at address below.

Send report to:

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(your address)

For an evaluation of the need for a Flash Flood System in \_\_\_\_\_ write NWS at address below. (location)

Your name and address:

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Telephone No.

**NOAA-National Weather Service  
Weather and Flood Warnings  
Coordination Staff-OA/Wx5  
8060 13th St.  
Silver Spring, Md. 20910**