The NAI Approach to Emergency Services

Emergency Services & Floodplain Management

NAI Emergency Services Tools

Emergency Services Case Studies

NAI How-to Guide for Emergency Services

Emergency Services

This park in Aroma Park, IL, illustrates the NAI approach. Waterfront properties serve the community with open, green space, but damage is limited during a flood. Photo credits: "Dry" photo by French & Associates, "Wet" photo by Kankakee County Planning Department.

SECTION ONE
The NAI Approach

SECTION TWO
Emergency Services and Floodplain Management

SECTION THREE
Emergecny Service Tools

ON THE COVER:

One objective of an NAI emergency services program is to get people to safety before their homes are flooded. This *Guide* reviews ways to use advance warning of an impending flood to protect people and property.

PHOTO: Texas National Guardsman lifts child to a first responder in a Light Medium Tactical Vehicles (LMTV) during an evacuation in South Central Texas, June 2, 2016. Texas Guardsmen supported local first responders during search and rescue operations following severe weather and flash flooding. (Photo Courtesy of TEEX, photo by Will Welch)

This playground equipment was built using natural materials while providing fun features for kids to explore. Cedar River at the Charles City Riverfront Park, IA. Photo courtesy of the city of Charles City, IA.

SECTION FOUR
Case Studies

SECTION FIVE
Resources & Fact Sheet

Contents

Acknowledgements

This *Guide* was funded in part by the ASFPM Foundation, which encourages all communities to take the No Adverse Impact approach to floodplain management.

Developing this *NAI how-to guide* was truly a partnership effort. Special appreciation is extended to the following individuals who assisted in the creation of this publication:

- ASFPM NAI Committee Co-chairs Terri Turner, AICP, CFM, Development Services Administrator, Augusta, GA, Planning & Development, and Alisa Sauvageot, CFM, Phoenix, AZ
- ASFPM Executive Office, especially Alan Lulloff, P.E., CFM, as Technical Editor and Project Manager, and Michele Mihalovich, Public Information Officer and Editor

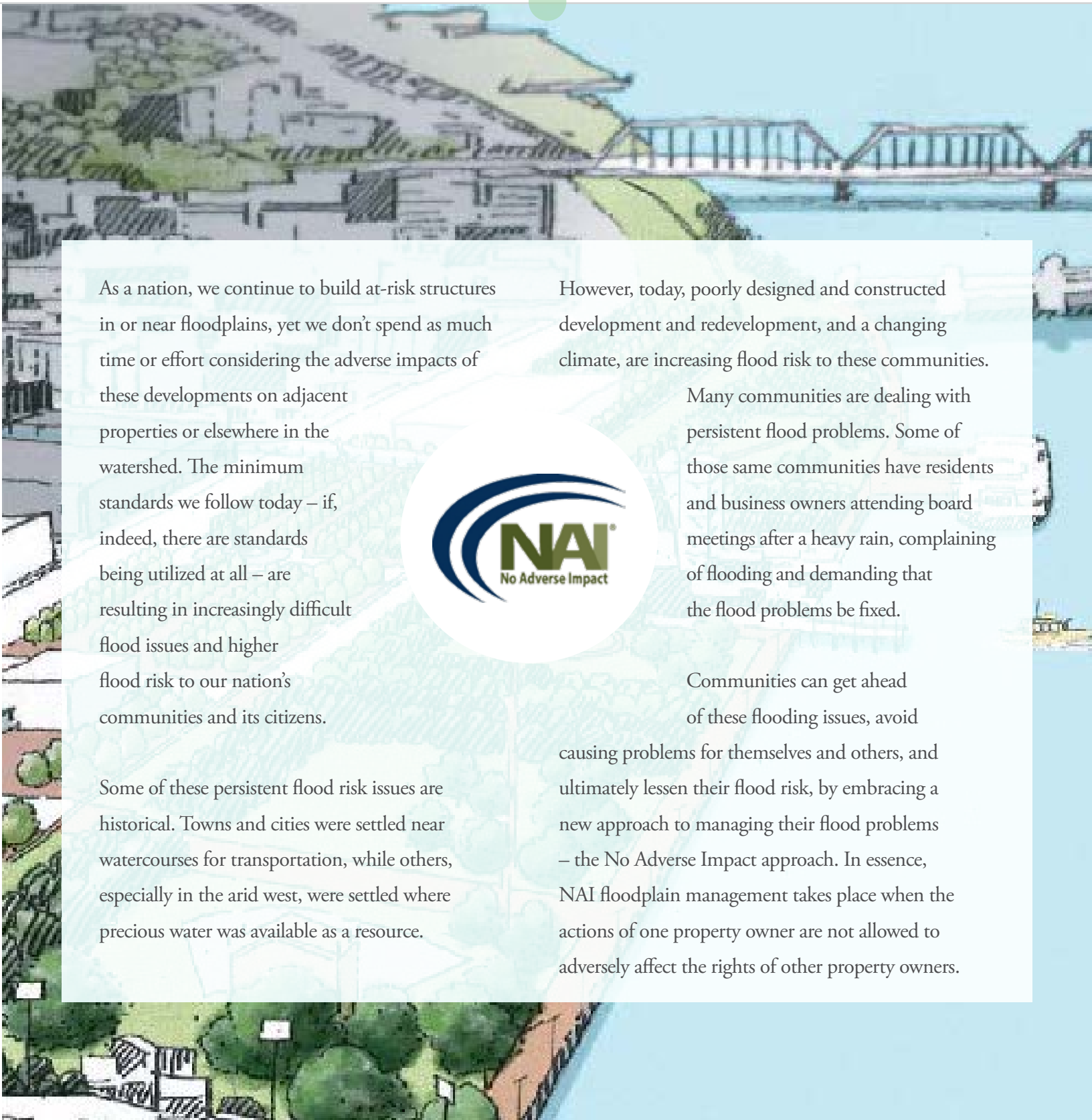
Technical Reviewers (Alphabetical Order):

- Maria Cox Lamm, CFM, South Carolina Dept. of Natural Resources, Columbia, SC
- David C. Curtis, Ph.D., F. EWRI WEST Consultants, Inc., Folsom, CA
- Leslie Durham, P.E., Department of Economic & Community Affairs, Montgomery, AL
- Steven Ferryman, CFM, Ohio Emergency Management Agency, Columbus, OH
- Al W. Goodman, Jr., CFM, AWG Consulting, LLC, Brandon, MS
- Roxanne Gray, Wisconsin Division of Emergency Management, Madison, WI
- Allison Hardin, CFM, City of Myrtle Beach, SC
- Eugene Henry, AICP, CFM, Hillsborough County, FL
- James D. Hinson, FPEM, CFM, Division of Emergency Management, Tallahassee, FL
- Victor T. Hom, NOAA, National Weather Service, Silver Spring, MD
- Alessandra Jerolleman, Ph.D., MPA, CFM, Water Works, New Orleans, LA
- David M. Key, P.E., CFM, ESP Associates, P.A., Raleigh, NC
- Bryan Koon, Director, Division of Emergency Management, Tallahassee, FL
- Roger D. Lindsey, P.E., CFM, Metro Nashville Water Services, Nashville, TN
- Barbara Miller, CEM, CFM, Jefferson County Homeland Security and Emergency Management, Kearneysville, WV
- Deborah G. Mills, CFM, Dewberry, Richmond, VA
- Tim Murphy, P.E., CFM, Flood Control District of Maricopa County, Phoenix, AZ
- John Powderly, AICP, CFM, Water Resources & Community Planner, Sacramento, CA
- W. B. Smith, P.E., CFM, HISINC, L.L.C., Mannford, OK
- Kevin Stewart, P.E., Urban Drainage and Flood Control District, Denver, CO
- David A. Stroud, CFM, Amec Foster Wheeler, Raleigh, NC
- Valerie A. Swick, E.I.T., PH, CFM, Flood Control District of Maricopa County, Phoenix
- Trevor W. Timberlake, P.E., CFM, Natural Resources Commission, Little Rock, AR
- Chuck Wallace, Grays Harbor County Emergency Management, Montesano, WA
- Chauncia Willis, MPA, MEP, CEM, CPC, Emergency Coordinator, City of Tampa, FL
- Terry R. Zien P.E., CFM, U.S. Army Corps of Engineers, St. Paul, MN

Case Study Reviewers:

- Frank Knittle, Village of South Holland, IL
- Chris Douville, P.E., CWP, City of Boulder, CO
- Lisa Foster, CFM, Floodplain Administrator, Pinellas County, FL
- Garrick Henry, Emergency Preparedness Coordinator, Our Lady of Lourdes Memorial Hospital, Inc., Binghamton, NY
- Tom Palko, P.E., CFM, Metro Nashville Water Services, Nashville, TN
- Bruce Rindahl, Watershed Protection District, Ventura County, CA
- JoAnne Tallon, CFM, Long Beach Township, NJ

Introduction



As a nation, we continue to build at-risk structures in or near floodplains, yet we don't spend as much time or effort considering the adverse impacts of these developments on adjacent properties or elsewhere in the watershed. The minimum standards we follow today – if, indeed, there are standards being utilized at all – are resulting in increasingly difficult flood issues and higher flood risk to our nation's communities and its citizens.

Some of these persistent flood risk issues are historical. Towns and cities were settled near watercourses for transportation, while others, especially in the arid west, were settled where precious water was available as a resource.

However, today, poorly designed and constructed development and redevelopment, and a changing climate, are increasing flood risk to these communities.

Many communities are dealing with persistent flood problems. Some of those same communities have residents and business owners attending board meetings after a heavy rain, complaining of flooding and demanding that the flood problems be fixed.

Communities can get ahead of these flooding issues, avoid causing problems for themselves and others, and ultimately lessen their flood risk, by embracing a new approach to managing their flood problems – the No Adverse Impact approach. In essence, NAI floodplain management takes place when the actions of one property owner are not allowed to adversely affect the rights of other property owners.

Who Should Use this Guide?

After a flood, damage assessments should be conducted to identify where changes can be made during repairs and reconstruction. Damage assessments are vital for a post-disaster plan, such as the ones discussed in Section 3, Tool 3, Estes Park, CO. Photo by Patsy Lynch/FEMA.

Anyone who wants a more resilient community that can withstand a major flood event should use this guide. That could mean anyone, from local officials, to elected officers, decision makers, floodplain managers, coastal managers, stormwater managers, emergency managers, planners, hazard mitigation specialists, public works and engineering staff, design professionals, concerned citizens, and various other groups in the community.

This *Guide* is one of a series of how-to guides that expand on the knowledge base within the No Adverse Impact Toolkit, a 108-page document prepared by the Association of State Floodplain Managers. The *Toolkit* is ASFPM's reference on implementing the NAI approach. It identifies tools for incorporating NAI floodplain management into local regulations, policies and programs; while the *How-to Guides* break down, by subject matter, that information into compact, usable information communities can apply.

This *Guide* reviews only four tools, but there are many more NAI tools for emergency services, and for each of the other building blocks found in the *NAI Toolkit*. The *Toolkit*, additional references, and more information can be found by clicking on the NAI icon at the bottom of ASFPM's homepage: www.floods.org

When the *How-to Guides* series is completed, there will be one guide for each of the seven building blocks found in the *NAI Toolkit:* (hazard identification and floodplain mapping; education and outreach; planning; regulations and development standards; mitigation; infrastructure; and emergency services. (links below)

The *How-to Guides'* ultimate goals are to have communities take a different approach to managing development that prevents increasing flood risk, and to incorporate NAI concepts into other community activities. This *Guide* identifies just a few ways a community can incorporate the concepts into its emergency services activities.

Users should view NAI as a continuum – every community is somewhere on the path between not addressing minimum flood standards at all, addressing only the minimum standards of the National Flood Insurance Program, and being 100 percent resilient and sustainable in the face of a flood threat. The more NAI steps a community takes, the better prepared it is for the next flood.

THIS HOW-TO GUIDE IS DIVIDED INTO FIVE SECTIONS:

SECTION ONE: The NAI Approach to Floodplain Management

SECTION TWO: Emergency Services & Floodplain Management

SECTION THREE: Emergency Services Tools

SECTION FOUR: Case Studies

SECTION FIVE: Resources & Fact Sheet

After reading this *Guide*, it is recommended that a community conduct an assessment of its emergency services activities. A gap analysis would identify what is being done and what is not being done from an NAI perspective. It would lead to strengthening existing programs and implementation of new ones that can help reduce the community's flood risk. Similar assessments should be conducted after reviewing the other *Guides* in this series.

Links:

Mitigation How-to Guide: www.floods.org/NoAdverseImpact/NAI_How-to-Guide_Mitigation.pdf
Mapping How-to Guide: www.floods.org/NoAdverseImpact/NAI_How-to-Guide_Mapping.pdf
No Adverse Impact Toolkit: www.floods.org/NoAdverseImpact/NAI_Toolkit_2003.pdf
Education & Outreach How-to Guide: www.floods.org/ace-files/NAI/EdcOutHowToGuideSept2015.pdf
Planning How-to Guide: www.floods.org/NoAdverseImpact/NAI_Planning_How_to_Guide_Final.pdf
Development Standards: https://www.floods.org/ace-images/ASFPMRegulationsGuideApril2017.pdf
Infrastructure: https://www.floods.org/ace-images/ASFPM-InfrastructureFinalJuly28.pdf

Common Terminology used throughout this Guide

This is an example of following the NAI floodplain management approach, letting nature follow its course with no threat to life or property. The waterfront is a community asset, of open green space and parks, where people can relax and enjoy the view. Photo from the CRS Coordinator's Manual.

NFIP: National Flood Insurance Program. Most community floodplain maps and floodplain management standards have been adopted to meet the NFIP's criteria. Learn more at www.fema.gov.

Community: The NFIP definition of a community is a political subdivision that has authority to adopt and enforce floodplain management for the areas within its jurisdiction. The term usually means cities, counties, and Indian tribal governments. For the purposes of this *Guide*, a "community" also includes a neighborhood, unincorporated settlement, or other non-governmental subdivision where people live or work together.

CRS: NFIP's Community Rating System is a program that provides reduced flood insurance premiums for policyholders in communities that go above and beyond the NFIP criteria. For more information see www.CRSResources.org.

This *Guide* identifies how communities can receive CRS credits for implementing NAI tools and standards.

Floodplain: Nature's floodplain, which includes the Special Flood Hazard Area (defined below), and other areas subject to flooding, includes:

Common Terminology, cont.

- Areas subject to greater than the 1 percent annual chance flood, often referred to as the 100-year flood;
- Areas subject to smaller, more frequent, or repetitive flooding;
- Areas subject to shallow flooding, stormwater flooding, or drainage problems that do not meet the NFIP mapping criteria (but where 20 percent of flood insurance claims occur);
- Areas affected by flood-related hazards, such as coastal and riverine erosion or subsidence; and
- Areas that will be flooded when future conditions are accounted for, such as sea level rise and upstream watershed development.

For these reasons, "floodplain" is the term that best reflects a community's true flood risk, and is used in this *Guide* instead of "SFHA."

Natural floodplain functions: The functions associated with the natural or relatively undisturbed floodplain that moderate flooding, maintain water quality, recharge groundwater, reduce erosion, redistribute sand and sediment, and provide fish and wildlife habitat. One goal of NAI floodplain management is to preserve and protect these functions, in addition to protecting human development.

Resilient: "Able to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies," as defined in FEMA's National Disaster Recovery Framework.

SFHA: A Special Flood Hazard Area mapped on an NFIP Flood Insurance Rate Map that shows the area subject to the 1 percent annual chance flood caused by rivers, lakes, oceans, and other larger sources of flooding.

Sustainable: "Able to meet the needs of the present without compromising the ability of future generations to meet their own needs," as defined in FEMA's National Disaster Recovery Framework.

The *Toolkit*, additional references, and more information can be found by clicking on the NAI icon at the bottom of ASFPM's homepage: www.floods.org

SECTION ONE

The NAI Approach to Emergency Services

Cleaning up a flooded home can be a long and expensive process. Cedar Rapids, Iowa, June 2008. Photo from FEMA library.

The NAI Approach to Floodplain Management

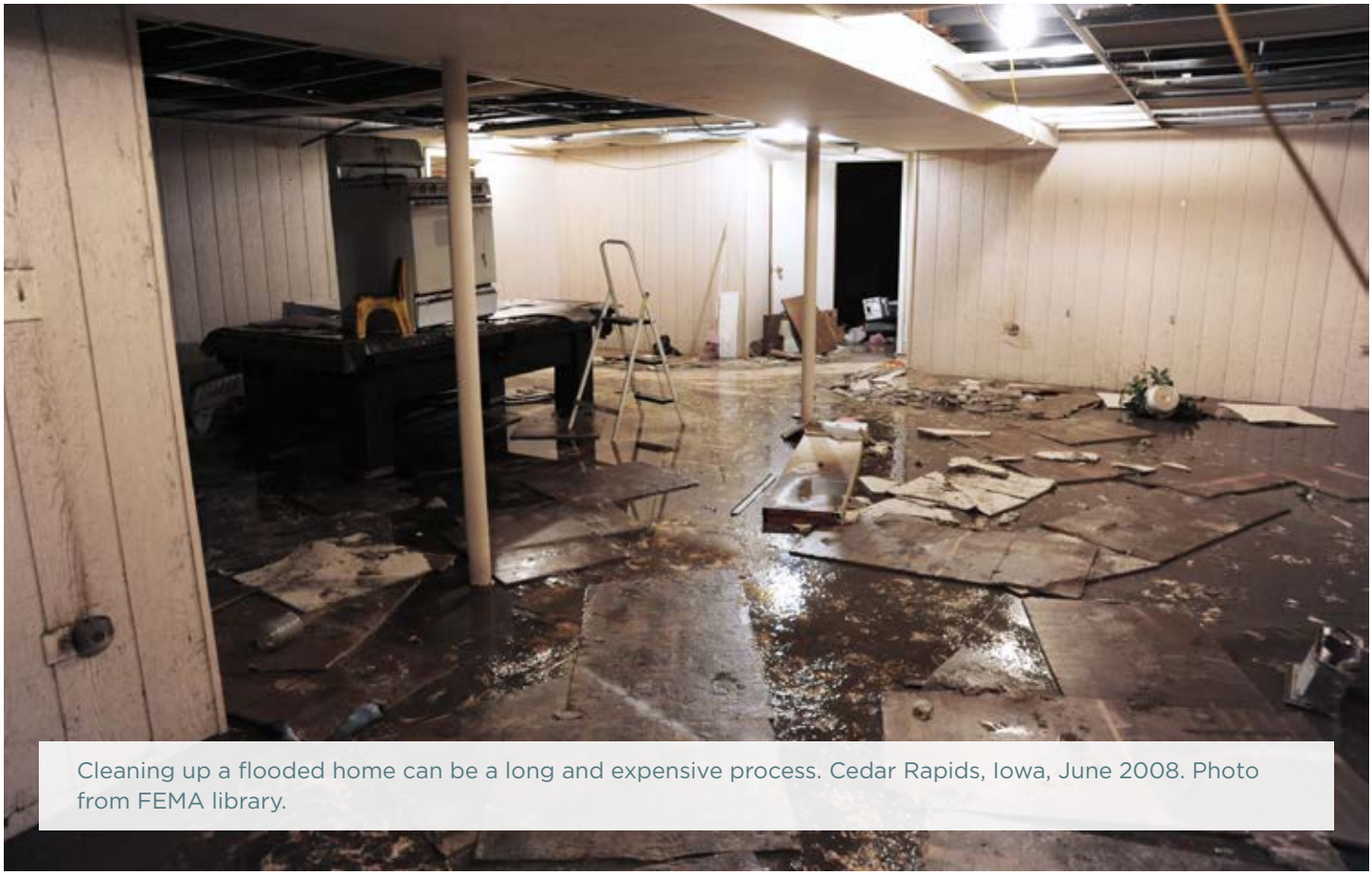
FLOOD LOSSES AT THE LOCAL LEVEL

Local flooding can have a much greater impact than is commonly thought. Consider that for every federally-declared flood disaster, numerous other floods never get declared – and little to no federal assistance is available. Studies show that communities experiencing a major flood take years, if not decades, to recover. For example, 50 percent of small businesses never reopen after a major flood, and those that do, fail at a higher rate within a few years.

For many communities that have not experienced a flood in recent years, it is only a matter of time until a major event occurs. When there is a flood in a developed area, any and all of the following impacts on communities and their residents and businesses can be expected:

- Decreased revenue due to loss of income, sales, tourism, and property taxes;
- Costs incurred due to post-flood clean up and repair of buildings;
- Loss of jobs due to businesses closing or cutting back on operating hours;
- Risk of injury or loss of life, including first responders rescuing those who did not evacuate or are stranded;
- Mental health and family impacts, including increased occurrence of suicides and divorce;
- Loss of historical or unique artifacts;
- Loss of programs or services that are cut to pay for flood recovery; and
- Deterioration of homes and neighborhoods as floods recur.

continued on page 9

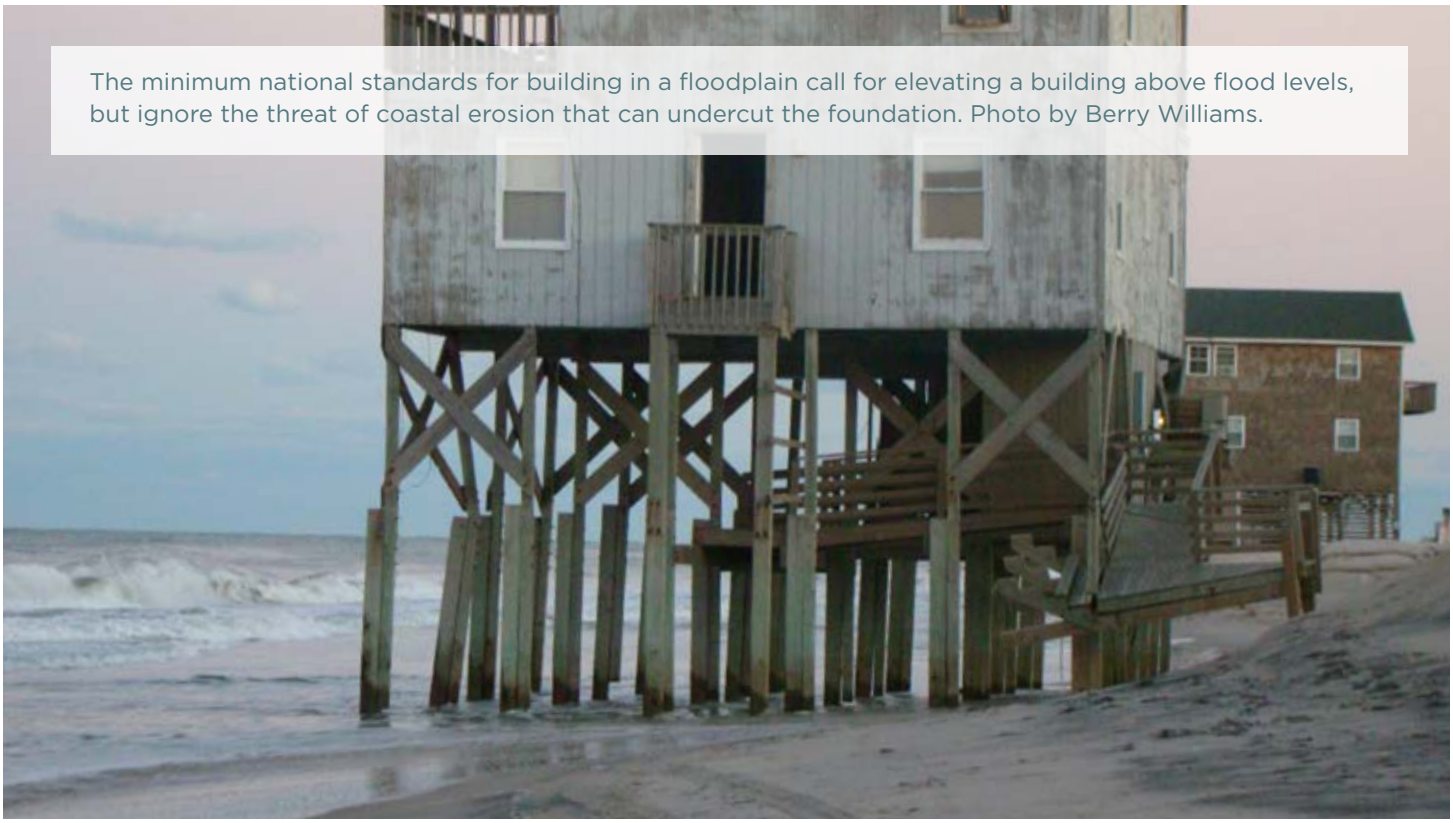


Cleaning up a flooded home can be a long and expensive process. Cedar Rapids, Iowa, June 2008. Photo from FEMA library.

NATIONAL STANDARDS

The NFIP's *minimum* standards have been accepted by many as the default standards for communities' floodplain management programs. However, they were designed for the purposes of an insurance program and not to control our escalating flood losses. The NFIP sets minimum construction standards for communities' in the mapped SFHA. These minimum standards are inadequate to stop and reverse the long-term trend toward increasing flood damage because:

- They do not address the entire floodplain. In other words, they neglect the potential for larger floods, other unmapped local flood hazards, or the effects of urbanization and a changing climate on future flood levels.
- They focus on how to build in a floodplain rather than how to avoid unsafe locations.
- They allow floodwater conveyance areas to be reduced, essential valley storage to be filled, and/or velocities to be increased – all of which can adversely affect others.
- The standards are flood-oriented and some construction techniques may increase exposure to damage from other hazards, such as wind and earthquakes.



The minimum national standards for building in a floodplain call for elevating a building above flood levels, but ignore the threat of coastal erosion that can undercut the foundation. Photo by Berry Williams.

- They assume the ground is stable, and that if a building is high enough, it will be protected from damage. This is not the case in areas subject to erosion or mudslides.
- There are no accepted national flood loss reduction standards for levees.
- While standards for dam safety are good as they relate to the protection level of the dam from failure or overtopping, there is a continued problem of increasing development downstream, necessitating a dam to be retrofitted to a higher protection standard.
- There are no commonly-applied flood loss reduction standards for buildings and critical facilities, such as wastewater treatment plants and emergency operations centers.
- Sedimentation, erosion, channel migration, ice jams in rivers, and coastal erosion, often cause flood hazards that are not adequately reflected in the NFIP's Flood Insurance Rate Maps.
- In areas subject to subsidence, floodplain maps lose their accuracy when the ground settles over the years.
- NFIP regulatory standards may not work adjacent to lakes where water levels may remain high for months or years.

For these reasons, relying on minimum national standards will not reduce flood losses or even stop the increases in flood losses.

continued on page 11

The NAI Approach to Floodplain Management, cont.

FLOOD LOSSES IN THE NATION

Local flood losses add up to very large numbers at the national level, and those numbers are getting bigger. From the early 1900s to 2012, the nation's flood losses have increased five-fold. Since 2000, that figure has averaged $10 billion annually. Hurricanes Katrina and Sandy occurred within seven years of each other. They were the two largest flood-related disasters in U.S. history at that time together caused more than $200 billion in direct losses (see the graph on page 12).

This continued pattern of destruction has persisted despite the investment of billions of dollars in structural flood control projects during the last 100 years, as well as the development of many other flood protection measures. Yet, even in the face of increasing flood losses, development continues in high risk locations. For example, it is predicted that the U.S. population near the water will increase by 50 million more people by 2050 – putting more people and property in harm's way. The federal government's programs are not curbing the increases in flood losses as floodprone areas keep developing at what many believe to be an alarming rate. Consider the following:

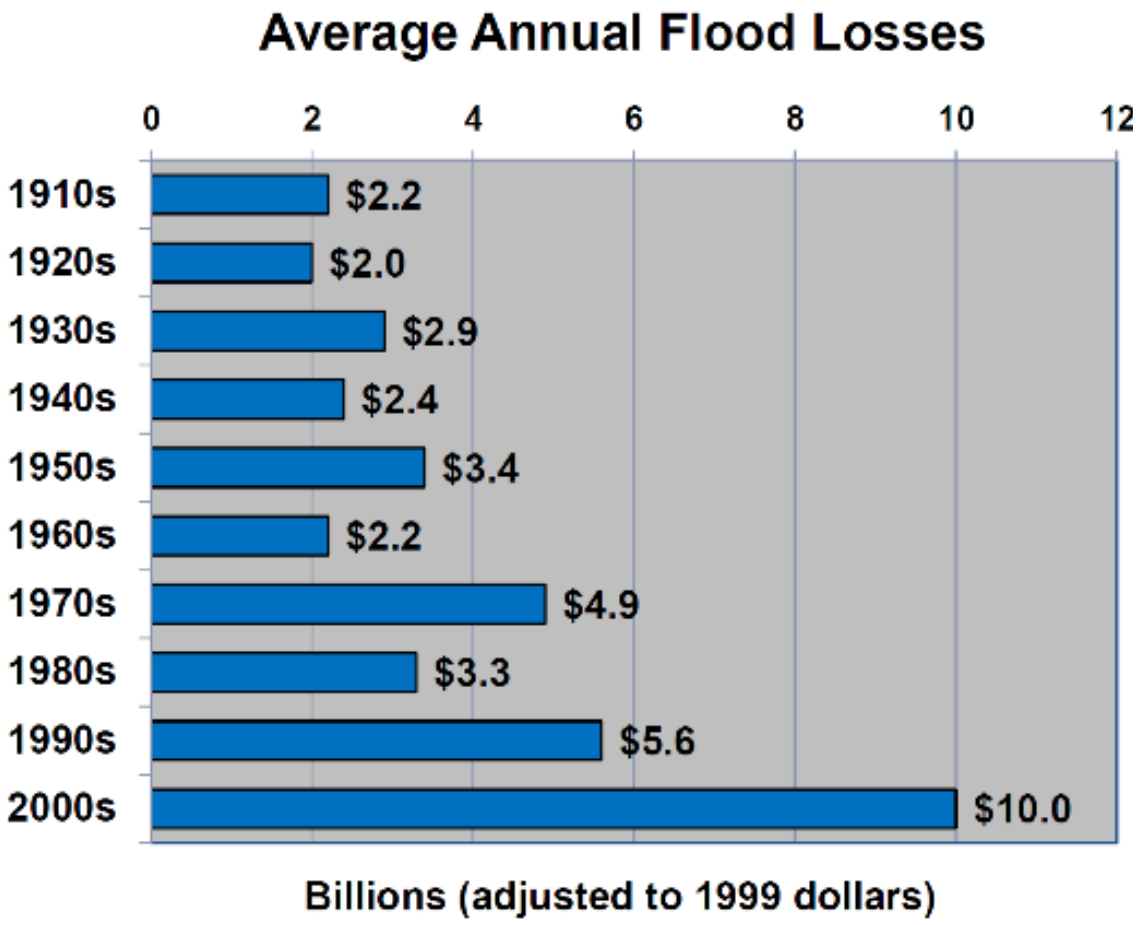
Comic created by Rob Pudim, and appeared in Natural Hazards Observer, May 2014.

- Funding for flood protection programs, especially structural flood control projects, has declined over recent years.

- Tax incentives and funding for disaster assistance have encouraged, and often subsidized, floodplain occupancy and development and reduced local and individual accountability for flood losses.

- The NFIP's national standards for managing floodplain development have not changed in more than 20 years and are assumed by many communities to be adequate for their floodplain management program, without regard to implementing other or higher standards that would address the hazard(s) they face.

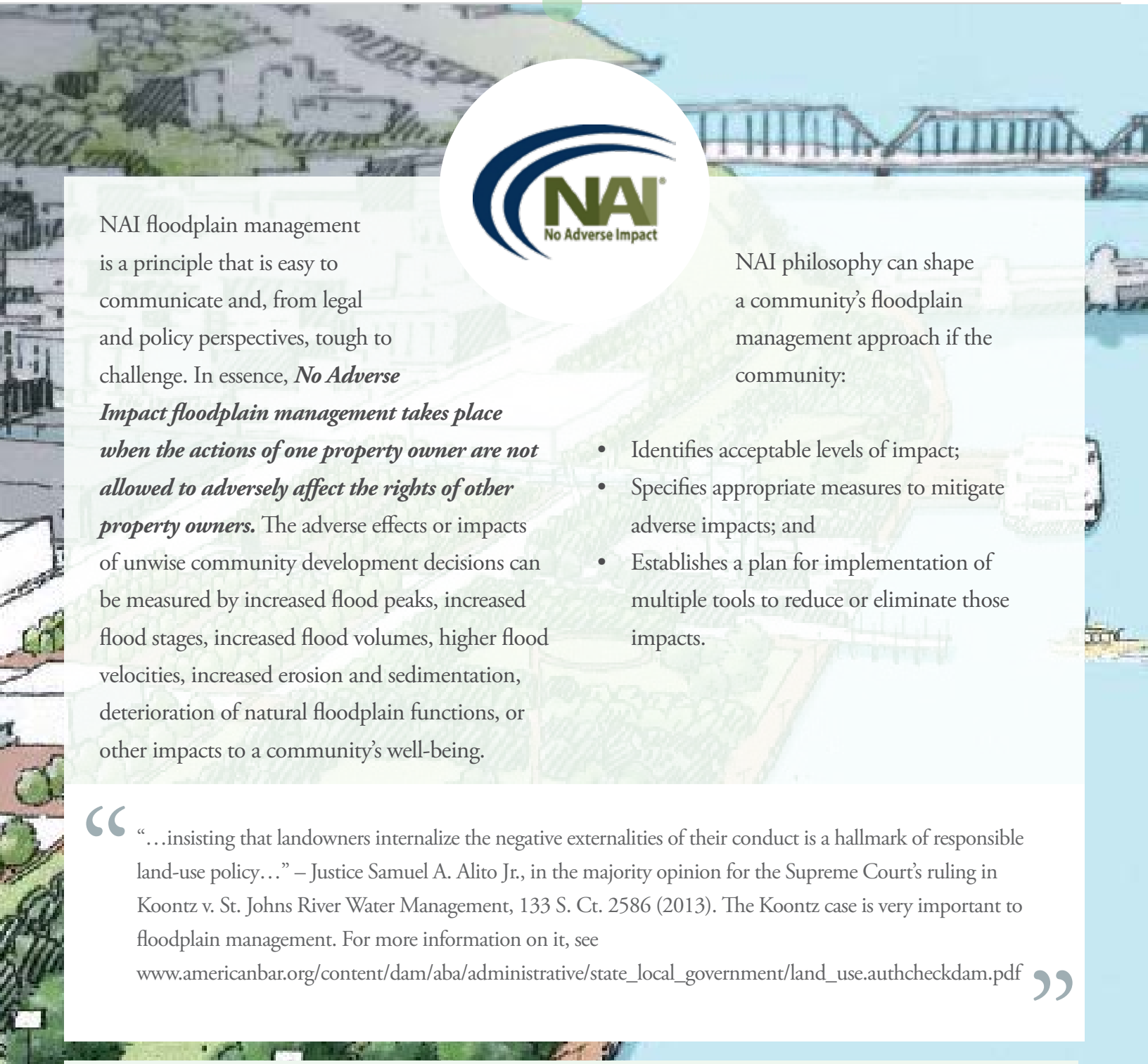
The NAI Approach to Floodplain Management, cont.



Jeff Stone with ASFPM's Flood Science Center created the graph above. Source: Flood Loss Data, National Weather Service, Hydrologic Information Center (Website Terminated in June 2018)

Further Information: Flood Damage in the United States 1926-2003 A Reanalysis of National Weather Service Estimates (www.flooddamagedata.org/).

The No Adverse Impact Approach



NAI floodplain management is a principle that is easy to communicate and, from legal and policy perspectives, tough to challenge. In essence, ***No Adverse Impact floodplain management takes place when the actions of one property owner are not allowed to adversely affect the rights of other property owners.*** The adverse effects or impacts of unwise community development decisions can be measured by increased flood peaks, increased flood stages, increased flood volumes, higher flood velocities, increased erosion and sedimentation, deterioration of natural floodplain functions, or other impacts to a community's well-being.

NAI philosophy can shape a community's floodplain management approach if the community:

- Identifies acceptable levels of impact;
- Specifies appropriate measures to mitigate adverse impacts; and
- Establishes a plan for implementation of multiple tools to reduce or eliminate those impacts.

> "…insisting that landowners internalize the negative externalities of their conduct is a hallmark of responsible land-use policy…" – Justice Samuel A. Alito Jr., in the majority opinion for the Supreme Court's ruling in Koontz v. St. Johns River Water Management, 133 S. Ct. 2586 (2013). The Koontz case is very important to floodplain management. For more information on it, see www.americanbar.org/content/dam/aba/administrative/state_local_government/land_use.authcheckdam.pdf

continued on page 14

The No Adverse Impact Approach, cont.

THE COMMUNITY'S ROLE

NAI principles give communities a way to promote *responsible* development measures through community-based decision making. Under NAI floodplain management, communities identify potential impacts of new development proposals, and implement actions to mitigate those adverse impacts before they occur.

A community's approach could be specific to flood damage or encompass related objectives, such as water quality protection, groundwater recharge, and protection of wetlands and riparian zones. NAI criteria can be extended to entire watersheds to support regional stormwater management methods to mitigate the adverse impacts caused by increased runoff from urban areas. At the community level, the NAI floodplain management approach and implementation plan should be comprehensive and address all the NAI building blocks:

- Hazard identification and floodplain mapping
- Education and outreach
- Planning
- Regulations and development standards
- Mitigation
- Infrastructure
- Emergency services

NAI ADVANTAGES:

Local empowerment: The NAI approach removes the impression that floodplain management is something imposed by federal or state government. Communities become accountable and accept responsibility for what happens. It also encourages development of a better informed public and a constituency for wise development.

More effective programs and projects: Floodplain management programs and flood mitigation projects are better tailored to local needs and conditions with the NAI approach. Communities are able to better utilize federal and state programs to support their own local initiatives.

Lower long-term costs: Over time, the NAI approach will reduce local government expenditures. For example: a mitigation project that relocates buildings out of a floodprone area not only can result in a community open space amenity, but in less maintenance of roads and public utilities, less risk to first responders who must conduct search and rescue operations when it floods, and lower disaster recovery costs.

Improved partnerships: Informed local officials can make the right decisions about protecting their community. Economic development organizations, transportation and public works departments, and local utilities do better when they work with planners and floodplain managers to implement an NAI based approach. This is especially true when everyone realizes that they have a role and a responsibility to address their own flood problems. Once people agree that flooding is a local problem and their department is affected, they are more willing to work together and share the workload.

continued on page 15

The No Adverse Impact Approach, cont.

Source: Natural Hazards Informer, July 1999, Natural Hazards Center, University of Colorado.

Reduced liability: NAI doesn't take away property rights – it protects them by preventing one person from harming another's property. One of the most important options a government typically has for reducing liability for flood losses is the prevention of increasing flood levels and erosion hazards due to government actions (or inaction). To do this, governments can adopt NAI standards for private development (through its regulations) and public infrastructure (through its design standards).

Meet community needs. NAI floodplain management is about communities being proactive toward understanding potential impacts and implementing preventive measures and mitigation activities. The NAI concept offers communities a framework to design programs and standards that meet their true needs, not just the minimum requirements of a federal or state governmental agency.

Greener floodplain: Flooding is a natural phenomenon and one goal of NAI floodplain management is to preserve and protect natural floodplain functions in addition to protecting buildings and infrastructure. An NAI emphasis will result in protection of natural buffers and environmentally sensitive areas, improvement in the biological, ecological and geomorphologic functions of riverine and coastal areas, improved water quality, more open spaces, protected

The No Adverse Impact Approach, cont.

fish and wildlife habitat, and similar benefits that come with maintaining an environmentally sustainable ecosystem.

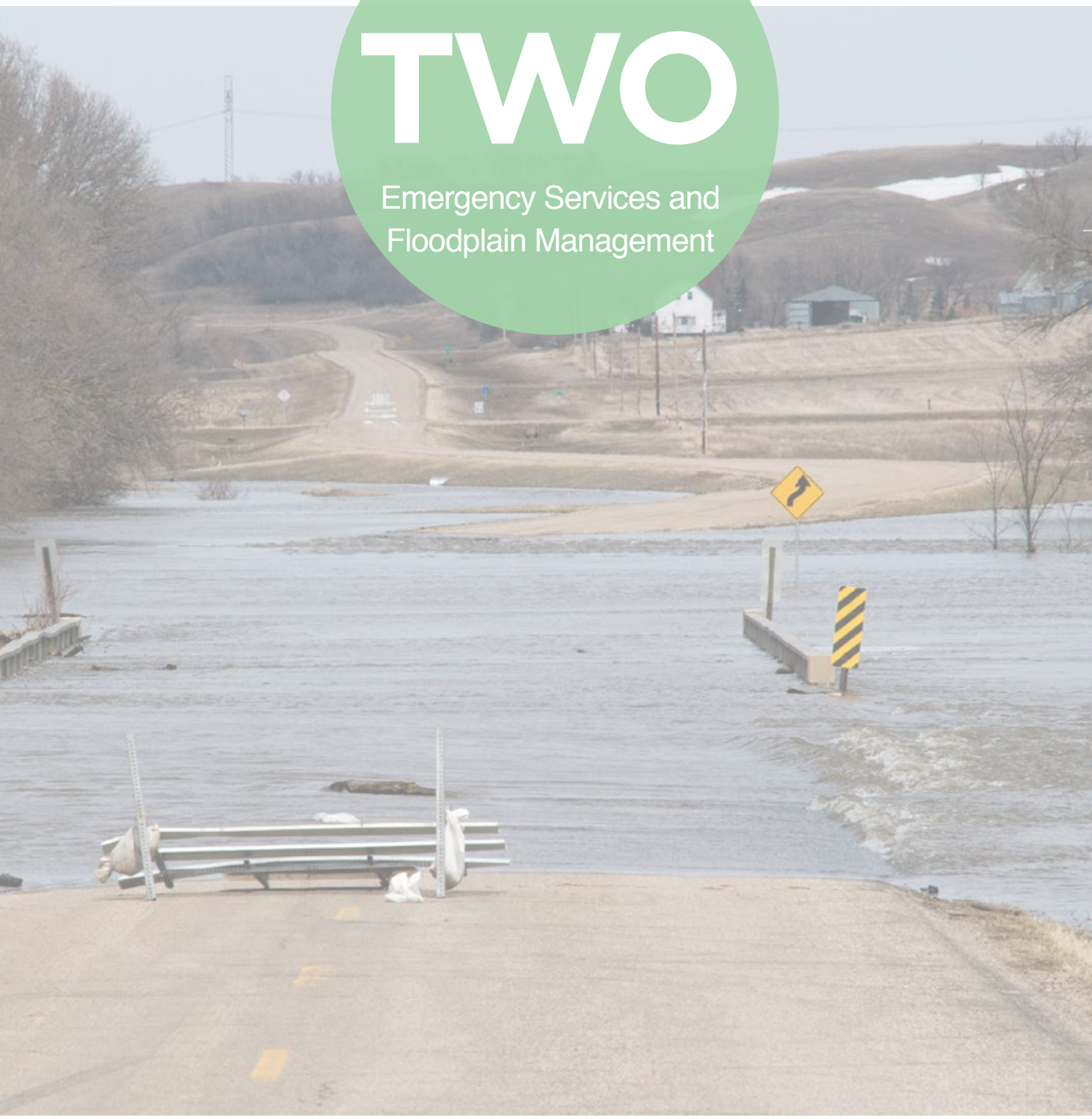
CRS credits: By continually seeking to meet local needs, a community will implement programs and projects that are above and beyond the minimum requirements of the NFIP. Such activities are encouraged by the NFIP because they do a more effective job of preventing and reducing flood losses. This encouragement is accomplished through the CRS, which provides reduced flood insurance premiums in communities that implement NAI floodplain management activities.

On the whole, the NAI approach has many benefits at the local and national levels. With these benefits in mind, the remainder of this *Guide* explores how to take advantage of the NAI approach in a community's emergency services plans and programs.

A wetland in Franklin County, NC. Photo by Jim Liestman via Flickr

SECTION TWO

Emergency Services and Floodplain Management



Emergency Services and Floodplain Management

While this *Guide* is written for floodplain managers, it can be very useful for emergency managers. Both are encouraged to become familiar with the other's duties and responsibilities.

When "you" is used, it refers to the floodplain manager and is not intended to assign responsibility to one office or another.

The terms "floodplain manager" and "emergency manager" also refer to their offices and staff.

EMERGENCY MANAGEMENT

It is important for floodplain managers to see the bigger picture, so this section reviews the context that emergency managers work in.

The community's chief executive officer is responsible for responding to and recovering from disasters and emergencies. Coordination duties are delegated to an emergency management office that may be in the fire, public safety or sheriff's department or in a separate office that reports directly to the chief executive. The head of that office is called the "emergency manager" in this *Guide*.

Emergency management activities are guided by state and federal laws implemented by the state's homeland security or emergency management office and the Federal Emergency Management Agency. Each county manages a countywide program. Larger cities generally have their own full-time emergency management staff. While smaller towns have a designated emergency manager, many rely on their county for services.

To facilitate communication and coordination between the various government levels and agencies, Homeland Security Presidential Policy Directives 5 and 8 established the National Incident Management System and the Incident Command System (http://bit.ly/2DIHGU8). This system provides a standard approach to an incident, such as an earthquake or explosion. Emergency services such as flood warning and response activities need to be designed to work within this NIMS and ICS.

Emergency managers prepare emergency operations plans. These have different names in different states and communities. An example table of contents for one is in the Pinellas County case study. Flood warning and response activities are usually spelled out in a flood annex to an overall plan, although the annex may be treated as a stand-alone document.

More introductory information on the field of emergency management can be found in FEMA's Emergency Management Institute resident and independent study classes "Fundamentals of Emergency Management," "National Incident Management System" and "Incident Command System."

Of course, the best way for floodplain managers to learn more about their communities' emergency management programs is to meet with their emergency managers, and spend time in their offices or the emergency operations center to see what they do.

FACTORS FOR EFFECTIVE EMERGENCY SERVICES

Floodplain and emergency managers have identified the following seven factors as key to having a successful flood warning and response program. The tools and case studies presented later in this *Guide* demonstrate how communities and local managers have succeeded by taking advantage of these seven factors. See the table on page 22.

1. **Clearly designate roles & responsibilities**
   During a flood or other emergency, staff move quickly, are responsible for unfamiliar tasks, and work with people they may not have met before. While the mayor or other chief executive officer is in charge, the emergency manager is usually the lead coordinator of the community's response and recovery activities and the floodplain manager has his or her own responsibilities and authorities. There are many emergency service tasks listed in this *Guide*. Clarifying duties and responsibilities early on can greatly reduce potential confusion and tensions.

2. **Communicate & coordinate**
   During an emergency, there

will be frequent briefings, so do attend them. During non-emergency times, the emergency manager may host exercises where local officials discuss potential emergency scenarios and each staff member's role. Attend them, especially those with a flood-related scenario. Visit the emergency management office to stay abreast of changes in policies and staffing.

Frequent contact will give you a better understanding of your role and will streamline communication and coordination during an emergency.

3. **Take advantage of help**
Your most important job is making sure your office is fulfilling its duties and taking advantage of all opportunities. Don't hesitate to ask for help or delegate to others so you can manage your overall responsibilities.

   Help comes in many forms, such as funding, staffing, materials, political support and even agencies and organizations that can take over some of your assignments. This *Guide* identifies agencies, such as the National Weather Service and the state dam safety office. Find your local contacts for these agencies, talk to them and learn what support they can provide.

   Check out the private sector, too. Consulting engineers, home improvement stores, heavy equipment operators and other businesses probably want to help their community and can offer help and/or materials.

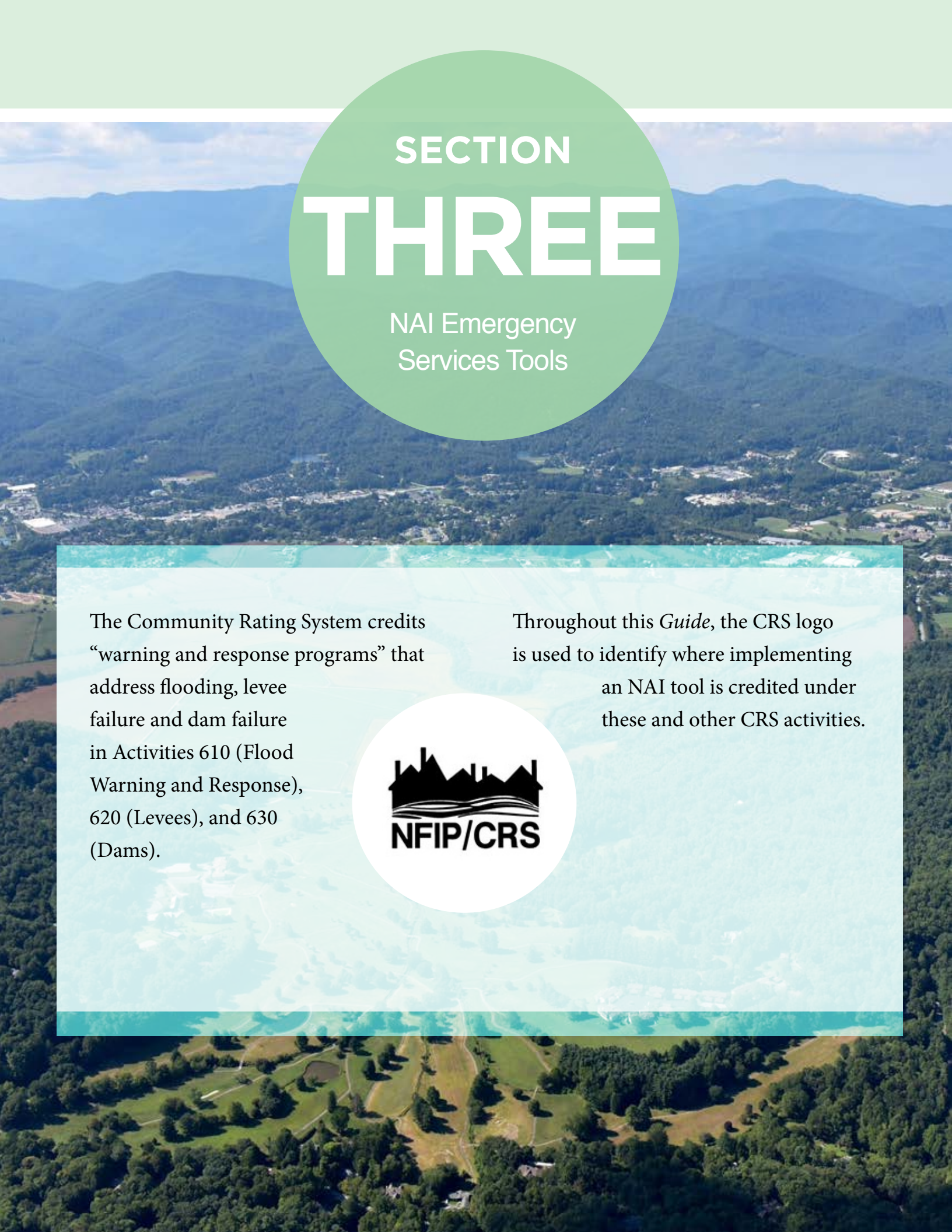
4. **Obtain & share the best available data**
Emergency managers need information on hazards they face, information you can provide. You need information on buildings that need to be inspected and repaired, information the emergency manager may have. Current and accurate data make everyone's job easier and more effective.

5. **Educate the public**
People need to be aware of flood hazards, flood safety precautions, flood insurance benefits, regulatory requirements and how to prevent future damage. Educated property owners, business managers and elected officials will be your best allies. Emergency managers have become experts in using various media for messaging. Take advantage of their expertise and communication mechanisms.

6. **Train & exercise**
The best way to prepare and stay prepared is to practice. Attend training opportunities and participate in periodic disaster response exercises. Ask for a flood or coastal storm scenario emergency response exercise.

   "*One thing that came out of a training exercise many years ago is that one of our floodplain representatives found out that the emergency managers were planning to set up evacuation shelters in the [Special Flood Hazard Area] for a different watercourse than the one in the exercise. Also, we… identified problems with potential evacuation routes." – Tim Murphy, CFM, Maricopa County, AZ Flood Control District.*

7. **Evaluate & improve**
Floods don't follow rules or stay within the lines on a map. You will learn something new every time one occurs. It's standard emergency management practice to evaluate a disaster response or training exercise and prepare an "after-action report" or improvement plan. Learn from the experience so you don't repeat the same mistakes.



SECTION THREE

NAI Emergency Services Tools

The Community Rating System credits "warning and response programs" that address flooding, levee failure and dam failure in Activities 610 (Flood Warning and Response), 620 (Levees), and 630 (Dams).

Throughout this *Guide*, the CRS logo is used to identify where implementing an NAI tool is credited under these and other CRS activities.

NFIP/CRS

NAI Emergency Services Tools

There are many tools in the NAI Toolkit, and this *Guide* does not cover them all. Instead, four illustrate the broad range of possible tools communities can use. They show how the factors for emergency services can help staff better protect people, property, critical infrastructure and even natural resources during and after a flood or other disaster.

The table below shows which case studies and community examples illustrate the tools. It also identifies which "Factors for emergency services" are highlighted in each example.

NAI Examples & Case Studies	Boulder, CO, WWTP	Lourdes Hospital, NY	Nashville, TN	Pinellas County, FL	Roseville, CA	South Holland, IL	St. Paul, MN	Ventura County, CA
Page number	60	67	66	65	30	64	33	68
Tools								
Tool1. Flood Threat Recognition		▪	▪	▪	▪	▪	▪	▪
Tool 2. Flood Inundation Maps		▪	▪	▪		▪	▪	▪
Tool 3. Flood Respponse	▪	▪	▪	▪		▪		▪
Tool 4. Protecting Critical Facilities	▪	▪	▪	▪				▪
Factors for emergency services								
1. Designate roles and responsibilities	▪	▪	▪	▪		▪		▪
2. Coordinate	▪	▪	▪	▪		▪	▪	▪
3. Take advantage of help		▪	▪				▪	▪
4. Obtain & share the data			▪	▪	▪	▪	▪	▪
5. Educate the public			▪	▪	▪		▪	▪
6. Train & exercise		▪	▪					
7. Evaluate & improve		▪	▪	▪		▪		

Tool 1: Flood Threat Recognition

The primary difference between floods and other emergencies is there's usually advance notice a flood is coming, unlike explosions and earthquakes.

An impending flood can be recognized in several ways, such as a rising river upstream, heavy rain in the watershed, or an incoming tropical storm. Establishing a system to do this, i.e. a "flood threat recognition system," is the foundation of a flood warning and response program.

The concept of a "flood threat recognition system" is simple: collect information about the impending flood and get it to the emergency manager. This can be done manually, using automated or remote sensing equipment, or relying on a state or federal agency already providing the information.

This system can provide valuable information about the hazard, such as: When will the flood arrive? Where will it go? How high will it rise?

Developing this system for the community can be a key role for floodplain management staff.

This tool reviews the community's needs, looks at types of systems available, and helps select the one that works best. Tool 3 covers advising the public about the flood and taking appropriate flood response steps.

Tool 1. Flood Threat Recognition
Tool 1 has five steps to prepare a system that provides early notification of an impending flood.

Step 1. Determine notification needs - *Decide where you want early notification*
Step 2. Review existing systems - *See what may already be available.*
Step 3. Investigate locally - *run systems to fill the gaps - Check out what you can do to prepare a system that meets your needs*
Step 4. Use it and improve it - *Make sure it gives you the results you need*
Step 5. Expand access to the system - *Give the public access to the early notifications*

NOAA - NWS

-Ventura County WPD

Most "flood threat recognition systems" rely on precipitation gauges (left) that measure rain and snowfall in the upstream watershed, and stream gauges (right) that measure river levels.

Tool 1: Flood Threat Recognition, cont.

HOW TO: ESTABLISH A FLOOD THREAT RECOGNITION SYSTEM

Step 1. Determine notification needs

Step 1 begins with a meeting of floodplain and emergency management staff. Together, they should review the community's flood-prone areas. Here are some data sources on those areas:

- Examine published maps, but remember that maps, such as the Flood Insurance Rate Map, do not show all flood hazards and are prepared for different purposes. FIRMs typically do not show flood hazards in smaller watersheds, areas that can be susceptible to flash flooding. Other concerns with FIRMs are reviewed in Section Two of the NAI How-to Guide for Hazard Identification and Floodplain Mapping.
- If your community is on or near the coast, find out about tropical storm, Nor'easter and/or a tsunami threats. Check out NOAA's Coastal Flood Exposure Mapper.
- Check for areas subject to local stormwater problems (pluvial flooding) that may not be covered by a flood model or show up on floodplain maps. While some may call these "nuisance flooding," they are still flooding problems that threaten people, damage property and can result in flood insurance claim payments. Therefore, they should be included in your flood warning needs assessment, and can be especially problematic when people attempt to drive through flooded streets.
- Obtain and map flood insurance claim data, especially repetitive claims, to identify unmapped flood problem areas and areas within your SFHA that have experienced damage. The Privacy Act has restrictions on how flood insurance data are handled (see box).
- Review records of citizen complaints about flooding or drainage problems.
- Are there dams upstream? Don't stop at county or state lines. Contact your state dam safety office (which you can find here), to determine if there are dams rated as presenting a high or significant hazard.
- Look for areas protected by a levee or floodwall. They may not show up as floodplain on the FIRM, but a levee failure or overtopping can have major consequences.

Once you've identified flood-prone areas, review the flood threat recognition needs with the emergency manager. Here are some things to consider:

- Are there areas with concentrations of population or vulnerable occupants, such as schools, group homes, retirement communities and nursing homes?
- Are there critical facilities? See Tool 4 for information on critical facilities.

The end product of Step 1 is a map, GIS layer or list of flood-prone areas where the community needs early notification of an impending flood.

Flood Insurance Data

The Privacy Act has restrictions on how flood insurance data are handled. For example, maps showing insurance data for individual properties (e.g., who has received an insurance claim payment) cannot be made public. When requesting this information from your FEMA regional office, you will be required to agree to follow Privacy Act requirements.

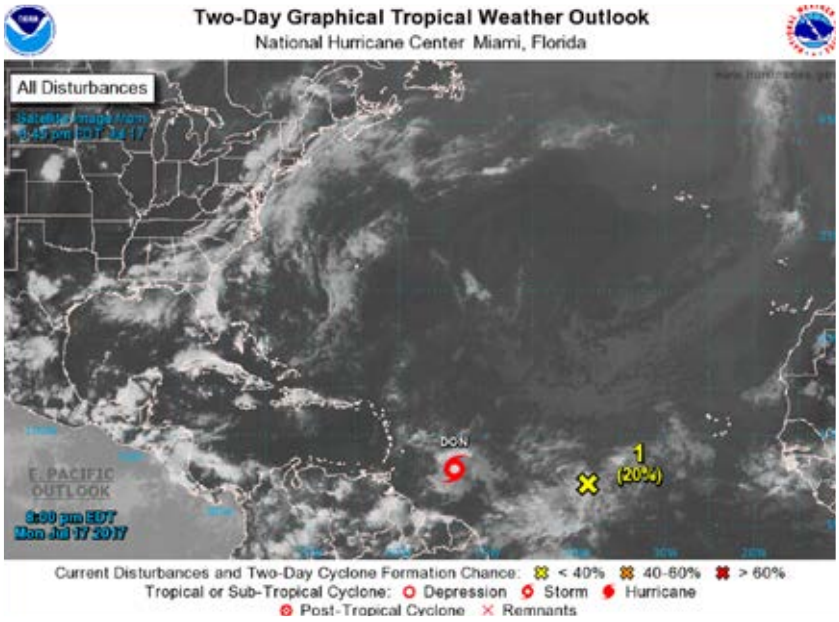
Tool 1: Flood Threat Recognition, cont.

Step 2. Review Existing Systems

If your community is on the coast or a large river, it is very likely there already is a flood threat recognition system that can help you. Here are the types of systems and typical agencies that manage them. Note that many communities are subject to more than one type of flooding and should review all systems that could help them. For example, a coastal community may be flooded from storm surge, small streams, local drainage and tsunamis.

Storm surge: The National Hurricane Center monitors tropical storms in the Atlantic and Pacific Oceans and the Gulf of Mexico. NHC provides several days of advance notice of potential flooding. Because of the severity of these storms, most coastal communities are familiar with this system.

Be aware that a hurricane warning usually focuses on wind speeds rather than flood levels. The NWS recognizes this and in 2017 began issuing storm surge watches and warnings for Gulf of Mexico and Atlantic Ocean areas.



Real-time tropical weather outlooks are at:
http://www.nhc.noaa.gov/gtwo.php?basin=atlc&fdays=2

Rivers: River gauges track and report river levels. The flood threat recognition system is primarily a matter of getting the upstream gauge readings to downstream communities by manual monitoring or automated telecommunications.

- The NWS manages the Advanced Hydrologic Prediction Service, which is a real-time prediction service for larger rivers based on gauges maintained by other agencies, such as the USGS. The AHPS website has more than 8,000 gauges, but only provides predicted flood levels for a portion of them.

Stage vs. Elevation

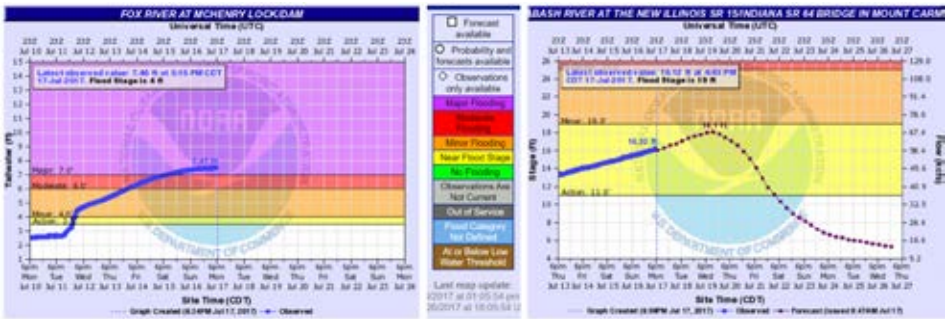
One confusing aspect of most river gauges is that stream levels are recorded and reported in terms of "stage" (i.e. so many feet above an arbitrary starting point). Usually a stage of "zero" is close to the level of the channel bottom. A conversion factor must be used to relate the gauge stage to elevation in feet above sea level (North American Vertical Datum 1988 (NAVD 88) or the older National Geodetic Vertical Datum 1929 (NGVD 29)) for each gauge.

At the St. Paul gauge discussed on page 33, a stage of zero is an elevation of 683.77. "Minor flooding" starts at stage 14, which is 697.8 feet above sea level. See also the **South Holland case study** and **Nashville Watershed Advisory Guide case study** for other examples that relate stage to elevation.

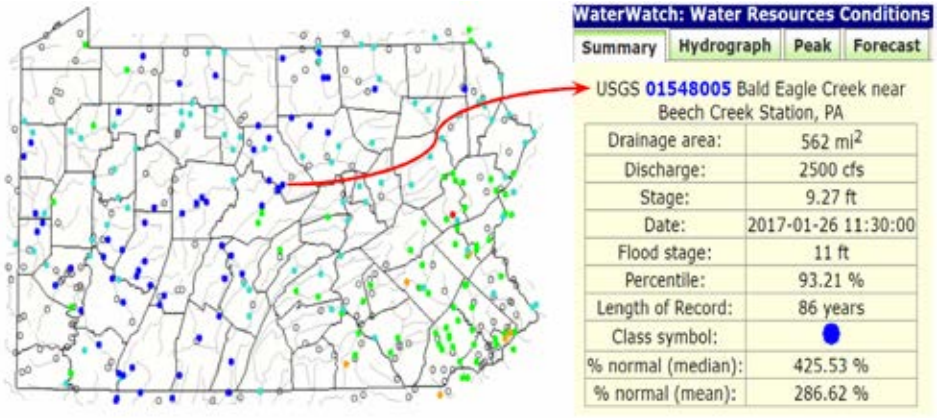
Tool 1: Flood Threat Recognition, cont.

- The AHPS webpage has a map of the gauges in its network. You can click on a state and then narrow down to the area of interest. Clicking on a gauge provides information in graphic formats, such as the examples right, and text on current and predicted conditions.
- See also National Weather Service Hydrologic Information on the Web: A Manual for Users.
- The USGS manages gauges and makes real-time data available on its website (see right). The site also has a page on current flooding locations.
- Other federal agencies may have gauges in your area:
  - U.S. Army Corps of Engineers
  - Tennessee Valley Authority
  - U.S. Bureau of Reclamation
- Some states have statewide or regional gauging systems. Check with the state water resources or emergency management agency.
- Some regional or county flood control or water districts have systems too.

Smaller streams: Smaller watersheds respond faster to storms. By the time a stream gauge measures a change in river levels, there may be little opportunity to take protective actions.

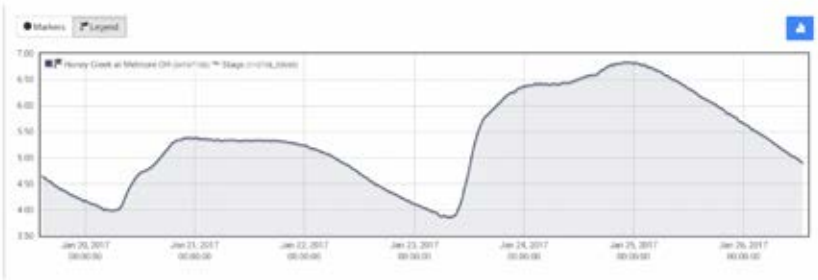


The gauge on the left only provides current or observed flood levels while the one on the right shows predicted flood levels and times. Another example is in the Our Lady of Lourdes Hospital case study.



The USGS website (https://waterwatch.usgs.gov/) shows the gauge locations by state. Clicking on a gauge provides real-time information. Some sites compare the current stream level to flood stage.

Ohio's Emergency Management Agency administers a statewide rainfall and water level reporting system at http://storms2.ema.state.oh.us/map/?sensor_class=20&view=cb072e42-4e3a-4519-a2f5-e4e07d2091a0 Click on a site on the state map and get real-time data.



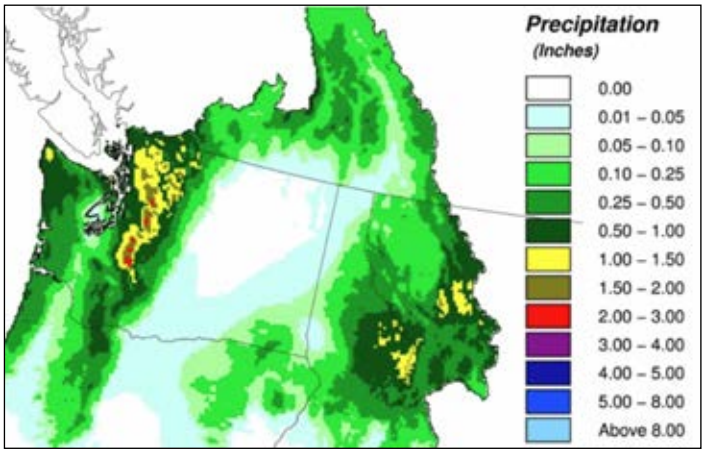
Tool 1: Flood Threat Recognition, cont.

Another problem is that a community may have many smaller streams and putting gauges on all of them can be cost prohibitive. Therefore, a flood threat recognition system for small rivers is often based on measuring rainfall or a combination of data from stream and rain gauges.

Rainfall: Heavy rains can overwhelm the local drainage system in many communities. "Pluvial" flooding may occur along several small drainageways and low spots during and after a storm.

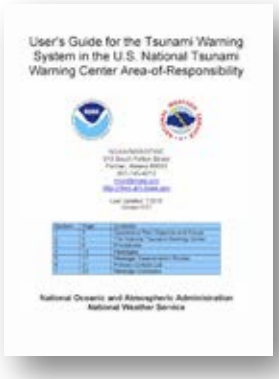
- The NWS now has a website that reports when rain is predicted to be "excessive." This site can help users identify where excessive rainfall might exceed the rainfall criteria commonly used for designing most drainage systems. This is a national monitoring system, but the user can select the area(s) of interest.
- The NWS also has a site that shows "qualitative precipitation forecasts," which depict the amount of liquid precipitation expected to fall in a defined period of time. In the case of snow or ice, QPF represents the amount of liquid that will be measured when the precipitation is melted. The website maps (top right) show where the amount of precipitation has a 5% chance or more of exceeding the level that triggers a flash flood warning.
- Some county and regional agencies have developed area-wide flood threat recognition systems. Two examples are explained in the Nashville and Ventura County case studies. The Urban Drainage and Flood Control District in Denver manages a regional Flash Flood Prediction Program (F2P2).

Some communities contract with private weather companies that provide more specific information for their community or special needs.



Example of a QPF map for Washington showing 24-hour rainfall prediction up to 3 inches along the Cascades.

Tsunamis: These floods, which can be caused by earthquakes, landslides, volcanoes, iceberg calving and asteroids, can severely impact water levels. Unlike flooding caused by meteorological events, there may be only minutes of notification if the quake is near a community. As with hurricanes, the National Oceanic and Atmospheric Administration operates tsunami warning centers that serve both coasts.



Dam failure: As with any flood, lead time is dependent on the proximity of the community to the source of the floodwaters. A dam-failure flood threat recognition system is based on coordination and communication with upstream dam operators. If a problem threatens, the local emergency manager should be one of the first people a dam operator calls.

Larger and federally-regulated dams are required to prepare emergency action plans that should include coordination with local officials.

Tool 1: Flood Threat Recognition, cont.

More on dam-failure flooding is included on pages 35 and 47 and in Tool 4 of the NAI How-to Guide for Hazard Identification and Floodplain Mapping.

The end result of Step 2 should be markings on the map or the list developed in Step 1 that show how the various flood-prone areas can be covered by one or more existing flood threat recognition systems.

Step 3. Fill the gaps

If the existing systems reviewed in Step 2 do not cover all the important areas or do not provide all the information needed, you may need to develop your own system. Because of the threat to life and safety, this is most often done in areas subject to flash flooding, such as mountain valleys, urban areas and along streams that drain areas burned by wildfires.

Volunteer system: One of the least expensive approaches for a local system would be to identify volunteers who agree to read a staff gauge (above right) whenever there's a heavy rain. They would periodically call or text the emergency management office to report the readings.

How often volunteers call should be pre-established. You also need

A staff gauge is like a yardstick that shows water depth.

formulas to convert the readings to expected flood heights downstream. This requires some advance modeling of the watershed. Each state has at least one NWS hydrologist who often can assist in the modeling and instructions.

There are shortcomings of this approach. Volunteers have to be home, in good shape and willing to go out in bad weather frequently. The time it takes to process the manual input means less time to issue warnings and initiate flood response measures.

If you opt to use volunteers, they can join the Community Collaborative Rain, Hail and Snow Network, or CoCoRaHS, for guidance and support. It is a non-profit network of volunteers with members from all 50 states and provides training materials and newsletters for volunteer gauge readers.

Automated system: Where more lead time can save lives and protect property, some communities invest in more expensive systems that may use automated river gauges, rain gauges, weather measurements and even radar. This has been more common in mountainous and urban areas subject to flash flooding, although they are used more and more by agencies that simply want better real-time information.

National Hydrologic Warning Council

The council is "a non-profit organization dedicated to assisting emergency and environmental management officials by providing expert advice on the use of real-time, high-quality hydrologic information from automated remote data systems..."

For more information: **www.hydrologicwarning.org**

Tool 1: Flood Threat Recognition, cont.

Examples of cities, counties and organizations that have automated systems may be found in the National Hydrologic Warning Council's list of Real-time Hydrologic Data Sources.

Help: Once you've decided to start your own system, it is recommended that you line up a hydrologic warning expert who can work out the details, develop specifications and assist in soliciting proposals. Some state or federal agencies may be able to help. Check with a nearby office on the list of Real-time Hydrologic Data Sources to see how they did it and what they'd recommend.

No system will be perfect. The final decision on what approach to use will likely be a trade-off between accuracy, timeliness and cost.

Cost: A major concern about starting a new program is the cost. The hydrologic warning expert can help determine installation costs for the remote data collection and processing equipment. Be sure to consider long-term maintenance costs. Your money will be wasted if the system is down or provides poor quality data when the flood comes.

In some cases, grants from FEMA's Hazard Mitigation Grant Program have supported installation of flood-hazard warning systems. Grant funds will not support maintenance.

One way to reduce the direct cost to your community is to share the service. Other communities in the same watershed may be interested. Other agencies, such as an irrigation district, may be willing to pay for the data for other purposes. More users and more beneficiaries will improve the long-term viability of your system. Ventura County, CA found funding support from fire agencies by co-locating gauges with weather stations that report wind speed and direction.

At the end of Step 3, you should have designed a system that works for your community's needs.

Step 4. Use it and improve it

Once your system is operational, here are some things to keep in mind:

- **Train staff:** There should be more than one person who knows how the system works and how it should be maintained. Staff and volunteers should also be trained on what the gauge readings mean. This should help eliminate confusion on predictions during an impending event.
- **Take care of your investment:** Follow the proper maintenance schedule, including periodic testing. This is essential for consistent data and may be required by the equipment's warranty.
- **Validate and calibrate:** No system will accurately predict every possible flood. You may find that it under-reports or over-predicts flood levels in different areas. Adjust the findings and/or software as you gain experience with actual flood events.
- **Be a cheerleader:** If the system works well, tell decision makers and community leaders they made a good investment. You may be able to show that the early notification resulted in closing a bridge an hour earlier than it would have been before you had your system. That may have saved lives by preventing cars from driving into floodwaters.

Step 5. Expand access to the system

In today's Internet world, most people can access gauge and flood-related data online. This can give more people an early notice that a flood is coming so they can take appropriate measures.

Information available to the public must be clear and use consistent, plain-language terminology. For example, one floodplain manager remembers a gauge stage reading of 20 feet.

Tool 1: Flood Threat Recognition, cont.

A local radio station reported that flooding was 20 feet deep in the city. Another recalls a local television anchor stating the flood the city was experiencing would occur only once every 100 years. If you're talking to a reporter or member of the public, do all you can to ensure they understand what the data mean.

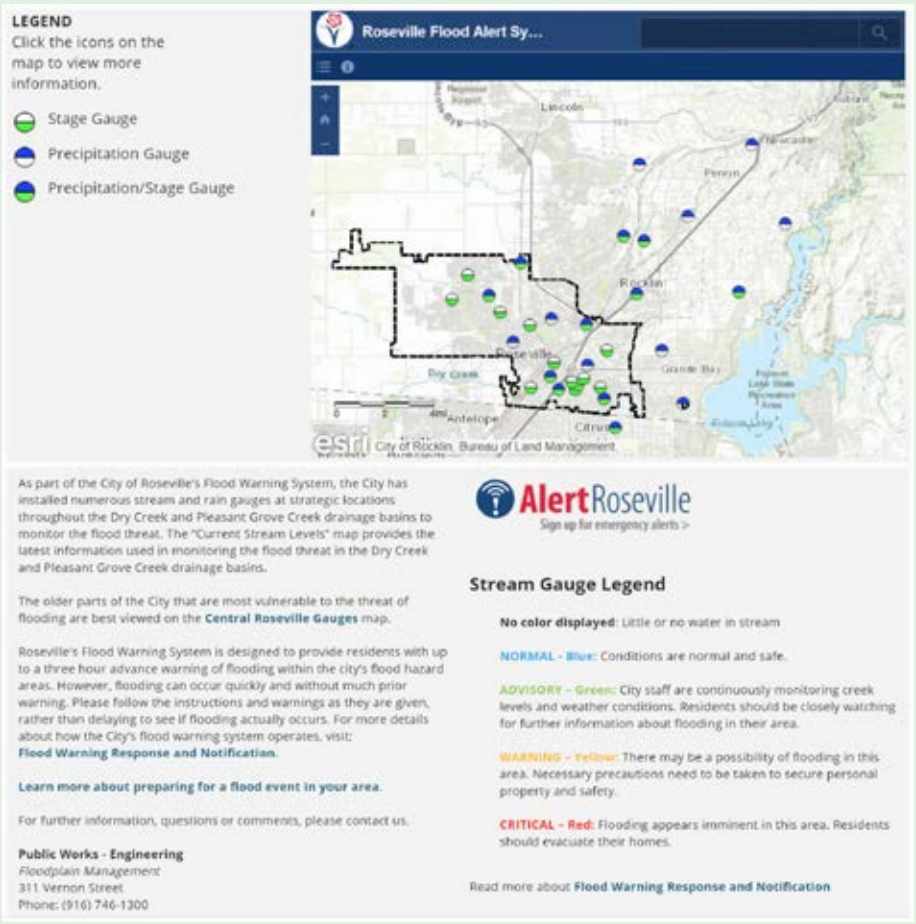
Whether the system is already on a public website or community-owned, the website should provide a link to the data with an explanation. More and more emergency management offices are providing information via Twitter and other social media.

Many long-time waterfront residents probably know what different gauge readings mean to their location, but explanations can help them too. Good examples of such explanations are Roseville's (see right) and South Holland's.

NFIP/CRS The CRS provides credit for flood threat recognition systems in Activity 610 (Flood Warning and Response), FTR – flood threat recognition. The credit increases for more automated systems and systems that cover more of the community's developed floodplains. A maximum of 75 points is available in 610. There is also flood threat recognition credit in Activities 620 (Levees) and 630 (Dams).

Roseville, California's Flood Threat Recognition System

The map below is from Roseville's public floodplain management website. It provides a good example of a mix of river and precipitation gauges in the watersheds that drain into the city. The site includes an explanation and links to pages that provide guidance on what people can do during a flood to protect lives and property.



NAHPS on Your Cell Phone

You can get ready access to gauge data in the AHPS system on your cell phone. Follow these steps:

1. On your phone, go to **http://mobile.weather.gov**.
2. Type in the "Zip, City or Place" and hit ">Go."
3. Scroll down to "Rivers/Lakes."
4. Hit "View map."
5. Enlarge the map and select your gauge of interest.

Tool 2: Flood Inundation Maps

Flood Insurance Rate Maps developed by FEMA show the area inundated by the base flood (also known as the 1% annual chance or 100-year flood). Some FIRMs may also show the area inundated by the 0.2% annual chance or 500-year flood.

If this is the only flood map available, users may think there is only one flood to be concerned about. This promotes an "in or out" attitude, i.e., if you're outside the mapped floodplain, you're safe. People in the 100-year floodplain sometimes assume the odds of getting wet are one in a 100, when in fact, they are probably in a location that gets flooded more frequently.

Flood inundation maps that show different levels of flooding can help counter these misleading concepts and help emergency and floodplain managers prepare for the next flood. Some agencies are calling these "flood inundation map libraries."

Flood inundation maps show where coastal or riverine flooding may occur over a range of water levels. When a flood is predicted to reach a particular level, the emergency manager can use the inundation map associated with that water level to identify areas that will be inundated. Then the emergency planner can determine what roads, critical facilities, neighborhoods, etc., will be flooded or isolated at different levels. A simple example is to the right.

Flood inundation maps are most useful when they correlate to a flood threat recognition system described in Tool 1. When the flood threat notice is received, the inundation map for the predicted flood level shows what areas will most likely be affected. Tool 3 covers using the map data to prepare effective emergency response operations plans that can protect people and property **before** water reaches the predicted area.

Tool 2 has four steps to prepare and utilize maps that show what will be affected by different flood levels predicted by the Tool 1 flood threat recognition system.

Step 1. Determine your needs Decide what flood hazards need to be mapped

Step 2. Prepare your maps Develop a map if one is not already available

Step 3. Calibrate your maps Make sure they reflect where recent floods went

Step 4. Post the maps for public access Share the information with those at risk of being flooded

This screenshot from the inundation maps for the west branch of the Susquehanna River at Milton, PA shows the areas under

water at six different flood levels. The levels are keyed to stage levels on a river gauge. See the Stage vs. Elevation box on page 25.

The emergency manager knows where a predicted flood stage will go. At 22 feet, for example, the islands should be evacuated and bridges closed, but response actions are not needed for those areas above stage 32.

SEDA-Council of Governments, PA

Tool 2: Flood Inundation Maps, cont.

If there is no flood threat recognition system, inundation maps may not be very helpful while water is rising as there will be no prediction of the areas affected. However, inundation maps can still be helpful for long-range emergency response planning and damage assessment after the flood has crested.

Types of inundation maps

There are three general types of inundation maps reviewed in this tool:

1. A series of maps showing areas flooded at different levels. In the South Holland and Ventura County case studies, each level is on a different page.

   Interactive digital maps show different areas affected by water levels selected by the user. Examples are the coastal inundation maps websites listed in the box on the next page, the National Weather Service's AHPS program, and Nashville's map.

2. A map that shows different coastal evacuation zones. Many of these are generated by predictive modeling programs that are keyed to hurricane category wind speeds, and not flood depth or area. But they perform the same function of showing what areas are affected by different flood levels. An example is on the next page.

3. A map that shows the area that will be impacted by a dam or levee failure or the release of water to prevent a dam from failing. Generally, these only show the worst-case failure flood, not a series of flood levels. They are especially useful when they show the timing of flood arrival downstream. These are discussed on pages 35-36.

Remember that no map will perfectly depict the area that will flood. There are many uncertainties in predicting flood levels because of factors like wind and tidal fluctuations, storm track and duration, channel obstructions, and the distribution of rainfall or snow within the watershed.

All mapping has inaccuracies in the topographic data and/or the flood study's engineering model.

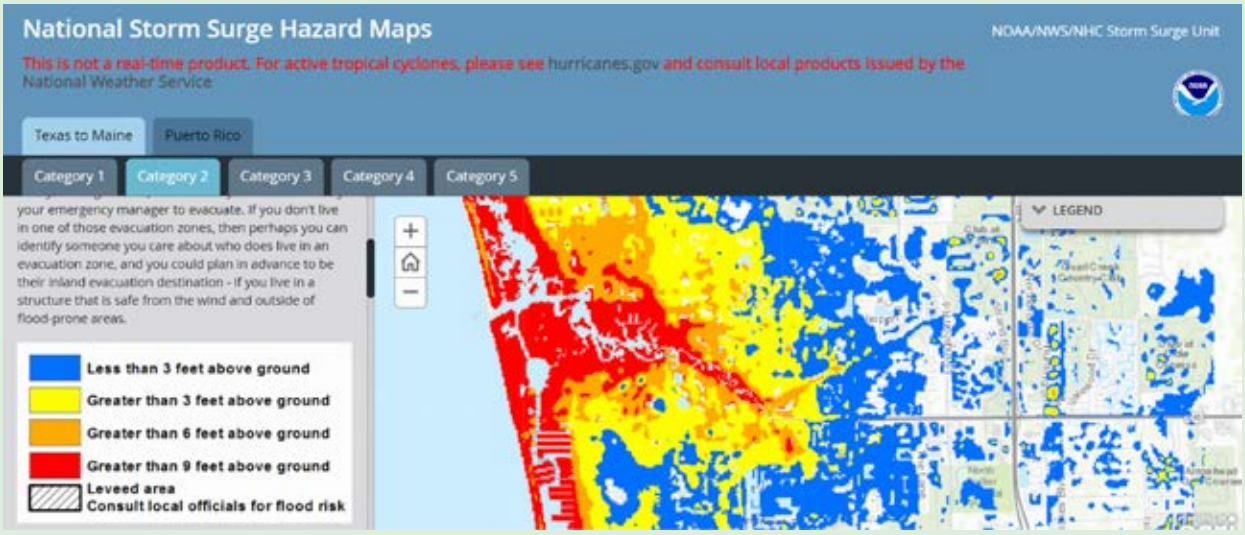
Horry County "Know your Zone" Map

This map shows three areas affected by coastal flooding. It is from the Horry County, S.C. "**Know your Zone**" program to inform citizens on their flood risk and what evacuation zone they are in.

Tool 2: Flood Inundation Maps, cont.

Interactive Coastal Inundation Maps

There are several websites that have interactive coastal inundation maps that show areas likely to flood at different storm surge levels. The Sea Level Rise Viewer allows people to see what happens at different water levels. Another source is the Surging Seas Risk Finder. NOAA has maps that show storm surge vulnerability along the Atlantic and Gulf coasts. See the example below. If one or more of these meets your community's needs, you can skip Step 2.



This screenshot shows the depth of flooding from expected storm surge during a Category 2 hurricane at Naples, FL. **Pinellas County, FL** uses this approach too.

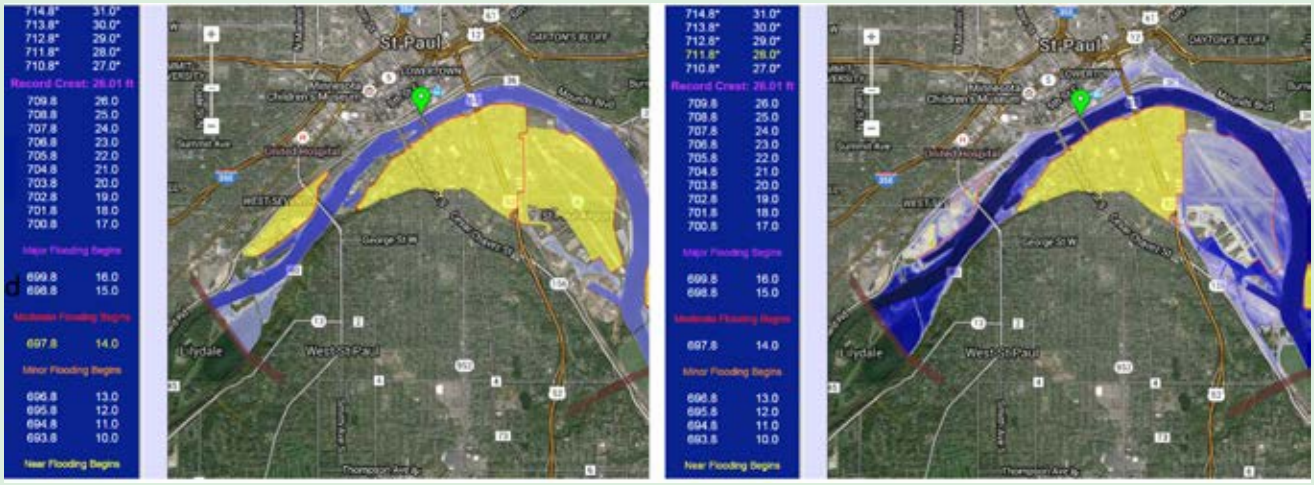
Interactive AHPS Maps – St. Paul Example

The National Weather Service's Advanced Hydrologic Prediction Service gauge data show the predicted time and level of the flood crest. The NWS has worked with local sponsors (who contribute funds) to include another information tool—the interactive inundation maps for more than 100 gauges.

On the AHPS home page map, zero in on St. Paul, MN. Click on the Mississippi River at St. Paul, STPM5. You'll see a hydrograph showing recent water levels, when water is rising and a predicted level over the next several days. The hydrograph relates water levels to levels like "flood stage" and "major flooding."

For this gauge, click on "inundation mapping" above the hydrograph. This brings you to a screen that looks like the ones on the next page. To the left of the inundation maps is a menu with "Inundation levels." Run the cursor over the levels.

Tool 2: Flood Inundation Maps, cont.



The map on the left shows the area inundated at river stage 14 feet, considered "minor flooding." Areas protected by levees are shown in yellow. The map on the right shows major flooding at river stage 28 feet, when two of the leveed areas are flooded. The flood depth is shown by shades of blue, with darker blue being the deepest.

The inundation mapping had many contributors coordinated by the local Silver Jackets team. ** LIDAR was provided by the state. Modeling and mapping was done by the Corps of Engineers and USGS. The city helped calibrate the maps to historic flood levels and the NWS posted the results on its AHPS page. The city will be adding informational placards along a waterfront trail and in the Science Museum of Minnesota.

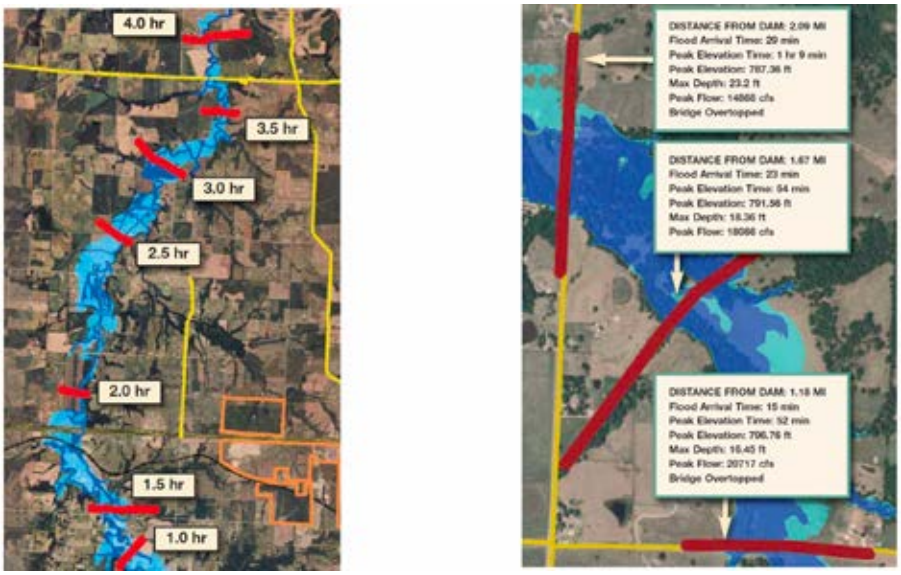
Any community on a stream served by a gauge in the system can request inundation mapping for that gauge. Another AHPS inundation maps example is at the end of the Our Lady of Lourdes Hospital case study.

** Silver Jackets is a program sponsored by the U.S. Army Corps of Engineers to bring state, federal and sometimes tribal and local agencies together to tackle flood-related issues.

Tool 2: Flood Inundation Maps, cont.

Dam Failure Inundation Maps

When there is the potential failure of a dam upstream, check with the dam operator, state dam safety office or state emergency manager. Larger dams are usually required to prepare dam failure inundation maps, which show when a flood would reach a downstream area (shown below).



Be aware that some dam failure inundation maps are treated as classified documents by some agencies and will need to be stored and secured appropriately.

Often, residents and even community staff underestimate the hazard of a dam failure. This is particularly true if they think the dam is for flood control or if the reservoir is dry or low most of the time. In many cases, the dam failure inundation area is much larger than the Special Flood Hazard Area shown on Flood Insurance Rate Maps, especially where the dam is rated as containing the 100-year flood.

The area that will flood when the spillway overflows, or when the dam operator opens gates to prevent overtopping, must be mapped. These concerns are discussed in Tool 4 of the NAI How-to Guide for Hazard Identification and Floodplain Mapping and ASFPM's report A Strategy to Reduce the Risks and Impacts of Dams on Floodplains.

In these cases, the inundation maps should be provided to the planning office that reviews new subdivisions and other developments so they are fully apprised of the hazard.

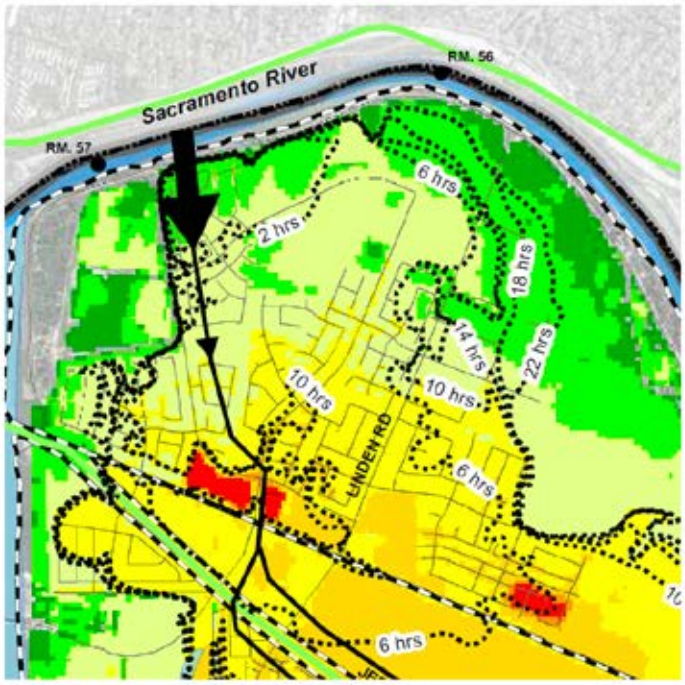
The current standard practice for dam breach inundation mapping is to map the maximum extent of the worst-case dam breach scenario. Breaches can be large or small, so there is really a range of areas that could be inundated. Some communities are now looking at dam breach maps in the same way they look at flood stage ranges, with different flood levels based on different breach scenarios.

Tool 2: Flood Inundation Maps, cont.

Levee Failure Inundation Maps

Leveed communities should investigate preparing levee failure inundation maps. Often, inundation maps assume the entire area protected by the levee will be flooded. That may happen, but it won't happen instantly. Emergency managers can do many things during the time it takes to fill up the levee-protected area.

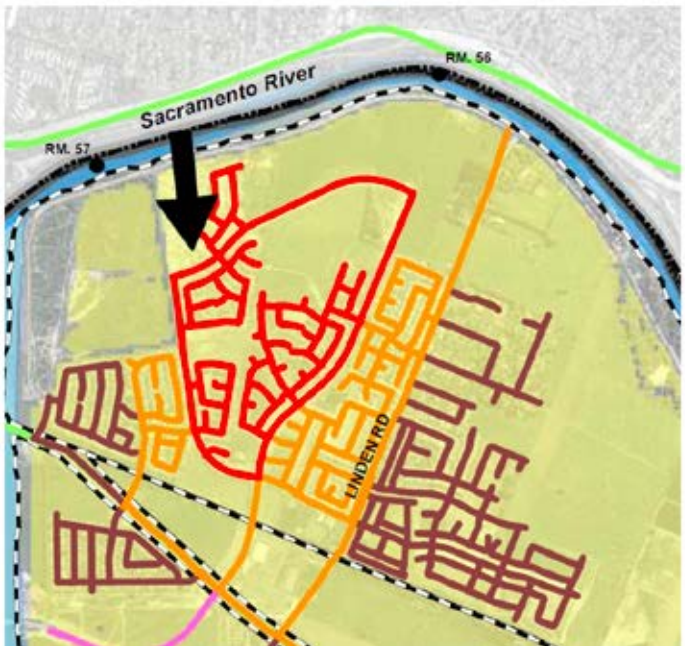
Today's technology can run scenarios for breaks in dozens of different locations. This example is based on a levee breach at the location of the black arrow.



The map to the left shows flood depths in different colors for the modeled flow. The dotted lines show the approximate number of hours from the time of the breach until the area outlined has water 1 foot deep.

Maximum Flood Depth (ft):

- 0 - 3
- 3 - 6
- 6 - 9
- 9 - 12
- 12 - 15
- 15 - 18
- 18 - 21
- 21 - 23



This map (of the same area as above) shows when the streets will be flooded to a depth of 1 foot.

Evacuation Routes Inundation Times (Approximate One-Foot Depth):

- Impassable in 0-4 hours
- Impassable in 4-8 hours
- Impassable in 8-12 hours
- Impassable in 12-18 hours
- Impassable in 18-24 hours
- Impassable in 24-30 hours

Maps from "Flood Emergency Preparedness Mapping," West Sacramento, CA, 2006

Tool 2: Flood Inundation Maps, cont.

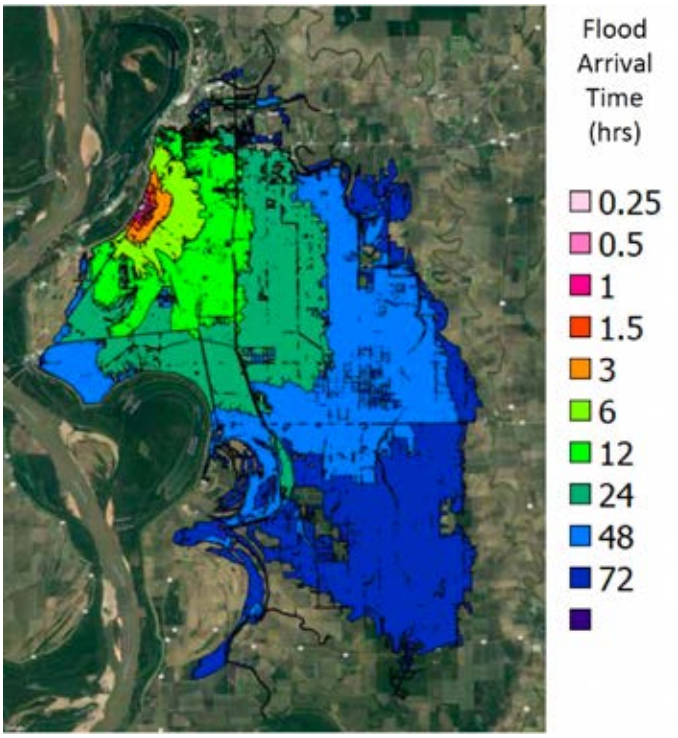
DSS-WISE

Decision Support System for Water Infrastructural Security is a web-based tool that displays areas of what could be flooded by a dam or levee failure. It is a free system developed by FEMA and the University of Mississippi. It's also a secure system, so users need to request access.

Being web-based, no special software is needed. It uses digital elevation modeling and already has data on dams and levees in the national inventories. The system is available 24 hours a day and results can be seen on mobile devices.

DSS-WISE has an interface with HAZUS-MH, FEMA's flood-loss estimation tool. It can provide data on the impact of the flood on people, property and critical facilities, so it is useful for training and running scenarios, as well as real-time flood emergencies.

More information about the tool can be found in a presentation at the 2017 ASFPM annual national conference.

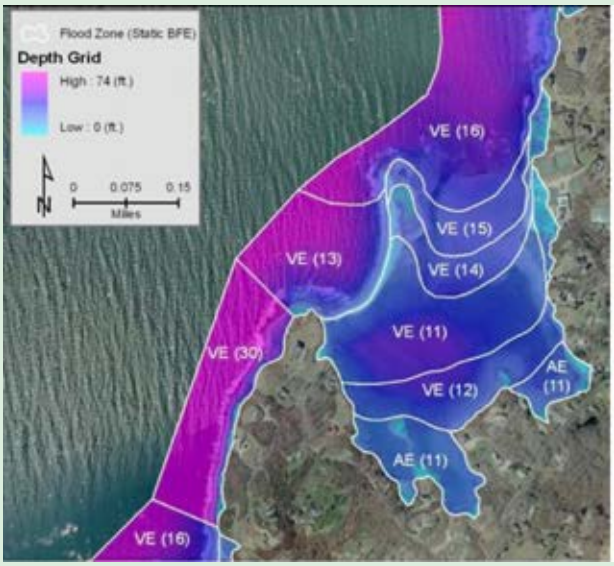


An example "Results Map" from a DSS-WISE Mississippi River levee breach simulation.

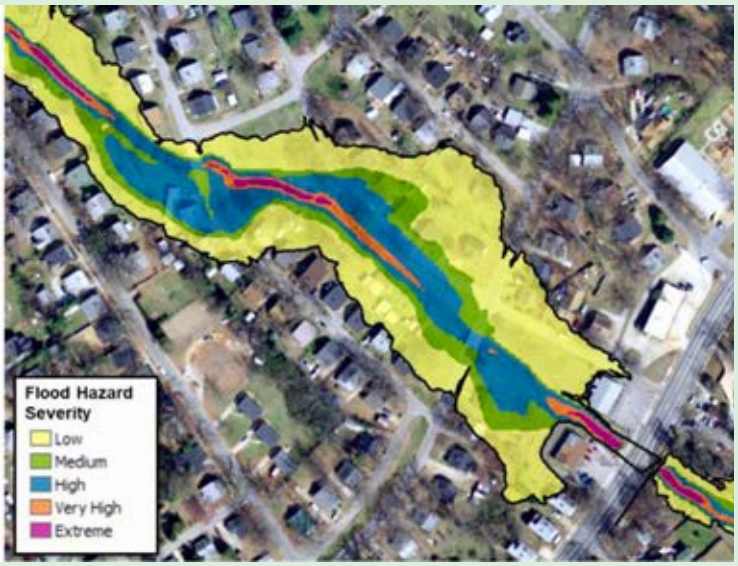
Tool 2: Flood Inundation Maps, cont.

Flood-Depth Grids

FEMA's Risk MAP program produces a flood-depth and analysis grid product, which shows the depth of the base flood above ground level (below left). Flood-depth grids can be helpful showing areas most impacted by flooding up to the base flood elevation. With care, they can be used to predict flood impacts, which helps in response, recovery and damage assessment.



A standard flood-depth grid, which shows the depths of the base flood in different colors.



This map shows a "flood severity" grid using a factor of depth x velocity.

Map Source: Guidance for Flood Risk Analysis and Mapping, FEMA, May 2014, pages 9 and 20

At the beginning of the Risk MAP process (discovery), a community can request a flood-depth grid that may vary from the standard products. A map showing the 500-year flood depth could be more useful, especially for a community that already has a lot of data on smaller floods. Another possibility is the example on the right, above. This map shows a combination of depth and velocity to delineate areas most hazardous to people.

These are not "flood inundation maps" as used in this tool because they don't delineate areas affected by different flood levels. But they can add valuable data for emergency management and flood hazard planners.

Tool 2: Flood Inundation Maps, cont.

How to: Prepare flood inundation maps

The following steps outline how to develop flood inundation maps. The preferred approach is to use an engineering flood model associated with the community's effective Flood Insurance Study. It should correlate to a stream gauge or other flood threat recognition system. However, if a hydrologic and hydraulic engineering model is not available, a simple topographic mapping effort may suffice.

If you already have flood inundation maps, you can skip Steps 1 and 2. See page 42 on calibrating the maps.

STEP 1. DETERMINE YOUR NEEDS

This section assumes the user has a flood threat recognition system linked to a local gauge or other prediction system, such as a NWS hurricane or storm surge prediction (see Tool 1).

The flood inundation mapping benefit is that it helps emergency managers determine what may happen at different predicted levels to assist in planning the flood response. Here are some things to consider:

- The flood levels do not need to be tied to any particular recurrence interval, such as a 50- or 100-year flood. However, if people are familiar with the SFHA on your FIRM, it may be helpful to have the BFE shown as one of the levels in the inundation maps.
- It may be beneficial to map the recurrence intervals of historic floods so users and the public can better relate to the map. See the levels for South Holland's map.
- In a slow-rising flood situation in a flat area, different flood levels can have very different impacts on the resources needed. The emergency manager may want to see where the water would go at every foot of flood level (or even every half foot). St. Paul (p. 33) and South Holland are in flat areas and their maps show 1 foot increments.
- The level of accuracy (and therefore the cost) may diminish if the objective is to inform the public of high-hazard situations or evacuation zones. Horry County's "Know your Zone" (p. 32) and Pinellas County's program use major roads and water features as the evacuation zone boundaries. The public can relate to these locations better than less obvious boundaries, like topographic contours.
- In a slow-rise situation, an interactive map can be more useful. On the other hand, in a flash flood scenario where minutes count, it may be dangerous for people to spend time interacting when they should be evacuating. Examples of interactive maps are on pages 31, 64 and 68.
- For flash flooding or in deeper valleys, there is not much time to respond and decisions have to be made quickly. The major concern is life safety, so a map that shows when critical bridges or roads will go underwater may be all that can be used. See the levee-failure inundation maps on page 36 that address when streets become impassable.
- Areas subject to local stormwater problems are most often mapped based on problems reported in the past. Check with your public works and emergency management offices for records of street flooding or citizen complaints during heavy storms. Review topographic

Tool 2: Flood Inundation Maps, cont.

maps that show smaller streams and low areas that have drainage or runoff problems. When preparing your map of stormwater problem areas, consider adding a foot or two of flood depth to account for bigger storms than have been reported.

- Often contour maps show large areas below a certain elevation when, in fact, some features are higher than the surrounding ground. This is common with roads, which are built up a foot or two higher than the original grade. The emergency manager needs accurate information and needs to know if a road will actually be usable, even though the contour map shows the area underwater.

STEP 2. PREPARE YOUR MAPS

If there are no existing flood inundation maps for your area, you will need to prepare your own. If there are existing maps, you should still calibrate them, as discussed on page 42.

Start by seeing who can help you.

- The USGS has a Flood Inundation Mapping Program.
- The National Weather Service's AHPS program has real-time inundation maps for over 100 locations. NWS also has a technical guide on preparing flood inundation maps.
- FEMA, your state NFIP coordinator, flood control district, regional water management district and similar agencies may have copies of existing flood study models for the area.

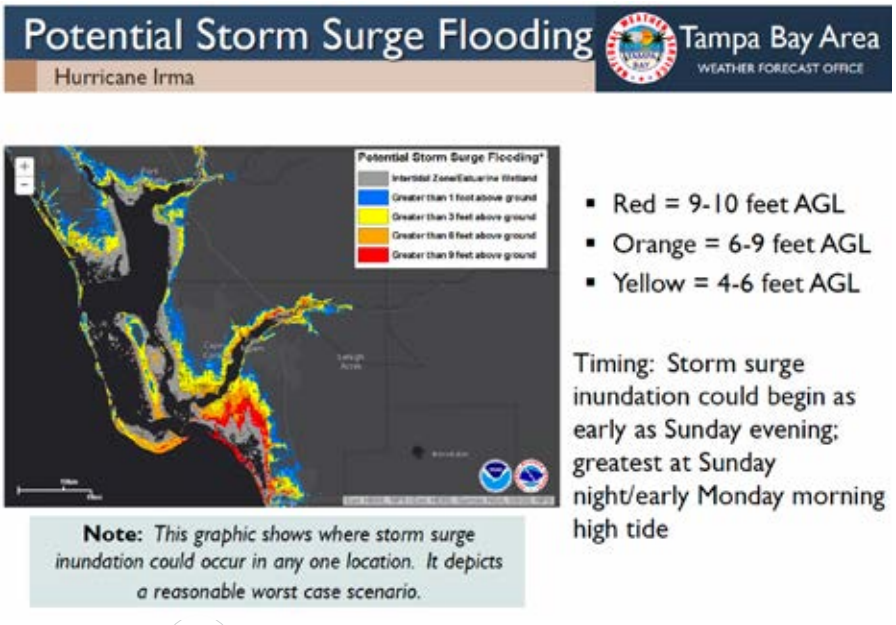
Note that the USGS and NWS programs require cost-sharing by the community.

The following approaches can be followed if you're on your own.

Coastal evacuation maps:
Because coastal storms are such damaging and frequent hazards, most coastal communities already have evacuation maps similar to the ones on page 32. If you don't have one yet, two things are needed:

1. Topographic base map
2. Access to predicted storm surge elevations. The NWS provides general surge predictions. An example is below. Check with your local NWS office to receive these.

Your regional or county emergency manager may have software, such as Sea, Lake and Overland Surges from Hurricanes (SLOSH), which can be used to prepare more local surge predictions. If that is the case, it's likely there already are inundation maps for your area.



Tool 2: Flood Inundation Maps, cont.

You can select how many surge levels are plotted, but they need to be keyed to the predictions. In the example on the previous page, the red, orange and yellow levels are in 2 or 3 feet increments. If the primary map use is to identify evacuation areas, just select a few levels (but note the "Factor of Safety" box). Be sure to coordinate with those responsible for evacuation, including public safety, transportation and emergency management staff. The boundaries for each level should be readily identifiable on the ground by the public, such as streets and water bodies.

Riverine flood model: The preferred approach for riverine situations is to run the different flood levels through a hydraulic model. This is more important where there is more at stake and there are more obstructions to flow that would make simply plotting riverine elevations misleading.

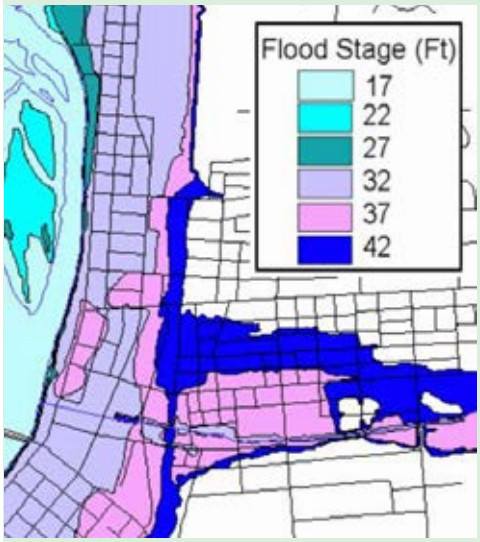
See if there is a model already available. Every riverine AE Zone on a FIRM is based on a model, which can be obtained from the FEMA engineering library. Contact your state NFIP coordinator or your FEMA regional office's engineer.

Check to see if the model has been updated to reflect the latest conditions, such as for a request for a map revision.

With the model, an engineer can provide profiles or elevations for different flood levels. The elevations are plotted on the best available topographic base map. Make sure the gauge height readings are converted to the elevation datum used in the map (usually NAVD 88, but can also be NGVD 29. See "Stage vs. Elevation" on page 25)

No flood model: Even without the model, the FIRM and profiles in the Flood Insurance Study can be very useful. The profiles show the 10-, 50-, 100- and 500-year flood levels and bridge elevations, information a lay person can use. These elevations can be plotted on a topographic base map at various locations upstream and downstream of the gauge. The boundaries of these flood levels are drawn by connecting the plots. This generates flood inundation maps for the 10- and 50-year floods to complement the 100- and 500-year inundation maps shown on the FIRM.

Factor of Safety



Consider a factor of safety in your flood response planning. For example, if you have plotted flood levels at gauge stages of 32 and 37 feet (above) and a flood is predicted to crest at 35 feet, you would want to use the area for 37 feet. This would account for a margin of error in the flood prediction and for unpredicted factors that would affect flood flow, like a log jam at a bridge.
There is a downside to this approach. People in the 35-37 foot areas may not get flooded. If they are advised to evacuate and return to find that their properties did not flood, they may be less disposed to respond to the next flood warning. There should be a follow-up public information effort to explain the community's decision.

A model was used in the St. Paul example on page 33 because:

- There are levees, bridges and other obstructions in the area;
- There is a dam downstream;
- There are a lot of people and valuable property in downtown St. Paul; and
- There already was a model available.

Tool 2: Flood Inundation Maps, cont.

South Holland did not use a flood model. It selected elevations to plot and related them to the 50- and 100-year flood profiles. The plotting was accurate because a LiDAR-derived topographic base map was used. Plotting is more difficult and less accurate if the topographic base map has larger contour intervals. It is also less accurate farther away from the stream gauge if there are bridges, a significant stream slope or features that affect flow.

If the flood threat recognition system uses gauge stage readings, make sure the maps refer or relate to stage, not just the elevations of the plotted floods. This will reduce confusion when a flood warning is issued.

Display: The map data can be displayed in different ways. The most sophisticated approach is to link the computer model to reporting gauge data and show the area affected by the specific flood that is predicted to crest at the gauge.

If the community has a geographic information system (GIS), the map should be tied to that system. This helps that map be correlated to the community's street map, critical facilities and building inventory. The National Weather Service, Pinellas County and Nashville maps do this. Otherwise, it could be a stand-alone document, such as South Holland's.

STEP 3. CALIBRATE YOUR MAPS

No matter what technique is used, your inundation maps should be calibrated. Calibration means comparing what your map says to what has actually happened. Use high-water marks or historic maps from past flood events to identify differences between your inundation maps and actual experiences. All differences should be resolved.

Keep the map(s) updated for changes on the ground, such as bridge replacements and filling, that impact where the flood will go. If you get a new flood insurance study or other updated flood data, or a better topographic base map such as LiDAR, consider preparing an entirely new map.

Stay alert for better data and changes on the ground that would help calibrate your map. If an area is flooded, record high-water marks quickly, as described on pages 35-36 of the NAI How-to Guide for Hazard Identification and Floodplain Mapping. Check social media for photos during the flood (and when they were taken). Use this information to compare the flood elevation and flooded area boundary with what your map predicted would happen at that elevation.

NFIP/CRS Flood inundation maps are a prerequisite for any credit in Activity 610 (Flood Warning and Response).

Having flood inundation maps (Steps 1 and 2) is good, but the real benefit is to develop a flood emergency response plan using what the maps tell you (Tool 3).

STEP 4. POST THE MAPS FOR PUBLIC ACCESS.

As with Step 5 for Tool 1, the flood threat recognition system can be very helpful to advise the public about what areas will be inundated. Some maps, such as the AHPS and coastal examples, are already on public websites. Some communities have put theirs on their own websites. Remember, it is not intuitive for citizens to hunt down inundation maps, so any messages warning of flooding should provide the specific website link to the online resource.

Tool 2: Flood Inundation Maps, cont.

As with publicly available flood threat recognition data, there should be some explanation of what is presented. It is very important viewers understand the map limitations, especially that it is not precise and the predictions have a margin of error. People should be advised that the lines are not exact and that properties just outside of an area expected to flood may also get inundated.

There should also be easy to follow information on what people should do in case of a flood. This information should be posted year-round to help people think about what they will do. Examples of this are in the Pinellas County and Nashville case studies. The Nashville NERVE website is a repository for press releases issued during an emergency declaration, and has real-time mapping for road closures with alternative routing to direct residents to active flood shelters.

Little Calumet River Flood Levels

Stage	Elevation	Event / Flood Response Level
26.5	601.5	500-Year Flood
25.0	**600.0**	**Black Level**
23.0	598.0	Purple Level 100-Year Flood
22.0	597.0	50-Year Flood
21.0	596.0	Red Level
20.8	595.8	November 27, 1990
20.2	595.2	June 14, 1981
20.1	595.1	July 14, 1957
20.0	595.0	Orange Level July 20, 1996
19.6	594.6	December 3, 1982
19.4	594.4	10-Year Flood
19.2	594.2	April 6, 1947
19.1	594.1	February 21, 1997
19.0	594.0	Yellow Level Water reaches buildings on Drexel
18.6	593.6	June 2, 1989
18.2	593.2	October 10, 1954
18.0	593.0	Thorn Creek begins to cover 170th Street
17.9	592.9	February 24, 1985 Water covers streets at Riverview and Drexel
17.7	592.7	December 27, 1965
17.0	592.0	Flood Warning issued
16.5	591.5	National Weather Service Flood Stage
16.0	591.0	Flood Watch starts
15.0	590.0	Water enters Veterans Park

Flood Assistance

- Flood Assistance
- Floodplain Management Plan
- Keeping Your Home Out Of Deep Trouble
- FEMA Flood Protection Library
- Elevation Certificates
- Little Calumet River Flood Levels
- Sewer Backup Prevention Pilot Program
- Flood Articles
- Flood Protection

Flood Articles

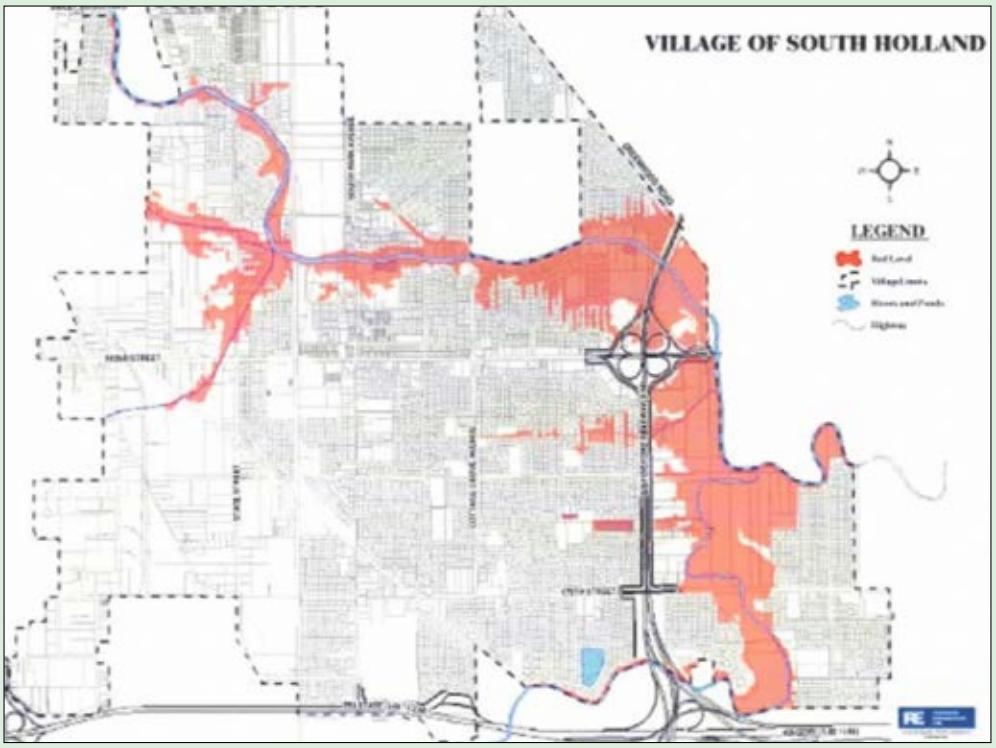
- Flood Articles
- Code Enforcement Answers
- Flood Insurance
- Floodplain Functions
- Village Regulations
- Why Flooding Occurs

Flood Protection

- Flood Protection
- Our Flooding Problems

Tool 2: Flood Inundation Maps, cont.

Red Level Floodplain Map Flood Stage 21 feet



South Holland's webpage with gauge data and maps includes links to information on what to do during and after a flood, as well as pages on flood insurance and permit requirements.

http://www.southholland.org/departments/flood-assistance/little-calumet-river-flood-levels

Tool 3: Flood Response

Flood response is a collective term for actions implemented after the community is notified that a flood is coming. At the local level, flood response activities are directed by the community's chief executive officer (mayor, county manager, etc.) and coordinated by the community's emergency manager.

"Coordination" is the foundation of emergency management. There are so many things that need to be done during and after an emergency by so many local, state, federal agencies, private companies and organizations, that a formal, consistent coordination process is necessary. The National Preparedness System's National Response Framework outlines how the Incident Command System is followed, so team members perform the duties assigned to their role and everyone knows who is responsible for what actions.

The National Incident Management System is a comprehensive, national approach to incident management that is applicable at all jurisdictional levels and across functional disciplines. It should work across the range of potential incidents, hazards and impacts, regardless of size, location or complexity. These two systems are well established and proven to work during all types of emergencies, especially those with little warning time, such as tornados, earthquakes and hazardous materials spills, as well as flash floods, tsunamis and dam failures. The Pinellas County case study, has some information on NIMS.

Each state and community has emergency operations plans and organizes its emergency operation center staffing to reflect their needs and the hazards most commonly faced. Most are consistent with the NIMS and ICS structure and use common operating procedures and terms to facilitate working with other emergency management and response agencies.

Tool 3 reviews four steps to incorporate flood data and floodplain management support into the community's emergency response program.

Step 1. Define the flood threat Review data on all aspects of flooding to set priorities for the plan

Step 2. Determine flood response actions Ensure the response plan includes key flood-specific actions

Step 3. Determine flood recovery actions Ensure the plan include flood-specific actions during repairs and recovery

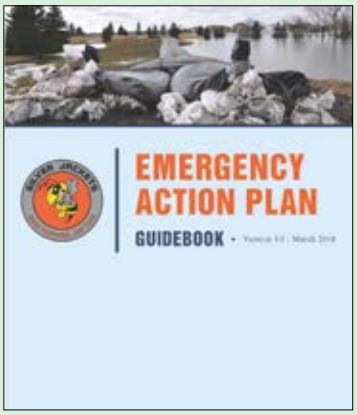
Step 4. Publish, practice and revise Document, drill (or be flooded), learn lessons and update the document

This *Guide* does not recommend developing a stand-alone flood response plan. Rather, the community's floodplain and emergency managers should work together to develop a flood-specific plan of operations as a **flood annex to the emergency operations plan.**

Tool 3: Flood Response, cont.

The CRS provides credit for flood response planning in Activity 610 (Flood Warning and Response), FRO – flood response operations. There are also response operations credits in Activities 620 (Levees) and 630 (Dams).

Note: While this Tool references "flood" response, much of what is discussed here is relevant to any type of disaster that impacts the floodplain.



If your community does not have an existing planning format or wants to develop a flood annex from scratch, a good guide is **Emergency Action Plan Guide-book** prepared by the Silver Jackets and the Corps of Engineers.

How to: Prepare a flood response plan

The floodplain and emergency managers should work together to develop a flood annex or incorporate flood-specific measures in the overall emergency operations plan.

This would be undertaken over several months, during normal (non-disaster) times after Tools 1 and 2 have been completed and the community has a flood threat recognition system and inundation maps.

During the post-disaster or after exercise evaluation, lessons learned should be reviewed and incorporated into the emergency operations program.

STEP 1. DEFINE THE FLOOD THREAT

As the repository of the flood maps, the floodplain management office should be the best source of data on the different flood threats, during either advanced planning or an actual flood. You should know what information you have and be able to retrieve it quickly.

It is essential to have well-indexed, easily-retrievable data. The flood-hazard maps should be linked digitally to the emergency operation center website, with paper copies available (you may not have the plotters or the time during an event).

Start with the flood inundation maps, if you have any. If not, use what you have, including the FIRM. Here is the type of information that can help the emergency manager:

- Where will different levels of floods go? How much warning time is there for each level?
- At what flood levels will critical facilities be impacted? Note that a critical facility can be impacted well before water reaches it. For example, a fire station can be high and dry, but of no use if the roads are underwater. Coordinating with critical facilities is discussed in Tool 4.
- Are there certain levels when a flood control structure could be overtopped, pumps overwhelmed or storm sewers back up?
- What areas should be evacuated at what flood levels? The emergency manager will need to estimate how many evacuees there will be, how many will have special needs, and whether farm animals will be exposed to danger.

Tool 3: Flood Response, cont.

- Are there preferred routes from evacuated areas to appropriate shelters? At what levels will roads, bridges and evacuation routes need to be closed?
- Will there be secondary hazards, such as debris from lumberyards, hazardous materials or polluted water?
- What actual or predicted flood level should trigger a flood watch or warning?
- Do you have pre-scripted messages? Should there be different messages for different areas?
- Is there a possibility of more severe coincidental flood events, such as small tributaries cresting at the same time as the main flooding source? While rare, the result could be higher flood levels.

In pre-flood planning, take the time to itemize the details at each flood level. South Holland, for example, determined the number of streets to close at each level and estimated the number of barricades that would be needed. The Nashville SAFE tool has color-coded icons that light up at each intersection and bridge that are impacted by rising water.

During a flood emergency, the focus is on life safety priorities, such as flooded critical facilities, and evacuation and sheltering, especially vulnerable populations and health care facilities.

Flooding Downstream of Dams

The Tool 2 inundation mapping process should include the area impacted by a dam breach and/or a dam release. Here are some things to consider when defining the flood threat in areas downstream of a dam:

- Has the emergency manager coordinated with the dam operator, and is contact information up to date?
- Is there an emergency action plan for the dam?
- Are there procedures to notify the emergency manager when a problem starts?
- Do the emergency manager, floodplain manager and the operator of the dam participate in each other's emergency exercises?
- Could a flood result from standard operating procedures that draw down the reservoir when water is high and the structural integrity of the dam appears threatened?
- Could problems arise when high water flows through the spillway? A good example of this is at the beginning of Tool 4 in NAI How-to Guide for Hazard Identification and Floodplain Mapping. Because the dam was rated as a 100-year flood control dam, the area downstream of the spillway was not mapped as a flood hazard area and homes had been constructed in the path of an overflow.

More information on dam failure mapping can be found under Tool 4 of NAI How-to Guide for Hazard Identification and Floodplain Mapping and from the Association of State Dam Safety Officials.

Tool 3: Flood Response, cont.

STEP 2. DETERMINE FLOOD RESPONSE ACTIONS

Once the flood threat is well defined, appropriate response actions can be determined. Many, if not all, response actions are probably already in the existing emergency operations plan. For example, evacuation and shelter require support functions that are similar for all disasters. Flood specific help would include identifying evacuation routes and shelters that will be unusable and estimating the number of evacuees at different flood levels. This step is not a complete list of everything done during a flood emergency. Instead, it identifies flood-specific factors that should be addressed in the flood annex and during the emergency response.

1. Activation levels: Many agencies use terms like "alert stage" and "flood stage." The National Weather Service program uses "flood watch," "minor flooding," "moderate flooding," etc. With flood inundation maps, a community can be more specific. In Step 1, the flood threat should be defined in terms of what happens at different flood levels.

Consider:

- A low level of flooding may not be a problem at all. A little higher level might only flood low-lying roads, in which case maybe only the first responders, police and highway departments are called. It may not be necessary to activate some offices or organizations until water is predicted to impact something that affects their area of responsibility.
- Consider lead times in addition to the locations shown on the inundation map. Some areas will have hours or days of advance notice while some flash flood areas may have only minutes.
- Each agency should review the flood threat information to determine their workload. They may need extra lead time for some assignments, well before the water might threaten an area.
- Examples of pre-flood plans with actions keyed to the different flood levels can be seen in the box to the right and in the South Holland, Our Lady of Lourdes Hospital, and Ventura County case studies.

Like the Community Rating System and Emergency Management Accreditation Program, the National Weather Service's StormReady and TsunamiReady programs can pro-vide additional incentives for the community to include flood and severe weather components in its emergency management program.

See:
http://www.weather.gov/stormready

KEY FLOOD ACTIVITIES THAT NEED TO BE MONITORED

12 Feet Close off Edgewater Park

13 Feet Close Grand Ave. between Alexandria Pike and Broadway. Notify residents along Short Hazlett, 1st & Madison, 2nd & Sycamore, and Riverside Dr. to prepared for sandbag operations and to make preparations for possible evacuation (dependent on forecast and rate of rise)

14 Feet Manhole at Athletic Park behind pool starts to overflow. Killbuck Creek begins to overflow into Aqua Gardens/Shadyside Lake—close off walking paths around lakes.

Example from the flood response plan for Anderson, IN showing specific actions at different flood levels.

Tool 3: Flood Response, cont.

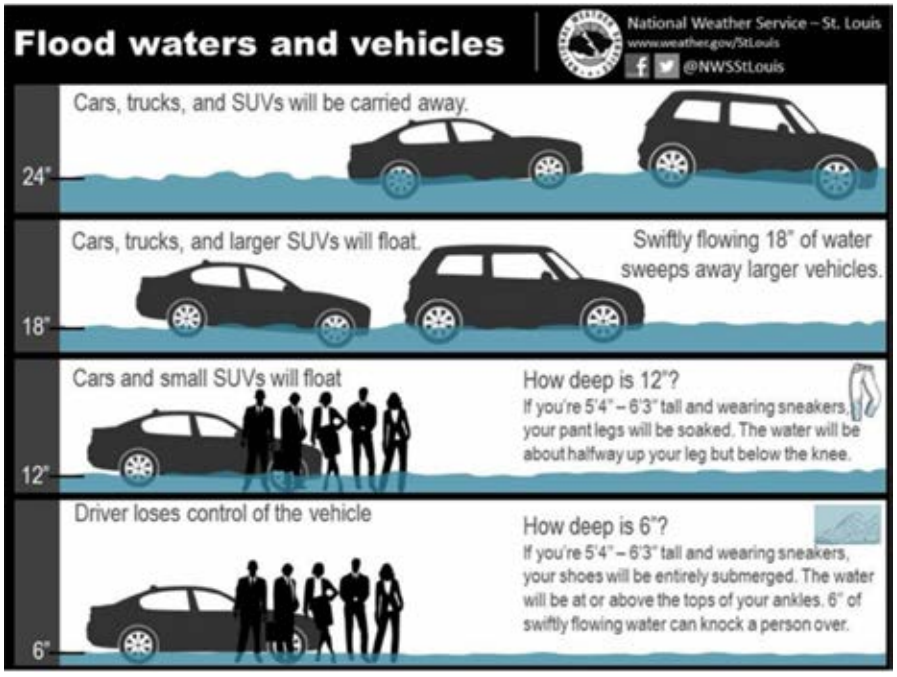
2. Warning the public: There are several different ways to convey a flood warning to affected residents and businesses. They can include posting a sign in a public place, radio and television broadcasts, telephonic notification systems, text messages and social media. The emergency manager is likely aware of and experienced with these approaches and is in communication with the state EOC and the NWS to coordinate notification.

Because in many cases flood watches and warnings can be issued well before the flood occurs, they can and should include instructions on what to do and where to go.

They should be repetitive, so people eventually get the message.

One concern in coastal areas is that people are used to warnings about hurricane categories (e.g., "Cat 1"). While these categories relate to wind speed, not flood levels, messages should include warning about storm surge and inland flooding.

One way to clarify the coastal flooding threat is to use letters instead of numbers for the evacuation zones. Horry and Pinellas Counties' "Know Your Zone" programs are examples of this.



The National Weather Service's flood safety message "Turn around, don't drown" should be repeated whenever a flood threatens to cover roads or bridges.

For more information:
http://tadd.weather.gov

Flood safety messages should be consistent among agencies and made a part of year-round public information activities. More information on reaching people with flood-related messages can be found in the NAI How-to Guide for Education & Outreach.

NFIP/CRS The CRS provides credit of up to 50 points for preparing flood safety and protection messages in advance under the element FRP – flood response preparations in Activity 330 (Outreach Projects) and up to 30 points for pre-scripted messages under the

Tool 3: Flood Response, cont.

element EWD in Activity 610 (Flood Warning and Response). The other two activities in the 600 series have similar elements: levee failure warning (620 – LFW) and dam failure warning (630 – DFW).

3. Evacuation: Experience has shown that it is very hard to get everyone at risk to leave the areas vulnerable to flooding or a coastal storm in advance of a flood. Perhaps it is because floods are viewed as less dangerous than other hazards or people need to see the threat and won't respond to a prediction. Others feel they need to stay to protect their property from damage or potential looting, or they do not want to leave their pets if pets are not allowed at evacuation centers. Having evacuation centers that accept pets and ensuring people are aware their pets are welcome can increase the numbers of people willing to evacuate. In any case, the emergency operations plan will detail evacuation procedures and staff and agency roles and assignments.

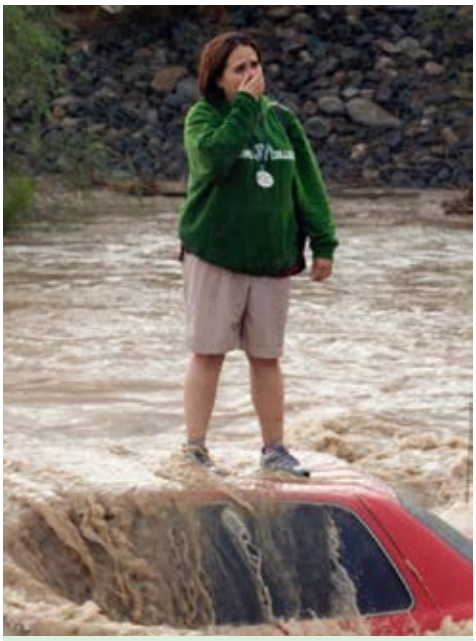
As noted earlier, the key is to use the flood inundation maps to answer these questions:

- Which areas need evacuating at what flood levels?
- What is the best place for evacuees to go?
- Does that area have adequate shelters?
- At what level will the evacuation routes become unusable?
- Are special vehicles needed to evacuate chronically ill and disabled people?

It would help if the community had a year-round public information program that explained flood hazards, the need to evacuate when advised to, and the dangers of a water rescue. The messages could also emphasize that more people are killed in their vehicles than anywhere else during a flood – that is the reason for the "Turn around don't drown" campaign. These messages will hopefully encourage early evacuation.

The Pinellas County case study provides an example of evacuation planning.

It should be noted there may not be enough time for everyone to evacuate before a flood arrives.



This scene is one possible result of an ill-timed evacuation (or someone who didn't get the message to "turn around, don't drown"). The woman was rescued. -Photo by Aaron J. Latham with Arizona Daily Star in FEMA photo library.

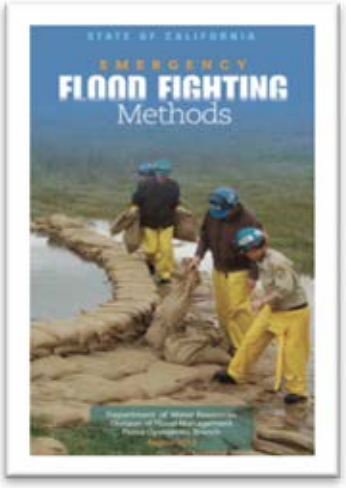
A pre-flood review of the inundation maps, flood timing, depths and velocities, residents at risk, special needs populations and road capacities may indicate that staying on a higher level floor could be safer than risking evacuation on congested roadways with poor visibility and high winds. Some communities in tsunami-prone areas are encouraging vertical evacuation, also called "shelter-in-place."

Tool 3: Flood Response, cont.

4. Flood fighting: This is a term that includes actions to take just before and during a flood to minimize damage to property. It can include:

- Implementing emergency action plans at critical facilities;
- Closing floodgates, checking pumps, etc., at water control facilities;
- Patrolling levees and other flood-control features to spot problems;
- Moving damage-prone property to higher levels; and
- Erecting barriers to protect areas or buildings.

The best known flood fighting measure is sandbagging. There are right ways and wrong ways to erect a sandbag wall. The Corps of Engineers has guidance and training materials on the right ways to build walls, reinforce levees, control sand boils, etc. A guide is on page 52. While sandbagging is labor intensive and has limitations, protecting doorways and openings can be an efficient way to protect buildings from low-level floodwaters.



This California Department of Water Resources guide is available at:

www.water.ca.gov/floodmgmt/docs/flood_fight_methods.pdf

Flood barriers can be erected without filling thousands of bags. Alternative methods include:

- Shields or closures designed and constructed to protect specific openings (below left)
- Bags filled with dirt or gravel instead of sand
- Tubes and bladders filled with water (below right)
- Steel structures with a waterproof membrane
- Hay bales, plywood or lumber covered with plastic sheeting
- Concrete traffic dividers (Jersey barriers)

Barriers fabricated to close openings are faster and easier than sandbagging. -French Wetmore

Bladders filled with water are another faster alternative to a sandbag barrier. -From U.S. Flood Control, makers of "Tiger Dams."

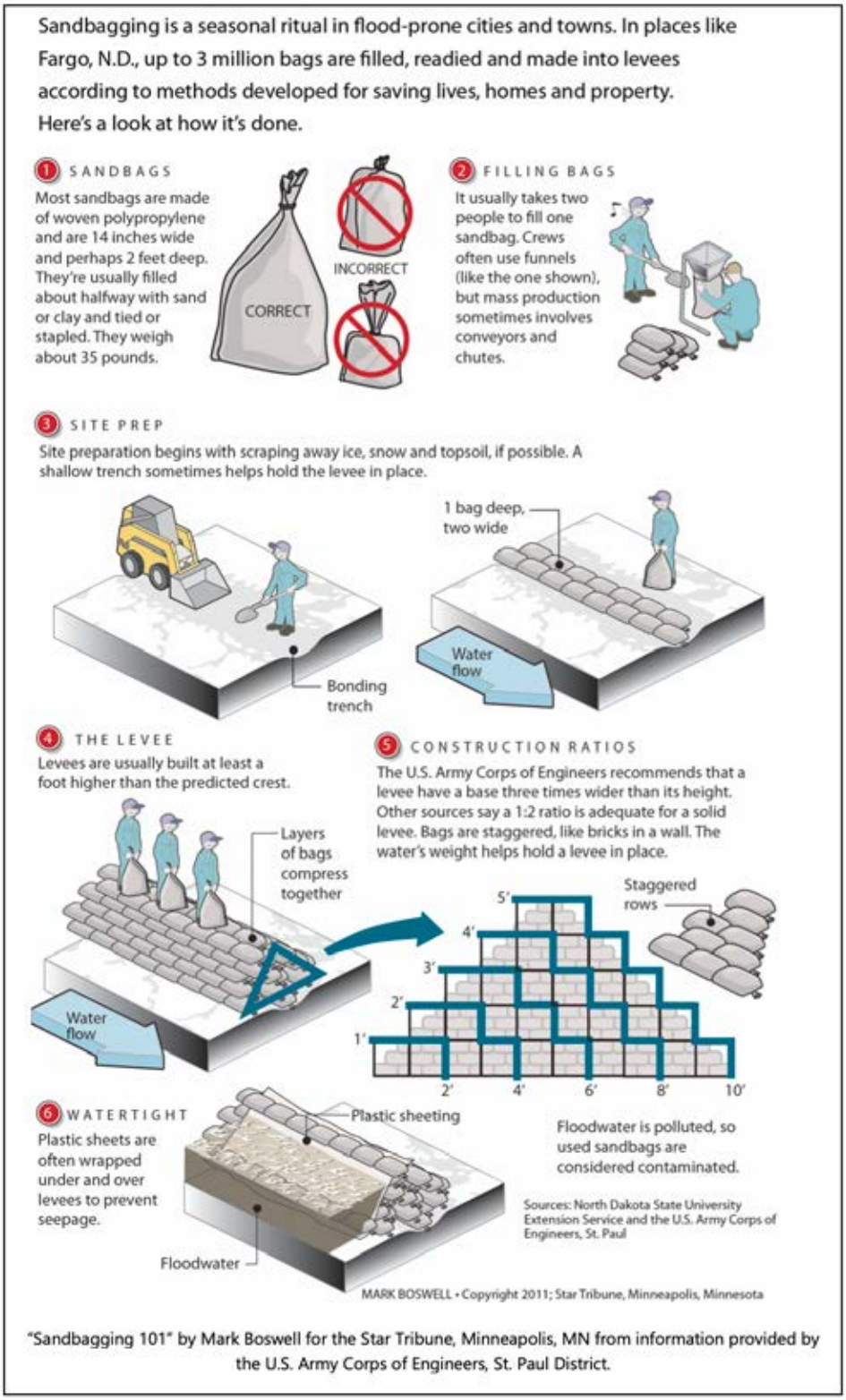
NATIONAL FLOOD BARRIER TESTING & CERTIFICATION PROGRAM

There are many companies that sell barriers and some have been tested by the U.S. Corps of Engineers and FM Approvals under a cooperative program with ASFPM. More information on the National Flood Barrier Testing and Certification Program is at **http://nationalfloodbarrier.org/**

Tool 3: Flood Response, cont.

Whether barriers are constructed with sandbags, inflated tubes or lumber, they all have three very important **shortcomings**:

1. Erecting barriers can be very labor intensive and can expose workers to the flood threat (right). Sandbagging can take a long time. It should only be attempted if you are sure it will be finished in time and that it will be high enough for the expected flood. In addition, sandbags can be a disposal problem. Sandbags used to be made of burlap that would gradually breakdown over time. Today, most sandbags are made of woven polypropylene. Due to the contaminants found in floodwaters, while they could potentially be reused, they cannot be easily recycled and often end up in landfills in which they will not decompose. Due to concerns about the long-term issues with plastics, in California, only burlap is an allowable material for sandbags. In keeping with the No Adverse Impact concept, communities should use burlap sandbags and have a remediation plan in place that focuses on cleaning and reuse.



Tool 3: Flood Response, cont.

2. Barriers can leak, be overtopped or fail. They are not as safe as evacuation of people or moving contents to higher levels.
3. Barriers can divert floodwaters to other properties. Such action could expose the community to liability for damage to properties that otherwise might not have been flooded. The emergency operations plan should limit barriers to locations very close to existing buildings, and not try to protect streets or larger areas if it would obstruct flood flows and reduce flood storage.

In short, flood-fighting efforts should be well planned in advance. They are not as preferred as the permanent preventive and mitigation measures outlined in the other NAI how-to guides.

STEP 3. DETERMINE FLOOD RECOVERY ACTIONS

Almost every disaster leaves people homeless, infrastructure damaged and debris to be cleared. Again, your emergency manager has procedures and training for this.

As the floodplain manager, you can help with the following flood-specific concerns.

1. Flood data: High-water mark data should be collected immediately after a flood passes. Water marks showing flood levels tend to disappear quickly. Immediately after a flood, people will start cleaning and power washing their buildings and driveways.

High-water marks provide vital information for insurance claims, characterizing the flood recurrence level, future flood response planning, and even future messaging. They are especially useful to refine flood inundation and regulatory maps. High-water marks need to be recorded and photographed right away. The USGS publication "Identifying and Preserving High-Water Mark Data" provides guidance how to collect high-water mark data. More information on this is in Tool 1, Step 3, of the NAI How-to Guide for Hazard Identification and Floodplain Mapping.

2. Polluted water: Floodwater is filthy. It carries sediment, oils, farm chemicals and other hazardous materials. If wastewater treatment plants or livestock feed lots are overwhelmed, it can include raw sewage.

As soon as it is safe to do so, water and sediment left by the flood should be tested by public health authorities.

HELP FROM THE CORPS

The Corps has two programs to help during flood response.
If there is an "imminent threat of unusual flooding," the Corps' Advance Measures authority allows districts to provide direct assistance to communities. Typical advance measures include strengthening existing levees, building temporary levees, clearing channels, dredging, and dewatering reservoirs if the dam is in jeopardy.

Under its Emergency Operations authority, the Corps can provide emergency assistance to save lives and protect public facilities and infrastructure during or following a flood or other natural disaster. There are two main types of assistance: technical (planning support, technical advice, engineering expertise and other guidance) and direct assistance (supplies and equipment, emergency construction contracting).

These programs are managed by your Corps district, which can be found here:
https://www.usace.army.mil/Locations.aspx

Tool 3: Flood Response, cont.

Private wells inundated by floodwaters should be tested to ensure they are not contaminated. There should be health and safety guidance for different pollutants and hazardous materials. Check with the public health office.

Current information on post-disaster health hazards should be available through the state department of health, state emergency management agency, in local media releases and the Center for Disease Control.

If the hazards are severe enough, residents should not be allowed to go back to a flooded area. This can be beneficial for managing post-disaster reconstruction and planning. For example, testing after a flood in Highland, IN in 1990 found traces of PCBs in the water. Access to area needed to be restricted for several weeks, allowing the town to develop a plan for mitigation before repairs and reconstruction began.

3. Debris: The emergency manager likely has a debris management plan that identifies priorities, local companies that can help, etc.

Aerial view of oils in flood waters from flooded propane tanks and cars. Franklin, VA, 1999. -FEMA photo by Liz Roll

After a flood:

- Be sure to clear river channels and drainage facilities. If they are blocked by debris, it won't take much rain to cause another flood.
- Consider whether the water was polluted enough that sand from sandbags may need to be taken to a hazardous materials landfill.
- Determine if wet building materials, appliances, etc., are contaminated to the degree that they should be segregated from other debris.
- The Corps of Engineers has special debris management authority that can support FEMA's debris management programs and provide technical assistance.
- Public information is very important. There are limits on the use of federal funds to remove debris from private property, so much of the work may be done by homeowners who are not aware of the health and safety hazards when they try to remove debris washed up in their yards.
- Environmental protection agencies should be involved in cleanup of any hazardous materials.

Tool 3: Flood Response, cont.

4. Mold and mildew: Mold and mildew are microscopic organisms that thrive in moist environments and grow on organic materials such as wood, cardboard, wallpaper, carpets, drywall and fabric. Mold colonies can begin to grow on a damp surface within 24-48 hours. Eventually they destroy the material they grown on.

Mold growing on a wall weeks after the flood subsided.
-Photo by French Wetmore

All molds can adversely affect human health when the airborne spores are inhaled. They can cause respiratory problems, sinus congestion, eye, nose, throat and skin irritations, memory loss and mood changes. People at higher risks include children, immune-compromised persons, pregnant women, individuals with existing respiratory conditions and the elderly.

These facts warrant treating mold and mildew as a special hazard during building inspections, repairs and reconstruction. Guidance from the Centers for Disease Control can be found at www.cdc.gov/mold.

5. Re-entry: There will be very strong desires for people to get back to their homes to clean up and move back in as soon as possible. There should be procedures for deciding if the area and individual buildings are safe to enter. Re-entry procedures should be part of the emergency manager's emergency operations plan. The Applied Technology Council has guidance on inspecting flooded and wind-damaged buildings for safety issues. More information is at www.atcouncil.org/atc-45.

Step 4. Publish, practice and revise

As noted earlier, the best approach for Tool 3 is to have the flood response actions established in advance of an event, preferably in a flood annex to the emergency operations plan. Even if you didn't get that luxury and you had to start your flood response work when the water was rising, you

Controls are needed to ensure safe and healthy conditions before people move back in.
-FEMA photo by Patsy Lynch

should still prepare an after-action report. Use the lessons learned to improve the response actions before the next flood.

In either case, there should be a document with flood response policies, procedures and staff roles. It should be circulated to all affected staff for review and comment. It should follow the format and adoption procedures of other plans or annexes used by the emergency management office.

Plans can become stale when floods are not frequent. Or worse, they can't be found when needed. Emergency managers know this and conduct exercises every year that remind participants what their jobs are. Different scenarios are run and new issues are revealed.

Tool 3: Flood Response, cont.

The exercises are evaluated and the plans updated accordingly.

This process is described in the Homeland Security Exercise Evaluation Program. Such exercises have proven so valuable, they are a prerequisite for CRS credit (right).

An exercise can take many forms. It can be an orientation, discussions around a table, running through scenarios in the emergency operations center, or even deployment of staff to the field with hands on practice filling sandbags. Short tabletop exercises may be the most popular and efficient.

"The important thing to stress is that key stake¬holders should get together at least annually to review the procedures in place and make appropriate adjustments. Some of our most productive sessions have been open discussion multi-jurisdictional meetings that lead to change. Recent event hot washing is another great way to improve systems."

– Kevin Stewart, Flood Warning Program Manager, Denver Urban Drainage and Flood Control District

Emergency operations exercises provide training and feedback for program improvements. -FEMA photo by Marvin Nauman

At the end of the South Holland case study is a discussion of its post-flood evaluation. Nashville's program is a product of after-action reports after its flood in 2010.

NFIP/CRS Credit for CRS Activity 610 (Flood Warning and Response) is only provided if there is "at least one exercise and evaluation of the flood warning and response plan each year… there must be an evaluation of the performance of the plan and recommended changes that may be needed, as is usually done in an after-action report."

ANNUAL WARNING AND RESPONSE EXERCISE

Activities 610 (Flood Warning and Response), 620 (Levees), and 630 (Dams) require an annual exercise or drill of the warning and response plan. A flood, levee failure, dam failure, or hurricane exercise qualifies as an exercise for all three activities.

An evaluation of the performance of the warning and response plan must include:

- A description of the exercise,
- An evaluation of the
  - Threat recognition procedures,
  - Warning dissemination,
  - Response operations, and
- Recommended changes to the plan.

The exercise requirement can also be met if the community responds to an actual flood or actual threat of a levee or dam failure, provided that the items listed above are discussed in an after-action (or similar) report.
-CRS Coordinator's Manual

Tool 4:
Protecting Critical Facilities

While different programs have their own definitions of critical facilities, they typically include:

- Facilities that are vital to flood response activities or crucial to health and safety (a hospital or emergency operations center); and
- Facilities that, if flooded, would make the flood problem and its impacts much worse (a nursing home, hazardous materials storage site or wastewater treatment plan).

If critical facilities are isolated or damaged, there can be severe safety and health repercussions, such as:

- Threat to public safety if a police or fire station is affected;
- Loss of access to health care if a hospital or urgent care center is isolated;
- Loss of vital utilities, such as drinking water and electricity;
- Loss of communication if phone lines or cell towers are damaged;
- Threat to the lives of people who need special care, such as nursing home residents; and/or
- Creation of additional dangers if hazardous materials storage sites are damaged.

Because of these hazards, most guidance for floodplain management and disaster assistance recommends new critical facilities be kept out of the 500-year-floodplain or protected to above the 500-year flood level. Protecting new critical facilities is discussed under Tool 2 of the NAI How-to Guide for Regulations and Development Standards.

While new critical facilities may be better protected, emergency management plans need to address those already built in a flood-hazard area.

NFIP/CRS CRS Activity 610 (Flood Warning and Response) has a separate element CFP for critical facilities planning.

Tool 4 has four steps to preserve vital health and safety services from flood damage.

Step 1. Identify impacted critical facilities
Inventory the sites that need to be protected

Step 2. Review their emergency response plans
See if they are ready for a flood

Step 3. Identify support needs
See where they need help

Step 4. Set up support procedures
Follow up and stay in touch with them

The other two activities in the 600 series have similar elements: levee failure critical facilities planning (620 - LCF) and dam failure critical facilities planning (630 - DCF).

How to: Protect critical facilities during a flood

While every critical facility is different, there is a standard four-step approach to protect them from damage or shutdowns during a flood.

Tool 4: Protecting Critical Facilities, cont.

Wastewater treatment plants are often found in the most flood-prone site in a community. Fenton, MO 2015. -Bill Greenblatt, UPI

STEP 1. IDENTIFY IMPACTED CRITICAL FACILITIES

Several state and federal programs require the emergency manager to inventory critical facilities. Title III of the Superfund Amendments and Reauthorization Act (SARA Title III) requires emergency planning for facilities with hazardous and toxic chemicals. Hazard mitigation plans provide a critical facilities risk analysis, but sometimes critical facilities information is redacted and must be requested by the floodplain manager.

While your emergency manager has a list of critical facilities in and near your community, check for things that might not have been considered critical for other hazards.

Using the inundation maps to run scenarios, see what happens at different flood levels. A bridge or road might not be on an existing list, but if one is flooded and fire and police vehicles cannot serve an area, it should be considered critical.

Review the list and plot the sites on your floodplain or flood inundation maps. It is important to identify facilities that could be impacted by flooding. This includes sites that are on high ground, but would be isolated by loss of access. A high and dry hospital is not of much use if an ambulance can't get there. Is there an emergency operations center in a basement or underground shelter that could be flooded?

On the other hand, some properties identified as critical facilities by the emergency manager may not be at risk during a flood. A cell tower with elevated electronics may still work when its base is flooded. A school isolated by a flood with 24 hours or more of warning time shouldn't have any threatened occupants by the time the flood arrives. However, it may have been designated as an evacuation shelter.

Once the inventory has been compiled, keep the contact information on the managers and emergency response contacts up to date.

NFIP/CRS Developing the list and keeping it updated is a prerequisite for credit under the element CFP – critical facilities planning in CRS Activity 610 (Flood Warning and Response). Credit is also provided for lists of critical facilities impacted by a levee failure (Activity 620 (Levees) and by a dam failure (Activity 630 (Dams).

Tool 4: Protecting Critical Facilities, cont.

-FEMA photo by Greg Henshall

-FEMA photo by Marilee Caliendo

A flooded gas station can result in floating or leaking underground gas tanks (New Hartford, IA 2008). To the right is a tornado shelter in a mobile home park, under water during a flood (Memphis, TN 2011).

STEP 2. REVIEW EMERGENCY OPERATIONS PLANS

There are state and federal requirements for some types of critical facilities to have emergency or disaster response plans. Most states require them of public health facilities, such as hospitals and nursing homes. The facilities' managers may feel satisfied that they meet all state rules, but their plans may be copies of generic templates or don't address local flood conditions.

You may find many flood-prone critical facilities that do not have emergency or disaster plans, or don't address flooding. In these cases:

- Start with a discussion of the flood hazard and the benefits of a flood operations plan.
- Walk through the facility with the appropriate staff and perform an informal vulnerability assessment.
- Ask what happens to residents, employees, patients or customers with special needs.
- Discuss possible damage during a flood, and whether the facility can still perform its mission.

If a facility manager is interested in preparing or revising an emergency operations plan, he or she would most likely want to see a good example.

There is information in this guide, such as the Lady of Lourdes Hospital case study, and FEMA and state emergency management agency plan templates. However, if you have a plan for a facility similar to theirs and/or nearby and subject to the same flood hazard, it may be more useful to them.

Depending on the facility, the plan could simply list the steps personnel should take when a threat notification is received or identified. It is important that the personnel are aware of the plan and are able to implement the steps without much research or interpretation. An example of a quick and simple approach is in the box on the next page.

Evacuating a nursing home can be a very time consuming operation that needs lots of trained staff. New Orleans, 2005. -FEMA Photo by Jocelyn Augustino

Tool 4: Protecting Critical Facilities, cont.

The plan should be reviewed and discussed with all staff prior to the hazard "season" and reviewed and updated after a hazard event, just as the community emergency operations plan is reviewed and updated following an incident.

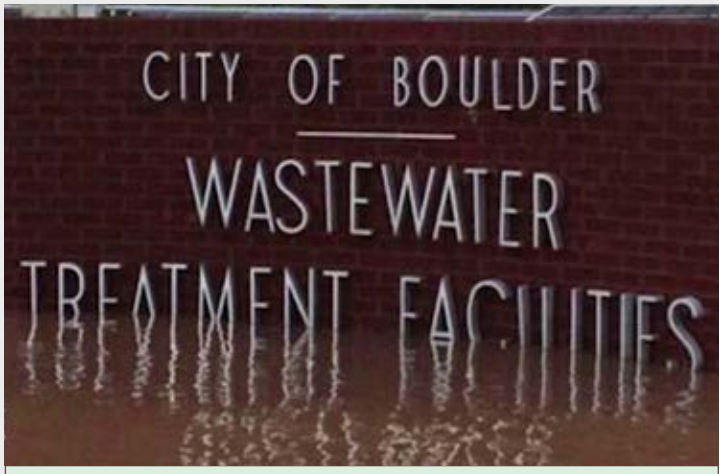
When There's Little or No Time

Sometimes, there is very little time between the flood warning and when the water arrives. In these cases, safety of personnel is the number one priority.

The 75th Street Wastewater Treatment Facility in Boulder, CO is downstream from two high-hazard dams. It may get an hour of warning, but the Facility's Dam Failure Mode response plan is clear, short and simple.

There are only four things to do after a notice of a dam failure:

1. "Notify the entire plant via the Emergency Warble Alarm (####) followed by a plant page (####), that immediate evacuation is necessary.
2. "Notify the Emergency Operations Center (303-###-#### – dispatch) that evacuation has been initiated.
3. "Operations staff needs to turn off propane valves at the tanks and turn off the main natural gas service valves (one at Operations Center and one at Biosolids Dewatering Building). Operations staff need to turn off and isolate bleach system at Non-Potable Water Building.
4. "Evacuate the plant site to safe high ground. See attached map…."



The flood of 2013 did not close the plant or warrant an evacuation. -City of Boulder

There is also a site plan with important information, such as the location of the shutoffs mentioned above and what chemicals are stored where. This facilitates emergency actions and access by first responders after the water goes down.

Steps 1 and 2 help determine whether your critical facilities are prepared for flooding or whether improvements are needed. Steps 3 and 4 help with those improvements.

Tool 4: Protecting Critical Facilities, cont.

Critical facilities managers need to understand that permanent mitigation measures are better than relying on emergency flood fighting. This gas station had an emergency ring dike that either leaked or was flooded by subsurface percolation. Minot, ND 2011. -FEMA Photo by David Valdez

STEP 3. IDENTIFY SUPPORT NEEDS

A good critical-facility flood-response plan identifies where support will be needed. Even if there is no written plan, you can walk through a flood scenario with the facility manager and identify support needs. Consider the following:

- Does the facility need a lot of lead time that would require early notification of a possible flood? If so, what is the best way to provide such a warning?
- Are there hazardous materials on site? If so, what would happen if they were released or mixed with the water? What types of warnings should be issued?
- What would trigger an evacuation?
- If the facility's residents or employees will need to be evacuated, will any special measures be needed (especially important in health care facilities and schools)? Does the community have designated special needs shelters that can accommodate the facility's residents? For example, Florida hospitals and nursing homes cannot use public shelters.
- Can modifications be made to the facility to reduce its exposure to damage, such as moving damage-prone equipment and contents to high ground or higher levels of a building or a flood-free site? Examples of such modifications can be found in the Our Lady of Lourdes Hospital and Nashville case studies. They are also discussed under Tool 5 of the NAI How-to Guide for Mitigation.
- Are the facility's structure and contents insured for flooding? If not, how will the manager finance restoring it to a safe operating condition?

STEP 4. SET UP SUPPORT PROCEDURES

Follow up is vital:

- Talk to facility managers at least once a year to make sure your contact information is current. Find out if anything has changed or if they'd like help with retrofitting or improving their flood response plan. Annual contacts are a prerequisite for CRS critical facilities planning credit.
- At least once a year, review and update community plans, programs and policies needed to help your facilities.
- Determine if you can help the facility develop or improve its own plan.

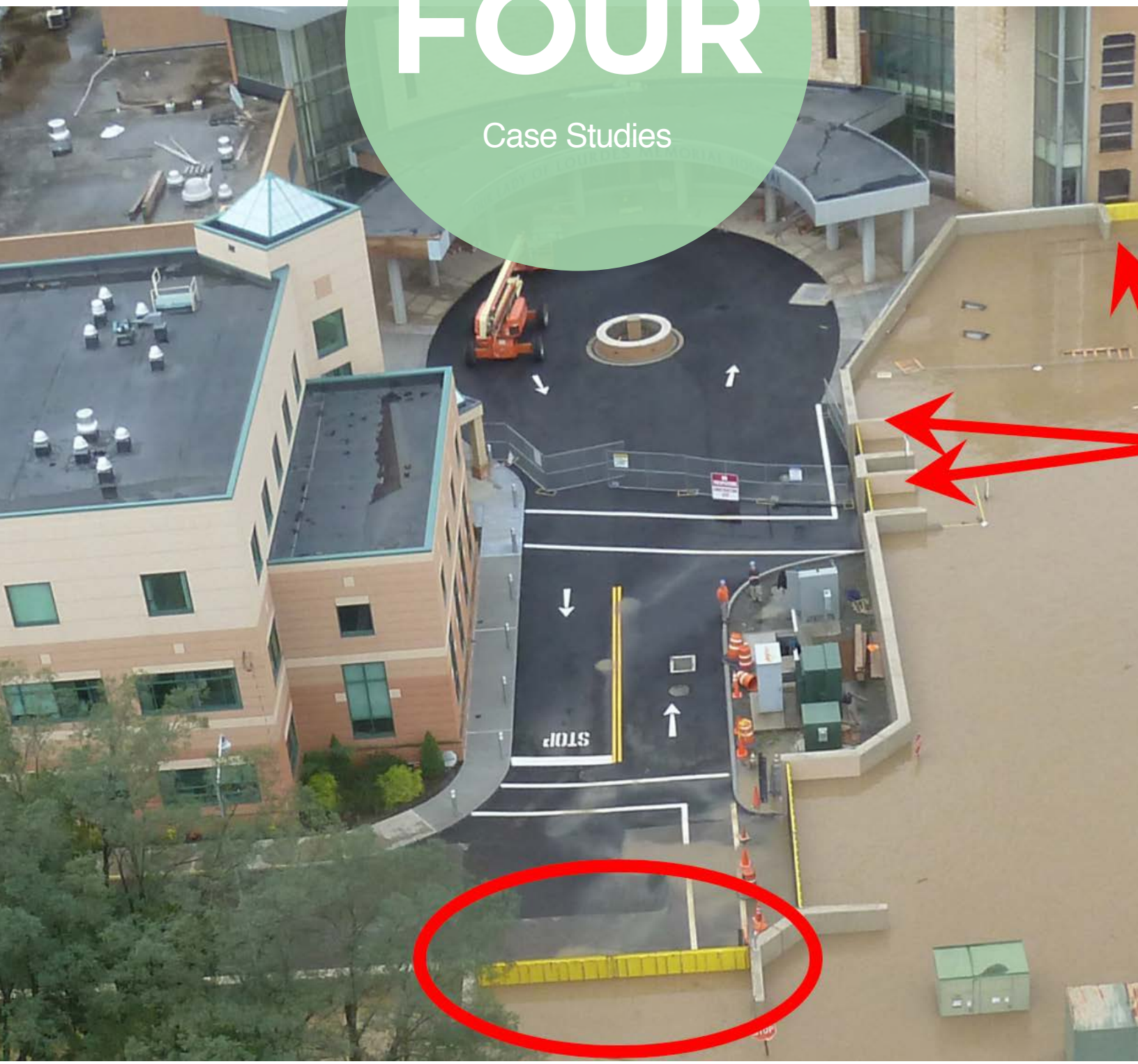
Tool 4: Protecting Critical Facilities, cont.

- Invite all the critical facilities to send someone to your annual exercises. This will help them, as well as identify needs in your community's emergency operations plan. If one facility has a good plan, it may motivate the others to have one.

The U.S. Environmental Protection Agency has a program to encourage and help communities protect their water and wastewater treatment facilities from flood damage. It can be found at **https://www.epa.gov/sites/production/files/2015-08/documents/flood_resilience_guide.pdf**

SECTION FOUR

Case Studies

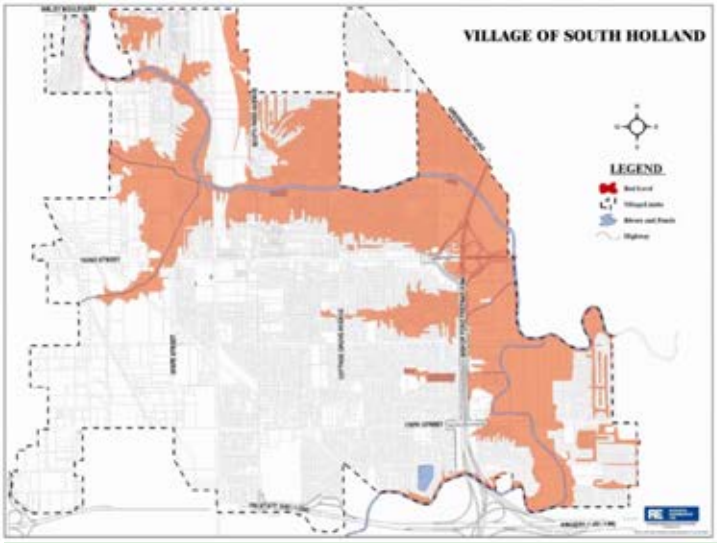


South Holland, Illinois

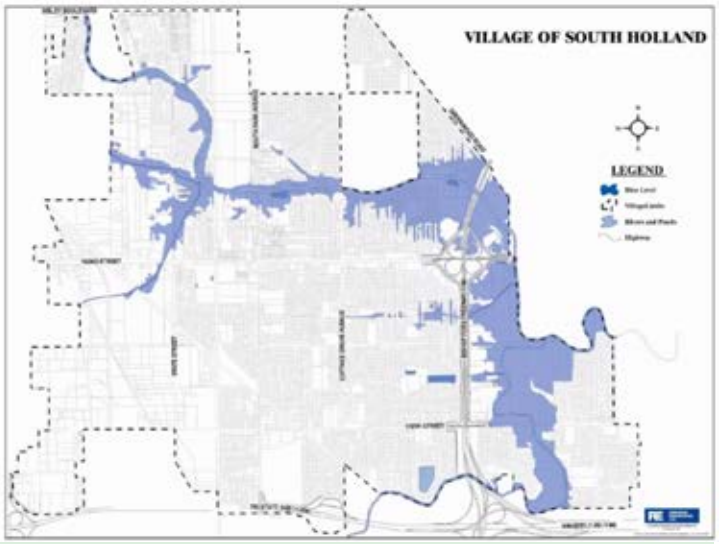
Inundation Mapping for a Flood Response Plan

The village of South Holland, Illinois was built on what was the bottom of Lake Michigan in geological times. It has a history of flooding from the Little Calumet River and its tributaries. In 2006 the village asked its consulting engineering firm to prepare a series of flood inundation maps. Rather than plan for arbitrary 50- or 100-year floods, the village selected five flood response levels: flood stages of 19, 20, 21, 23 and 25 feet (594, 595, 596, 598 and 600 feet above sea level). Using river stages facilitated relating the maps to flood levels predicted by the National Weather Service. The five levels were given color codes, an effort to get people to stop thinking every flood was a 100-year flood. Two of the maps are shown below.

South Holland's Flood Inundation Maps



Red Level Flood (approx. 100-year flood)



Blue Level Flood

The village administrator asked each department to review the maps and detailed inventory to determine what they needed to do to support the flood-response effort. The various reports were collated and coordinated in the Flood Warning and Response Plan. The village also posted the maps on its website. The site includes a graphic that relates the maps' elevations to historic flooding. Two years after the plan was adopted, the Little Calumet River flooded. The village prepared an after action report that noted needed improvements, as recommended in Tool 3, Step 4.

To read the full case study, go to: https://www.floodsciencecenter.org/koha?id=2451

Pinellas County
Coastal Flooding Response Program

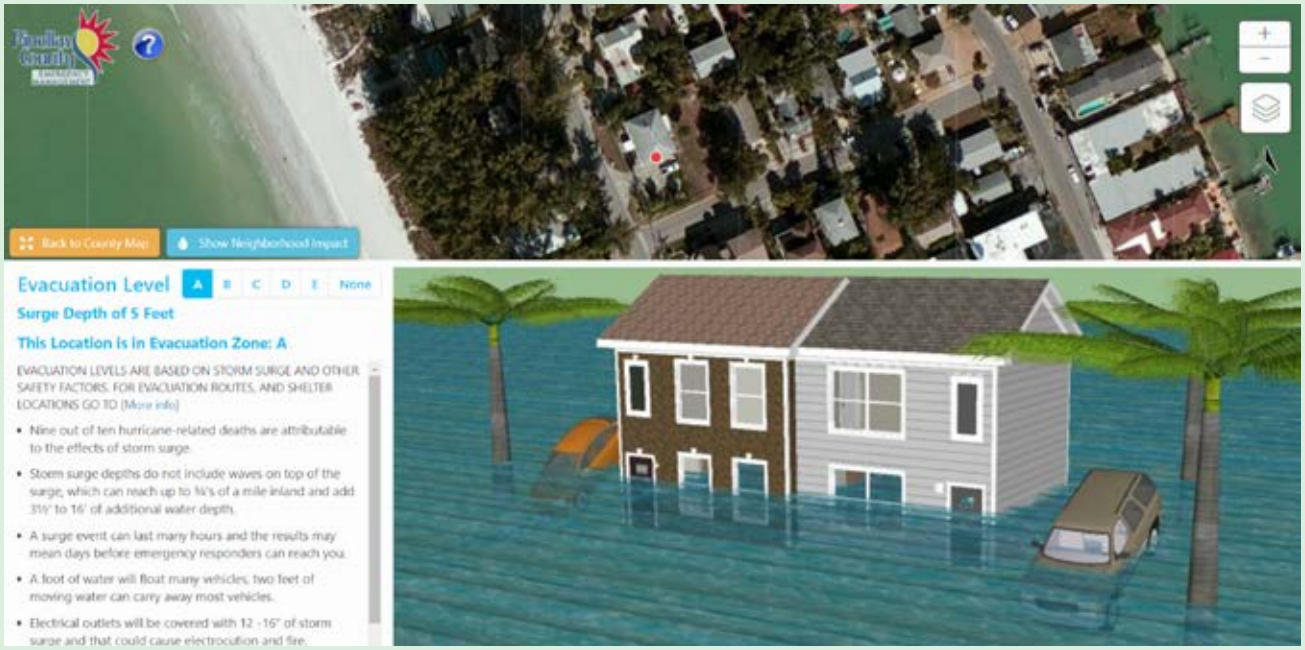
Pinellas County is the most densely populated county in Florida, with nearly a million year-round residents and 40 percent of the county's land area is within the Special Flood Hazard Area. While flood threats come from coastal storm surge, inland overbank and local drainage sources, coastal flooding from storm surge poses the most danger to county residents.

Pinellas County uses GIS software to plot the delineation of a predicted storm surge and determine what will be flooded, isolated and/or evacuated at different surge levels.

The county has a "Know Your Zone" outreach program where residents can find their zone via the county's floodplain management website. The website has a tool where anyone can enter an address to find their Flood Insurance Rate Map zone. Someone looking to find out if they are in a SFHA will see their evacuation zone and emergency preparedness information, such as how to sign up for alerts.

Also on the "Know Your Zone" site is a tool that provides a very graphic image of the storm surge depth at the property. The case study shows how the flood warning response aspects fit in with the county's overall comprehensive emergency management plan and how it worked during Hurricane Irma in 2017.

To read the full case study, go to: https://www.floodsciencecenter.org/koha?id=2450



http://egis.pinellascounty.org/apps/stormsurgeprotector/index.html

Nashville

SAFE and NERVE Flood Forecasting & Response Tools

In early May 2010, central Tennessee experienced rainfalls from 10-20 inches. Widespread flooding in the region led to 26 flood-related deaths, 11,000 damaged structures, damage to critical infrastructure, and $2 billion in property damage.

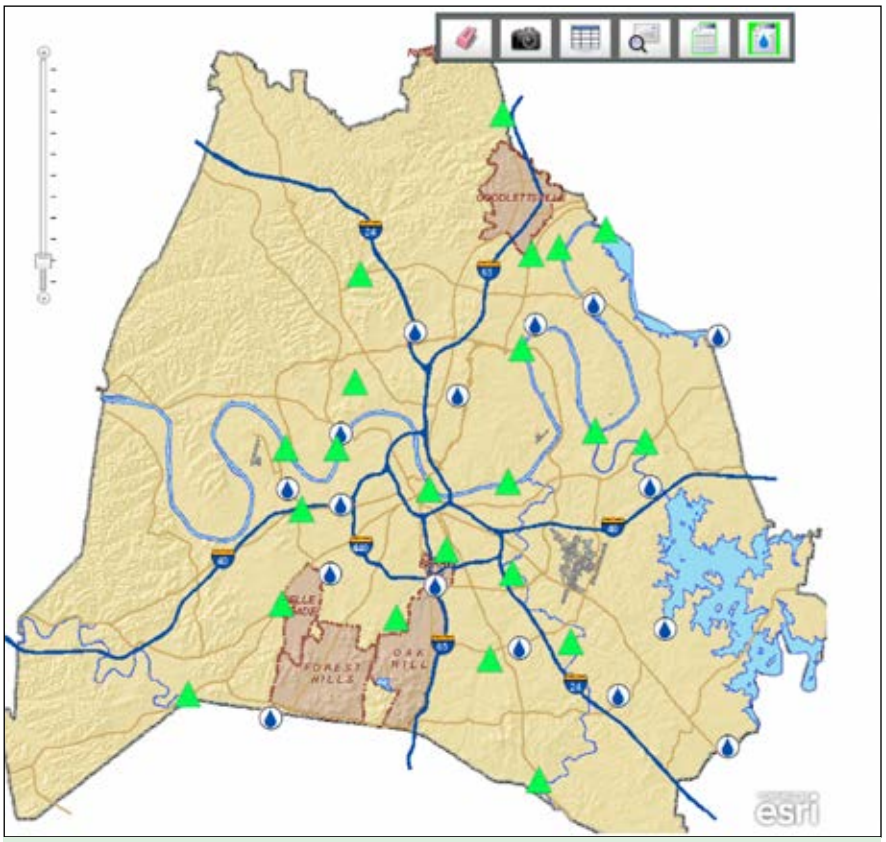
After this event, the city realized there was a need for more and better data, improved coordination and better training for personnel. To fulfill this need, the city developed Nashville Situational Awareness for Flooding Events, or SAFE.

The SAFE tool relies on data from more than 20 USGS stream gauges and newly updated hydraulic and hydrologic models to produce real-time flood inundation maps. The extensive flood modeling resulted in new Flood Insurance Rate Maps for 300 miles of streams not previously mapped. Beyond the static FIRMs, as the rising gauge heights reach the NWS flood categories, the triangles on the map change color to match the flood category. They also blink, providing a visual indicator of the onset or existence of flood conditions.

NERVE, the Nashville Emergency Response Viewing Engine, was the next logical step after SAFE was developed. It's a public site, and the home screen tells the user if there are any emergencies happening and whether the Emergency Operations Center has been activated. The user enters an address and can choose from a menu of nearby hazardous areas, shelters, closed roads, etc. One can select a destination and NERVE will provide directions to it that avoids closed roads and bridge.

The case study also reviews actions taken to protect critical facilities and manage recovery and reconstruction.

To read the full case study, go to: https://www.floodsciencecenter.org/koha?id=2449



Distribution of SAFE's rain and river gauges. Plans are to extend the program to smaller watersheds.

Our Lady of Lourdes Hospital
Flood Mitigation & Flood Response Plan

Our Lady of Lourdes Hospital was founded in Binghamton, New York in 1920. The hospital was built on donated land, which was unfortunately located in the Susquehanna River floodplain. In June 2006, the then flood-of-record inundated the ground floor.

As the waters rose and it became clear the hospital would have to evacuate its 150 patients, emergency medical service crews from the area were called in to take everyone to safety. The hospital was out of operation for only 10 days, but that is too long for a critical facility. Damage was estimated at $20 million. The power plant, emergency generators, fuel tanks and water supply sustained severe damage.

Moving the complex was out of the question, so a mitigation and emergency operations plan was put together and funded with FEMA grants, state grants and insurance payments.

Mitigation: Mitigation measures included a $7 million, 1,365-foot-long floodwall built to the 500-year flood elevation, and stop logs at indoor locations in case the floodwall fails or is overtopped. The floodwall has six open¬ings that automatically close with flood¬gates that rise when flooded. They do not require human intervention or power and remain hidden beneath the entryways, allowing unimpeded access.

The hospital complex, September 2011. The yellow parts of the wall are the floodgates.
-Courtesy of Our Lady of Lourdes Hospital.

In September 2011, three months after the wall and floodgate systems were completed, Binghamton was hit by Tropical Storm Lee. Floodwaters went 2.7 feet higher than in 2006, and 2,000 buildings in the area were flooded. However, as seen above, the wall worked. While the riverside parking lots flooded, there was minimal damage to the facility. Elective surgeries were cancelled, but otherwise Our Lady of Lourdes continued to serve the community at full capacity.

Flood Emergency Response Plan: The hospital has had a Flood Emergency Response Plan since 2002, and it relies on the NWS and its two gauges that are part of the Advanced Hydrologic Prediction Services. It describes the general situation and overall approach, followed by three pages of a Flood Plan Matrix, which has specific actions to take at different flood levels. To read the full case study, go to: https://www.floodsciencecenter.org/koha?id=2448

Ventura County

California's Flood Warning & Response Program

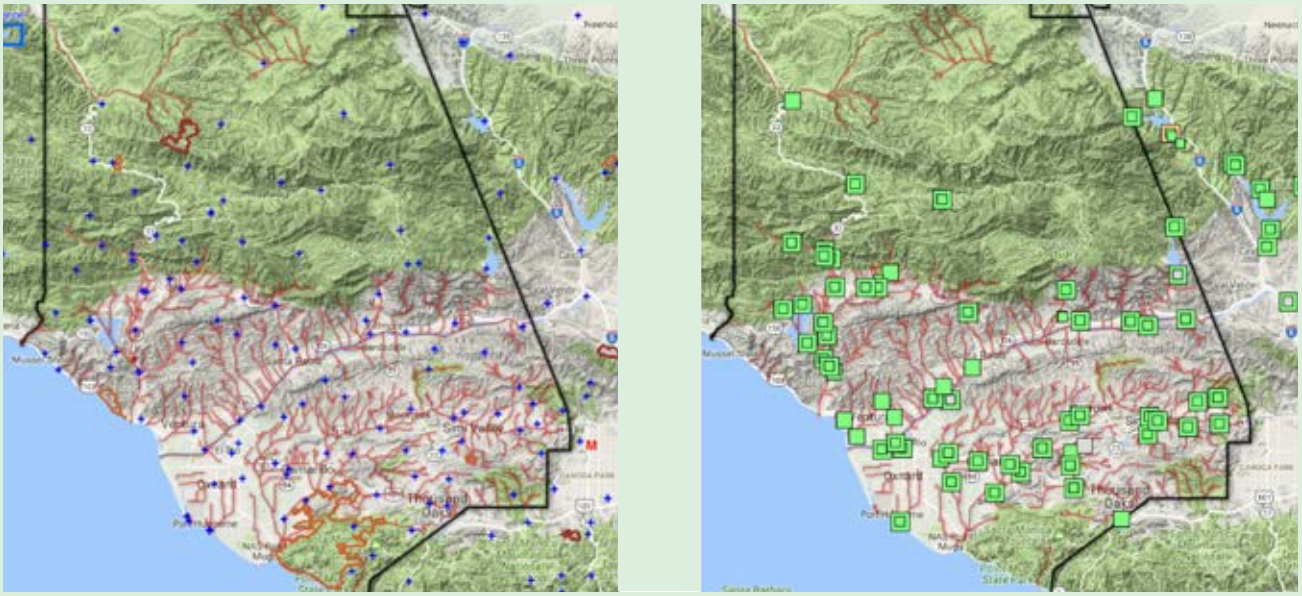
Ventura County has had a flood on average every 10 years since 1862. The worst was in 1969 on the larger rivers. Thirteen people lost their lives and property damage was estimated at $60 million (1969 dollars). Calleguas Creek flooded in 1983, causing $39 million in damage, half of it to agricultural lands. Repairs to flood-control facilities after the 1983 flood were estimated to cost $15 million.

After a 1978 flood on Sespe Creek damaged homes and a wastewater treatment plant, the county established a flood-warning system for the Sespe Creek watershed. As other areas flooded, the system was expanded, so that today the system includes 155 rain gauges and 53 stream gauges in the county.

These gauges are part of the Ventura County Advanced Hydrologic Prediction System. The system has inundation maps for all unincorporated areas of the county mapped in the Special Flood Hazard Area. Information on them and their current readings are available on the district's flood warning website at www.vcwatershed.net/fws. Website screenshots are displayed below.

Alarm criteria for specific flood levels and rainfall rates are set by specific thresholds for each gauge. Once an alarm is triggered, an alarm message is sent via email, pager text, SMS cell text and Twitter message to county emergency personnel. For each level, the plan describes "actions needed."

To read the full case study, go to: https://www.floodsciencecenter.org/koha?id=2447



The rain gauges (✚) are distributed throughout the county, including in the undeveloped forest areas to the north, in order to report rain in the watershed. The stream gauges (■) are located downstream on the larger rivers. The district monitors gauges outside the county in watersheds that drain into Ventura County. www.vcwatershed.net/fws

SECTION FIVE

Resources & Fact Sheet

Resources & References

Flood threat recognition and inundation maps

- National Weather Service Hydrologic Information on the Web: A Manual for Users, NOAA, 2013. https://bit.ly/2PYFIcm

Flood response

- Community Resource Toolbox website, U.S. Army Corps of Engineers. https://bit.ly/2DBfqXH
- Emergency Action Plan Guidebook, Silver Jackets and the U.S. Army Corps of Engineers, 2018. https://no.floods.org/EmActionPlanUSACE
- Emergency Flood Fighting Methods, California Department of Water Resources, 2012. https://bit.ly/2Tc4uo4
- Flood Fight Handbook, U.S. Army Corps of Engineers, 2016. https://bit.ly/2zRpUhl
- Levee Monitoring Guidance, Criteria for Community Levee Inspectors Emergency Operations, U.S. Army Corps of Engineers, undated. https://bit.ly/2RMUP5M
- National Incident Management System, FEMA, 2017. https://bit.ly/2B3cUHo
- Sandbag Levees Brochure, US Army Corps of Engineers, 2016. https://bit.ly/2K2t72i

Post-flood

- Floodplain Management Desk Reference, FEMA 480, 2005. https://bit.ly/2rYNqW4
- Increased Cost of Compliance: Guidance for State and Local Officials, FEMA 301. https://bit.ly/2RVnbLr
- Planning for Post-Disaster Recovery: Next Generation, American Planning Association, 2014. https://bit.ly/2PoBye8
- Repairing Your Flooded Home, American Red Cross, 1992. https://rdcrss.org/2rXqPt5
- Substantial Damage Estimator (SDE) User Manual and Workbook, FEMA P-784, 2014. https://bit.ly/2zTyiwH
- Substantial Improvement/Substantial Damage Desk Reference, FEMA P-758, 2010. https://bit.ly/2z76dCG

Fact sheet:

NAI How-to Guide for Emergency Services

"If we continue to encourage at-risk development and ignore the impact to others, can we accept the consequences, and are you willing to pay for it?"

-Larry Larson, ASFPM

"No adverse impact is an approach that ensures the action of any community or property owner, public or private, does not adversely impact the property and rights of others."

-NAI Toolkit, 2003

For case studies and specific examples of NAI success, visit http://bit.ly/1H5SeXL.

To speak to a No Adverse Impact expert, contact ASFPM at ASFPM@Floods.org or (608) 828-3000.

THE CONCEPT

Communities that effectively reduce flood losses and promote and protect public safety make sure the actions of one person do not adversely affect others. That is the essence of No Adverse Impact floodplain management.

One of the seven tools of the NAI approach is providing a well-planned and effective response to a pending flood that will protect life, property and natural floodplain functions. Such a response should take advantage of available floodplain management data, programs and staff. Therefore, a key tenet of this approach is for the floodplain manager and emergency manager to work together before, during and after the flood.

Emergency services should make life safety and protecting critical facilities a priority and ensure that flood response efforts do not adversely impact properties already exposed to flood damage.

The *NAI How-to Guide for Emergency Services* reviews what can be done when the floodplain manager and the emergency manager use available resources and coordinate their activities to develop an effective warning and response plan. Seven factors are recommended for communities to follow to improve their warning and response plans and programs:

1. Clearly designate roles & responsibilities
2. Communicate & coordinate
3. Take advantage of help
4. Obtain & share the best available data
5. Educate the public
6. Train & exercise
7. Evaluate & improve

While there are different approaches to organizing emergency services, this *Guide* describes four tools that illustrate the basic parts of such a program:

Fact Sheet, cont.

Flood threat recognition

The primary difference between floods and other emergencies is there is usually advance notice a flood is coming. Communities should use this lead time to warn people and protect property before the water arrives, i.e., take steps to prevent problems rather than react after the disaster happens. A flood threat recognition system uses weather and water data to provide a prediction of what will happen. The floodplain manager should be familiar with the sources of data and should help design, maintain and evaluate a system that provides the maximum amount of early warning time and an accurate prediction of how high the flood will go.

Flood inundation maps

Maps that show areas that a predicted flood will inundate and provide vital information to the emergency manager, such as where an evacuation is needed, safe routes for evacuees, areas that could be protected with a flood fighting operation, and whether to mobilize additional resources. All of this can be known before the water arrives, provided such maps are prepared in advance and the impacted areas are inventoried – another key job for the floodplain manager.

Flood response

Emergency managers are the experts in disaster response measures, such as evacuation and sheltering. However, the floodplain manager can help with some flood-specific emergency measures, such as locating and erecting barriers to flows that can be faster and safer than sandbagging, taking precautions for mold and mildew, and recording high water marks to improve the flood threat recognition system and inundation maps.

Critical facilities

Critical facilities, such as fire stations and hospitals, are vital to flood response activities or crucial to health and safety. The term also includes facilities that, if flooded, would make the flood problem and its impacts much worse, such as a nursing home or a hazardous materials storage site. This *Guide* recommends working with each critical facility to ensure they have their own emergency services plan that is coordinated with the community's program. This fourth tool provides guidance on how this can be done.

In Summary

Experience has shown that when an emergency or disaster response plan includes flood-specific measures, it will help save lives and reduce property damage when a flood occurs. This *Guide* encourages close cooperation between the floodplain manager and emergency manager to develop, practice, use, evaluate and revise emergency services tools that take advantage of the early warning time, a system that provides the early warning, and flood inundation maps that show where a flood will go.

Resources

For more information refer to ASFPM's NAI Resource Center: http://bit.ly/1Ei2r19