NAI
No Adverse Impact

No Adverse Impact Floodplain Management

COMMUNITY Case Studies 2004

ASFPM
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The No Adverse Impact Vision

Imagine that . . . . in your community, the National Weather Service predicts record rainfall. It rains, and the rivers rise, but no homes or businesses are flooded, no roads are closed, no businesses shuttered. No citizens are injured in the event, and rescue workers are not put at risk. Erosion and sedimentation are minimal because natural floodplain systems are storing and dissipating flood waters with no adverse effects on humans or the built infrastructure. After the storm passes, your community's natural floodplains continue to provide open space, parks, recreation, habitat for wildlife and fish, hiking and biking trails, alternative agricultural crops, and improved quality of life. Furthermore, flood levels do not increase over time, because of the NAI management approaches you use. Increases in flood elevation caused by any development are mitigated so they do not affect others. Development takes place carefully, in a way that does not pass the cost of flooding on to other properties, other communities, or future generations.

What is NAI?

No adverse impact (NAI) floodplain management is a managing principle developed by the Association of State Floodplain Managers (ASFPM) to address the shortcomings of today's typical local floodplain management program. Rather than depending on the minimum requirements of federal or state programs, the NAI approach provides tools for communities to provide a higher level of protection for their citizens and to avoid increased flooding now and in the future.

No adverse impact (NAI) floodplain management is an approach by which the action of any community or property owner, public or private, is not allowed to adversely affect the property or rights of others. It is consistent with ancient legal principle, "Sic utere tuo ut alienum non laedas," or "so use your own property that you do not injure another's property."

An adverse impact can be measured by an increase in flood stages, flood velocity, flows, the potential for erosion and sedimentation, degradation of water quality, cost of public services, or other factors. No adverse impact floodplain management extends beyond the floodplain to include managing development in the watersheds where flood waters originate. NAI does not mean "no development"; it means that any adverse impact that is or would be caused by a project—or the cumulative impact of projects—must be mitigated, preferably as provided for in the community or watershed based plan.

For local governments, NAI floodplain management is a more effective way to tackle flood problems. The concept offers communities a framework to design programs and standards that meet their true needs, not just the requirements of a federal or state governmental program. NAI floodplain management empowers communities (and their citizens) to work with stakeholders and build a program that is effective in reducing and preventing flood problems. NAI floodplain management is about communities being proactive, understanding potential impacts, and implementing mitigation activities before the impacts occur.

NAI floodplain management has many benefits. By undertaking activities that truly address your local situation and that do not harm others, your community can

- Prevent flooding from increasing or damaging other people or communities;
- See a reduction in flood losses over time;
- Avoid challenges and lawsuits over causing or aggravating a flood problem; and
- Receive recognition for your efforts (and a discount on flood insurance premiums) through the National Flood Insurance Program's Community Rating System.

How to Use this Document

This document showcases certain aspects of the floodplain management programs of communities that are recognized as the nation's leaders in implementing NAI principles. You will find here descriptions of tools and activities they use to reduce flood losses and community liability through the use of NAI approaches. Also included are techniques that have proven effective in implementing NAI approaches, and alternatives from which your community can select workable applications.

Earlier NAI community research revealed that there was a need to analyze and report, in more detail, on the specific NAI programs, plans, and actions that communities were taking to implement NAI floodplain management. The ASFPM received a grant from the Public Entity Risk Institute to research and compile this document.

Each of the 11 communities exemplifies a specific aspect of NAI floodplain management. All of the communities conduct full floodplain management programs, even though only certain parts of them are described here. Seven of the communities were selected because their programs and actions are excellent examples of a specific NAI building block. Four additional communities were selected for their integrated approach to unique circumstances: integrated management techniques, a small-town's comprehensive program, coastal management, and habitat-based watershed planning.

This report emphasizes the seven NAI building blocks, and follows the organization of the *NAI Toolkit* (see the list of NAI materials at the end of this document). Each community "case study" discusses

- "Adverse impacts" that are targeted by the community;
- The community's actions in support of the primary NAI building block it uses;
- Some additional activities undertaken by the community;
- How community support for NAI floodplain management was generated;
- Background information about the community; and
- Contact information.

Readers should note that all dollar figures have been converted to 2004 values. Technical terms found within the document are defined in the Terms & Acronyms section. A list of NAI publications appears on the last page.

Building Blocks of NAI Floodplain Management

Hazard Identification & Mapping
Education & Outreach
Planning
Regulations & Development Standards
Mitigation
Infrastructure
Emergency Services

City of Charlotte & Mecklenburg County, North Carolina

Mecklenburg County faces overbank flooding from its many streams, stormwater drainage problems, erosion, channel degradation, and the occasional flooding caused by hurricane-related rainfall. The County includes Charlotte and six other towns and covers over 500 square miles in south-central North Carolina. Its 2.1 million population is growing steadily.

Primary NAI Building Block

Hazard Identification & Mapping

Charlotte-Mecklenburg took a pro-active approach to floodplain management by considering full-build-out conditions and land use both within and outside the floodplain in order to identify the cumulative impacts of development within each watershed. Extensive filling anywhere in the watershed may affect the capacity to convey flood waters, causing unwanted downstream impacts such as increased flood risk and potential damage. Floodplain mapping that considers the ultimate build-out condition is one scientific tool that can be used to set regulations and development guidelines so that other properties are not affected by proposed development.

Other NAI Building Blocks

- Public Education & Outreach
- Planning
- Regulations & Development Standards
- Mitigation
- Emergency Services

Charlotte-Mecklenburg works to avoid these "adverse impacts"...

- dangers to life and property "at or above or below the property location;"
- water or erosion hazards that endanger health, safety, or property;
- increases in flood heights or velocities;
- decreases in flood carrying capacity;
- decreases in the ability of the County's drainage system to carry and store flood water;
- decreases in the amount of land available to store flood waters;
- decreases in the function of the buffer zone; and less than a 2-to-1-acre replacement of wetland or bottomland hardwood acreage lost.

Hazard Identification & Mapping

When Charlotte-Mecklenburg calculated how much higher flood heights would be when the watershed is fully developed (a substantial increase), it was able to quantify the damage and disaster costs that would be prevented if that future development were protected from flooding through regulatory and other measures. It turned out that, even though new County-wide flood maps and regulations based on future-conditions land use would be a significant expense, the savings in future damage would more than offset the investment. The County's work proved that mapping to future conditions is a scientific tool that can be used to set policy and regulations that will reduce flood damage throughout the watershed, thus lessening impacts to others—a good example of no adverse impact (NAI) floodplain management.

Mapping to Future Conditions

- Charlotte-Mecklenburg Storm Water Services researched and quantified the effects that future development in the floodplain and watershed would have on flood heights, the impacts that would result from different allowable rises in the floodway, and the benefits of water quality buffers along streams. The agency concluded that the expense of mapping and regulating hazard areas based on ultimate development conditions in the watershed, and requiring water quality buffers along streams, would be offset by the future damage and disaster costs that would be prevented by such an approach. This research made it possible for the future-conditions and accompanying regulatory data to be incorporated up front, as all the floodplains of the County were being remapped.
- Research and modeling showed that

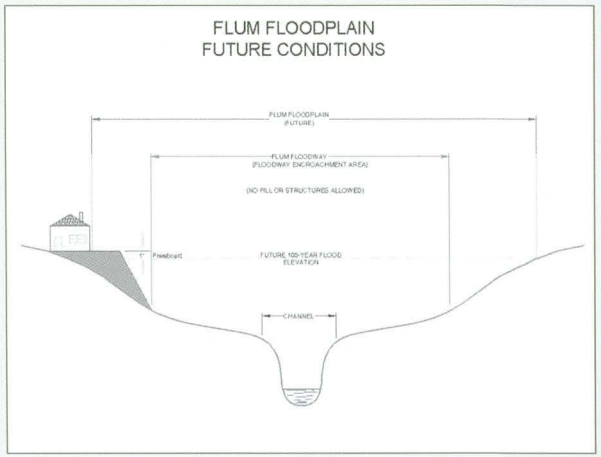
  The average flood elevations based on ultimate build-out of the watershed were 4.3 feet higher than those on the old maps (based on 1975 land use). About half of that increase resulted from land use changes between 1975 and 1999 and the rest is from changes projected to occur between 1999 and full build-out.

  The average floodways on the new maps are more than 160 feet wider than the 1975 floodways.

  The new floodways are based on ultimate build-out and a 0.1-foot allowable rise, and were calculated to be an average of 454 feet wide. In contrast, the average width of the floodway based on the 1975 Federal Emergency Management Agency (FEMA) maps (which allowed a 1-foot rise) was only 290 feet.
- It was calculated that setting aside lands for filtering pollutants decreased flood heights by 0.5 feet. Water quality buffer locations were overlaid on the floodplain maps, and where appropriate, either the water quality buffers or the new floodplain boundaries set the limits for development in and around the floodplain.
- The study of cumulative impacts indicated that filling in the floodplain fringe, as allowed by the old regulations, could result in increases in flood elevations of almost 2.5 ft.
- The staff proposed, the development community supported, and the governing bodies accepted, the proposal that the regulatory flood elevation guiding further development in and around the floodplain would be based on ultimate development in the watershed, plus 1 foot of freeboard.

  If the 1995 land use had been the basis for regulations, new development could have been permitted that would have been 4.3 feet below future flood heights.

  Additional stream water quality buffer requirements, currently in place as part of the Surface Water Improvement and Management initiative, further restrict development in some floodplain fringes, preventing an increase in flood heights of about 0.5 ft.



Cross section of the Floodplain Land Use Map (FLUM) with the top line showing the width of the future floodplain, the middle line showing the width of the floodway encroachment area, and the dotted line showing the width of the future 1% chance flood elevation.

—Mecklenburg County Stormwater Services

- The Charlotte-Mecklenburg floodplain maps were based on

  past, present, and future land use;

  hydrologic/hydraulic analysis;

  soil types;

  slope of the land;

  rainfall amounts;

  creek characteristics (size, shape, slope, and roughness); and

  structural measures in place (culverts, bridges, etc.).
- The maps are available in a geographic information system (GIS) format, allowing for modification and recalculation of stormwater runoff variables such as amount of impervious surface or soil conditions.

One of the Nation's First Map Modernization Projects

In 1999 Charlotte-Mecklenburg hired a consulting firm to work with the U.S. Army Corps of Engineers and FEMA to map the County's floodplains. The mapping project cost $1.4 million, with 60% being provided by Charlotte-Mecklenburg and 40% being provided by state and federal agencies. Charlotte-Mecklenburg became a Cooperating Technical Partner (CTP) with FEMA through that agency's CTP Program.

- Charlotte-Mecklenburg funded the local match through a surcharge based on the impervious area of a property. The surcharge amounted to about $5 per month for residential properties and was added to each property's water bill.
- As a Cooperating Technical Partner (in the first FEMA cooperative Map Modernization Project east of the Mississippi River), Charlotte-Mecklenburg increased its "ownership" of the flood mapping process. It was able to resolve many issues before the maps were submitted to FEMA;

  incorporate its local knowledge of and expertise about the flood problems into the mapping process; and

  integrate the mapping basis with the community's floodplain management approaches, including wider floodways and use of future land use conditions to better serve its citizens.
- The maps are digital and updated through a geographic information system (GIS), based on FEMA's specifications for Digital Flood Insurance Rate Maps (DFIRMs). Up-to-date floodplain maps will be displayed on the Charlotte-Mecklenburg website, where the user may choose to view real-time updated, topographically correct local floodplain maps or the formal "effective" FIRM for a parcel or area.

Mecklenburg County Storm Water Services shares its success at reducing yard loss for 70 mostly residential properties along Briar Creek.

—Mecklenburg County Storm Water Services

Benefits and Costs of Mapping to Future Conditions

- Approximately $137 million in damage will be prevented by upgrading the mapping system from the 1975 maps to include ultimate build-out conditions.
- For the McAlpine Creek watershed alone, investing $250,000 in floodplain mapping could help prevent $16 million in flood damage. This documents the losses avoided due to up-to-date floodplain maps integrated with regulations based on future development. It also provides a baseline for measuring the loss potential in the watershed and the relative impacts of proposed flood mitigation techniques.
- Based on a Flood Loss Economic Study of the new County-wide floodplain maps and associated regulations, Charlotte-Mecklenburg's use of full-build-out conditions as a basis for regulation is preventing future flood damage to approximately 460 single-family and commercial structures. It is estimated that over $330 million in structure and content losses (for a single 1% annual chance event after ultimate build-out) have been avoided with the new approach.

Additional Actions

Public Education & Outreach

The extensive public education and outreach done by Charlotte-Mecklenburg's floodplain management program has been crucial to getting community support. Because community members understand the history of flooding and the options for mitigation, they have been supportive of ongoing and new initiatives to mitigate flood losses (including an increase in utility fees). In addition, receiving input from community members has helped to shape the mitigation plan for each drainage basin.

Planning

The principles of Charlotte-Mecklenburg's watershed-wide management approach are reflected in the guidance document and mitigation plans for each basin. Because planning is accomplished before individual project development, each new project is part of a comprehensive basin-wide solution that avoids adverse impacts, as defined by the community.

Regulations & Development Standards

Considering upstream and downstream impacts before receiving a permit requires that adverse impacts be mitigated before approval. This applies to all lands throughout the watershed. Local definitions such as "community base flood" and "floodplain land use map," support the Charlotte-Mecklenburg definition of "adverse impact." Strict buffer zone regulations help to treat water quantity and quality problems on-site, rather than transferring the problems downstream.

Mitigation

Charlotte-Mecklenburg has identified appropriate mitigation actions to address flood problems in each basin. This supports the NAI concept that the local community determines the level of acceptable impact. As a mitigation technique, acquisition avoids damage from floods. Floodproofing, as a mitigation technique, contributes to reducing flood losses. Greenways, open space, and buffers enhance the natural and beneficial functions of floodplains,

therefore reducing adverse impacts downstream. Charlotte-Mecklenburg committed a portion of its Project Impact grant to provide assistance to a number of floodprone commercial structures. This assistance was in the form of free flood audits and the construction of a Floodproofing Demonstration Project at one location.

Emergency Services

Charlotte-Mecklenburg's Flood Information and Notification System (FINS) includes 70 rain gages, 32 stream gages, and 6 water-quality sites that provide real-time data through radio frequency transceivers to emergency managers and first responders. Water quality parameters are monitored, and action-level thresholds are set to send ALERT (Automated Local Evaluation in Real Time) transmissions. Water quality warning thresholds are being developed in the FINS network to allow tracking of plumes from hazardous materials spills and sanitary sewer overflows.

Community Support

Working on both the remapping and acquisition projects became known as the "balanced approach" to floodplain management. Both efforts have been supported by the residents because they were asked to participate early on in setting goals and helping to devise solutions. Regulations were also supported by the environmental and development communities for similar reasons; they were asked to help create the solution.

Significant local funding for the acquisition program (35% of the total project costs) has not been controversial because the residents accepted the approach during the process of developing the *Floodplain Management Guidance Document* and the watershed-specific mitigation plans. Local support for the Acquisition Program is directly related to the education and outreach programs conducted.

A total of 260 miles of floodplain was re-mapped with support from the residents, FEMA, and the Corps of Engineers. This is a tremendous feat, considering Charlotte-Mecklenburg was one of the first in the nation to insist on ultimate build-out land use conditions as the basis for floodplain modeling.

Expending significant local funds for buyouts illustrated that floodplain maps are a critical element to proper development in and around the floodplain. As part of the pilot study, Charlotte-Mecklenburg quantified both the reduction of flood heights based on local watershed quality stream buffers and the cumulative impact of allowing development in the floodplain. Combining the science of re-mapping with mitigation techniques has proven to be an essential part of the success.

Background

Mecklenburg County, including the City of Charlotte and six incorporated towns, covers 525 square miles of south-central North Carolina. The metropolitan area has a population of 2.1 million, an increase of 245,000 in the last two decades. An additional 300,000 residents are expected over the next 25 years.

In the 1970s, Charlotte-Mecklenburg joined the NFIP, using it as an opportunity to provide a much-needed level of protection to citizens. The U.S. Geological Survey maps, developed in 1975, assumed 1990 land use, providing 20 years of "comfort" for the development and regulatory community. Today, the City of Charlotte and the six incorporated towns all participate in the Community Rating System as a class 8, receiving a 10% reduction in flood insurance premiums for policyholders.

In 1989, Hurricane Hugo caused $1 billion in wind and flood damage to the Charlotte area, and 1995 flooding caused $20 million in losses. In 1994, Charlotte-Mecklenburg had initiated a stormwater management program, funded by a stormwater fee, to address infrastructure problems on private property and expand the existing floodplain management program. During the 1997 flood, there were $60 million in losses, including more than 10 homes with first floor elevations above the base flood elevation. At that time, Charlotte-Mecklenburg adopted the *Floodplain Management Guidance Document*, leading the County to consider floodplain mapping assuming ultimate build-out land use conditions.

Charlotte-Mecklenburg has three types of flooding and stormwater problems. Overbank flooding, mainly on the

Oversized maps and other visuals are used to highlight projects for an array of audiences.

—Mecklenburg County Storm Water Services

Working with the Charlotte Fire Department and the local Red Cross, Mecklenburg County Storm Water Services began a flood education program for school-aged children.

—Mecklenburg County Storm Water Services

major stormwater system, affects 1,500 structures built before flood regulations. Local drainage problems on streams that drain less than one square mile are a second category; there are up to 10,000 sites at which better maintenance could reduce flood damage. Finally, there are channel erosion and degradation problems in urban areas throughout the County.

Sign at Freedom Park, site of a project to restore the meander on Little Sugar Creek in this urban area.

—Mecklenburg County Storm Water Services

Contact Information

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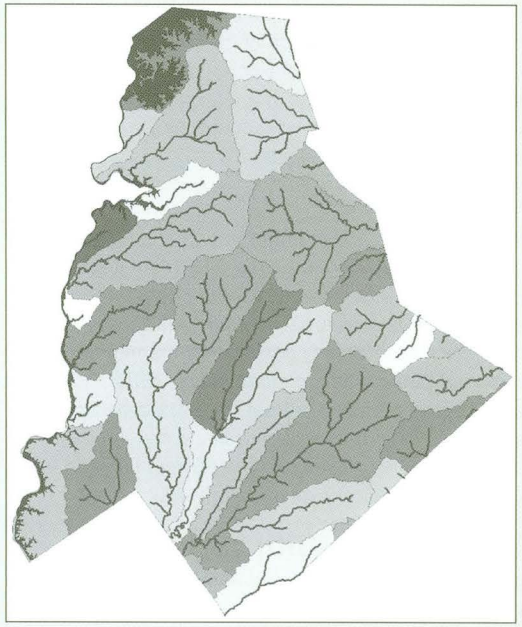
Bill Tingle, Floodplain Administrator, Mecklenburg County Storm Water Services, (704) 336-3734 or tinglwr@co.mecklenburg.nc.us

http://www.co.mecklenburg.nc.us

http://www.stormwaterservices.com



The 32 watersheds of Mecklenburg County, North Carolina. All water in Mecklenburg County (except the Catawba) originates in the county.

—Mecklenburg County Stormwater Services

Orange County, Florida

This fast-growing county in central Florida, within easy reach of Disney World and related attractions, is flat and low-lying, with slow-moving waterways, over 500 lakes (some of them land-locked), sinkhole depressions, and heavy precipitation, not to mention the threat of hurricanes. The headwaters of both the St. Johns and Kissimmee river systems lie within Orange County, along with the many natural resources associated with water bodies. The County has an extensive infrastructure of canals, control structures, pumps, and other drainage works, but older subdivisions in particular are still susceptible to flooding during and after heavy rains.

Primary NAI Building Block

Education & Outreach

Education and outreach is one of the primary activities Orange County undertakes in the management of its resources and the protection of its residents. This activity is carried out by all of the departments of the County, often with guidance and input from various advisory boards. The population of Orange County is particularly vulnerable to the devastating effects of hurricanes, tornadoes, and intense thunderstorms. The County is rich in wildlife, fisheries, and other natural resources that must be protected to retain the quality of the environment and lifestyles the people have come to expect, and to maintain the natural defense against coastal waves and wind. Only through education and public involvement can the County hope to maintain its resources and meet this expectation.

Other NAI Building Blocks

- Mitigation
- Hazard Identification & Mapping
- Planning
- Infrastructure
- Emergency Services
- Regulations & Development Standards

Orange County works to avoid these "adverse impacts" . . .

- An increased peak flood flow, flood stage, or water velocity into a receiving body of water;
- A decrease in water quality; or
- A decrease in quality of or negative impact on the area's natural resources or the ecosystem as a whole.

Education & Outreach

Orange County has been practicing education and outreach initiatives for the past 20 years. The County realized early on that to be effective in meeting the challenges of a rapidly growing community, local government must use the resources of its citizens. County management believes that the better-educated and informed the public, the easier it will be to practice the principles of no adverse impact (NAI) floodplain management. The more individual citizens, property owners, community groups, and youth groups learn about the benefits associated with floodplain resources, wetlands, stormwater management, and wildlife ecosystems, the less likely they are to do things that will negatively affect their environment. Only through public education and outreach could this goal be achieved.

The County often receives guidance and input from advisory groups and boards. With this assistance, the separate County departments then can prepare and distribute informational publications, conduct seminars, workshops, and community fairs, and prepare publications and presentations for use in the various local media.

Each of the actions taken under the County's Education and Outreach Program has a direct relation to its ability to practice NAI floodplain management. By keeping the public informed at all levels, from elementary schools through property and business owners, they have developed a program that has been adopted by the community. The many citizen advisory committees that have been formed around the various issues that confront the County on a regular basis exemplify this. These citizen advisory groups represent their respective community groups, giving those groups a voice in the county-level decisions.

Information about stormwater management and other programs of interest to the citizens of Orange County is distributed in various manners.

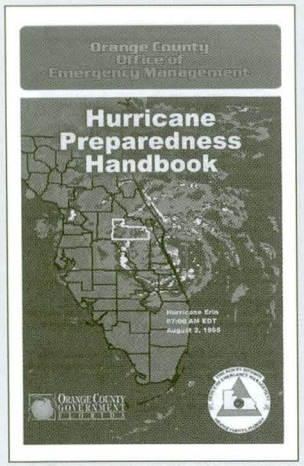
- Orange County conducts yearly events such as the "Meet the County Day," and "Community Conference," during which the services offered by the County are explained. Meet the County Day is most often held at a local mall in a very informal setting. Citizens come to the booth staffed by Stormwater Management Division personnel and may receive flyers about floodplain management, flooding, maintenance, and stormwater pollution prevention, to name a few.

Community Conference announcement

Orange County, Florida, and Orange County Homeowners Association Alliance

- Community Conference is a one-day gathering in which all citizens of Orange County are invited to attend to learn about the services offered by the staff of Orange County. One-hour seminars are offered by the Public Works Department, addressing issues related to stormwater management, roads, traffic, and drainage. The Environmental Protection Department staff also offers seminars on lake pollution and pollution prevention.
- Anytime the Stormwater Management Division undertakes a capital improvement project, some of the numerous floodplains are invariably affected. The staff sets up public meetings in which the scope of the project, preliminary design details, construction schedule, and potential impacts during construction are explained in full detail. Public comments are incorporated into the final design where practical. During the public meeting, the staff provides additional details regarding the services offered by the Division. In any given year, it is expected that from 30 to 40 projects will be underway with about six public meetings conducted.
- Every year, the County sponsors an Earth Day celebration. Most recently, this event has targeted elementary and middle school children. During the celebration, displays are presented on rainfall, stormwater issues, pollution prevention, and floodplain management.
- Major projects undertaken by the County are often conducted in cooperation with the local Water Management District. As part of the outreach programs, staff from the District and Orange County attend meetings with special interest groups, such as "Friends of Wekiva" and "Friends of Econ." In these meetings, flyers describing the projects and guides to management of stormwater systems are distributed.
- Staff from the Stormwater Management Division participate in "Engineer's Day" sponsored by the East Central Florida Branch of the American Society of Civil Engineers. During this event, high school students are given an opportunity to look at how and what a county engineer does at work. The staff tells the students about the functions of the Public Works Department, including floodplain management duties. They are also taken on a site tour.
- Orange County owns and operates "ORANGE TV," a local access channel. All meetings of the Board of County Commissioners are aired live. It is also open to the various County departments who need to share public information. Panel discussions are also conducted on various subjects, such as a representative of the Stormwater Management Division participating in the recent panel discussion on the National Flood Insurance Program, flood insurance in general, and the Community Rating System.
- The Manager of the Stormwater Management Division periodically conducts seminars for the

engineering community in the greater Orlando area about issues in floodplain management, the Community Rating System, and projects undertaken by the County that affect various segments of the population. These seminars are typically arranged by the American Society of Civil Engineers, Florida Engineering Society, or the Florida Stormwater Association.



Hurricane Preparedness Handbook

Brochures published by Orange County, Florida, American Red Cross, WESH, Channel 2, and Gooding's Chrysler-Plymouth

- Whenever there is a County activity occurring within or near a particular neighborhood, "doorknob" flyers are prepared and hung on the affected community's doors or mailed directly, explaining the activity, why it is occurring, who is conducting it, how long it will last, and the benefits to be realized. These simple flyers make it easier for the work crews to complete their tasks and cut down on the numbers of phone queries to find out what is happening in the community.

Orange TV Brochure

Brochures published by Orange County, Florida, American Red Cross, WESH, Channel 2, and Gooding's Chrysler-Plymouth

Additional Actions

Mitigation

As populations grow and development expands, some past management practices often need correction. This is usually done with various forms of mitigation through which, if done properly, some or all of the adverse impacts can be corrected. Orange County has addressed this through several mitigation activities, including the Community Rating System, drainage improvements, preservation of environmentally sensitive lands as greenways and blueways, a hazard mitigation plan, and projects to minimize streambank erosion.

Hazard Identification & Mapping

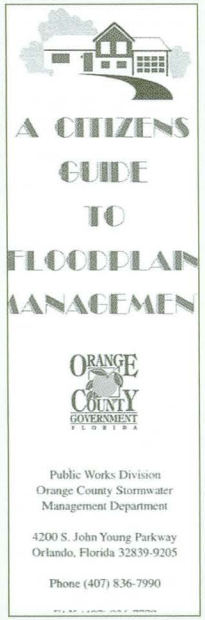
Proper pro-active management of a community's natural resources and hazard areas cannot be accomplished without good mapping. These tools lay a strong foundation for providing the ability to practice NAI floodplain management. In 1982, Orange County began an ambitious project to map its major drainage basins. With the cooperation of the various Water Management Districts, the County obtained 1-foot contour aerials of all basins, except the St. Johns River basin, where the majority of the lands are under county or state ownership. The staff delineated the 100-year floodplains with elevations obtained either from the Federal Emergency Management Agency or from reports submitted to Orange County in the course of development projects. Periodically these maps were revised to reflect the change in contours due to growth. In 2000, the County began to update its maps with new 1-foot contour coverage of its 12 basins.

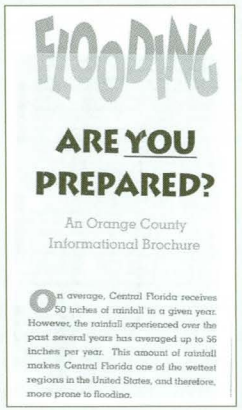
Planning

Orange County has incorporated NAI principles into its major planning documents and initiatives. To effectively manage the water quality and preserve the wetlands and floodplains, the staff of the Stormwater Management Division began a Basin Master Plan in 1994. Each of the 12 basins has a plan based on a comprehensive study and analysis evaluating water quality and the basin ecosystems. The staff has used the master plans to set priorities for capital improvement projects, to help in updating the County's Flood Insurance Rate Maps, to update the inventory of the County's drainage infrastructure for maintenance, to incorporate surface water modeling data into a groundwater model for water supply withdrawal, and identify water bodies requiring total maximum daily load reduction.

Infrastructure

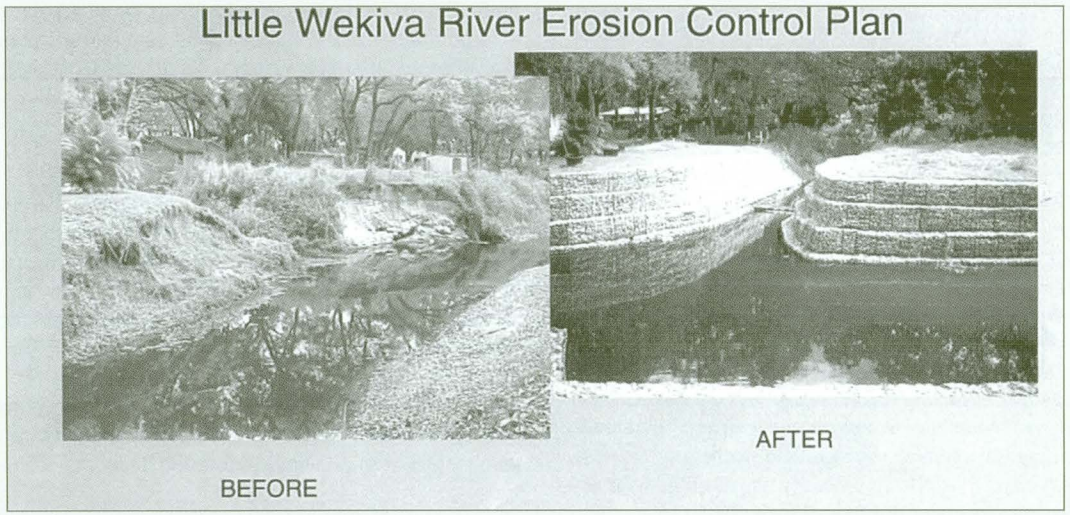
Florida is noted for its wetlands and water-related resources, and the Orange County area is no exception. This part of the state also has extensive farming and citrus groves. The County has found that through the construction of various facilities, the agricultural interests can be fostered while the vast natural resources are maintained and protected. Orange County maintains about 95 miles of primary canals, 17 stormwater pumping stations, 69 drainwells, 54 control structures, and over 1,300 ponds. County personnel dedicated to infrastructure maintenance number 309, with an annual operating budget of $52 million.





Some typical Orange County informational mailers or doorknob flyers

Orange County, Florida



Little Wekiva River Erosion Control Plan, Orange County, Florida

Emergency Services

Emergency services for Orange County are provided by the Fire and Rescue Department. During hurricane emergencies, the department issues warnings, coordinates evacuations, and handles all disaster-related mitigation measures. The Office of Emergency Management carries out a variety of activities that enhance NAI floodplain management, including informational services for the building trades, a geographic information system, lists of advisory boards, and lists of volunteer opportunities.

Regulations & Development Standards

The County's Office of Code Enforcement administers all codes. The County also requires mitigation for any damaged or destroyed wetlands that should occur during project development. Among the County's standards are a requirement for compensatory storage for fill; 1 foot of freeboard for new construction, 25-year stormwater retention onsite, and water quality treatment for the initial runoff or first flush after rainfall.

Community Support

Orange County approved a land use policy in 1972 that served as a guide for future growth. In 1985, the Florida legislature required all local governments to establish level of service standards to ensure the availability of public facilities and services, including drainage, concurrent with the impacts of development. In 1990, Orange County reevaluated its level of service, goals, objectives, and tasks related to stormwater, aquifer recharge, conservation, open space, intergovernmental coordination, and capital improvement projects. Many of the tasks are directly related to the County's NAI management policies.

Additionally, Orange County experienced severe freezes in 1989, damaging the citrus industry. Many landowners sold to developers rather than continue agricultural activities. This, coupled with additional growth in tourism, followed by expansion by Disney, Universal, and Sea World theme park attractions, continued to strain resources. The County recognized that, to retain the character and resources that made it attractive to this growth, the practices and

principles of NAI floodplain management were not only desirable, but also a necessity.

Many of the NAI activities undertaken are joint efforts of local agencies including the cities, water management districts, and adjacent counties. All agencies work together on NAI floodplain management. For example, a local hazard mitigation strategy was developed for Orange County by a task force consisting of representatives from 12 local municipalities, state agencies, and civic organizations through a public education process. All mitigation projects are undertaken through citizen participation and, if necessary, through a formal public hearing before the Board of County Commissioners. Consulting engineers, water management districts, and citizens accept County rules and regulations, and the County receives cooperation from municipalities, water management districts, and state agencies.

Various sources of funding are used to carry out County activities and policies:

- General funds to undertake the capital improvement projects of stormwater retrofits (mitigation) and provide emergency services;
- Transportation Trust Funds and local gasoline taxes to undertake maintenance-related activities;
- Municipal Service Taxing Unit to maintain residential ponds;
- Municipal Service Benefit Unit to undertake lake-related capital improvement projects;
- Bonds and public service taxes to acquire environmentally sensitive lands;
- User-based fees to support development review and inspection services; and
- Grant monies from water management districts to support outreach projects and education.

Background

The average annual growth for Orange County from 1990 to 2000 was 21,885 persons per year or 2.84%, as compared to Florida's 2.14%. The chart below shows the population trend for the County.

	1990*	2000*	2003*	#Change 1990 - 2003	% Change 1990 - 2003
Total	677,491	896,344	982,328	304,837	45.0
Unicorporated	432,305	596,164	645,469	213,164	49.3
Incorporated	245,186	300,180	336,859	91,673	37.4

*1990 and 2000 Census, U.S. Census Bureau

**Estimate for April 2003, University of Florida, Bureau of Economic & Business Research

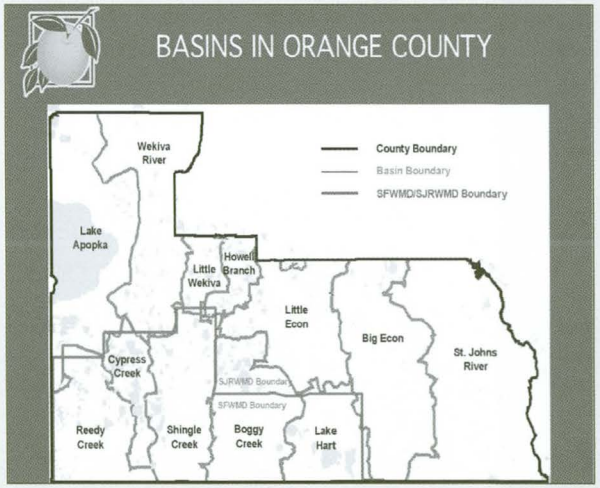
In 2002, the service and retail trade sectors made up the largest part of the local economy in terms of employment. The top five occupation categories were business services, amusement and recreation services, health services, restaurateurs, and hotels and lodging.

Orange County's goals are outlined in the Comprehensive Policy Plan, which covers natural resources as well as other County government activities. The plan, originally adopted in 1991, undergoes minor changes periodically with major revisions every seven years through the Evaluation and Appraisal Report process.

Within Orange County lie the headwaters of two major river systems, the St. Johns River flowing north and the Kissimmee River flowing south. There are over 500 named lakes and other sinkhole depressions in Orange County. While a majority of these lakes has a drainage overflow to a river or canal, some are landlocked, creating drainage problems during above-average rainfall. To remedy the flooding around the landlocked systems, drainwells were constructed during the 1930–1960 era. It is reported that 500 such drainwells were dug to alleviate the flooding.

In 1960, Hurricane Donna devastated central Florida, flooding almost every urban area of Orange County. In response, Orange County established the Primary Water Advisory Board, which was tasked to upgrade the primary canal system. The Board undertook a water control program for all basins throughout Orange County. It planned and undertook major drainage improvements focusing on getting the water out of the County via canals, ditches, and pumps during extreme rainfall events. Subsequently in 1965, the County adopted subdivision regulations including the County's original stormwater regulations. A major revision to the subdivision regulations was adopted in 1989. However, older subdivisions built before the implementation of the rules were still experiencing flooding problems during intense rainfall.

Because of the infrastructure of canals, control structures, pumps, and drainwells, flooding was limited to older subdivisions and the floodplains of landlocked water bodies. Major floods occurred in 1987 in west Orange County, in 1997 in closed lake basins, and in 2003 in three isolated basins.



Twelve Orange County drainage basins

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http://www.orangecountyfl.net/dept/pw/storm/default.htm

References

Orange County Office of Emergency Management. "Hurricane Preparedness Handbook."

Orange County's website can be accessed at http://www.orangecountyfl.net.

Orange County, Florida. 1991. "Comprehensive Policy Plan." http://www.ocfl.net/planning.

Advisory boards serving Orange County are listed at http://www.orangecountyfl.net/aware/advisory/defualt.asp.

Orange County Emergency Services are described on the website at http://www.ocoem.com/Default.htm.

Information on Orange County's level of service can be found at http://www.orangecountyfl.net/dept/growth/planning/CPP-current/publications.htm.

Maricopa County, Arizona

Maricopa County covers over 9,000 square miles of the Sonoran Desert in south-central Arizona. Five major river systems drain the County, the largest being the Gila River. The arid climate and topography induce flash flooding; many smaller tributaries or washes are dry most of the time. The population of 3 million, concentrated in the Phoenix metropolitan area, is expected to double by 2030.

Primary NAI Building Block

Planning

Because it takes a comprehensive approach to planning and development, Maricopa County has lessened the adverse effects of growth on its surface water and groundwater resources even while it remains one of the fastest-growing communities in the nation.

Other NAI Building Blocks

- Regulations & Development Standards
- Mitigation
- Infrastructure

Maricopa County works to avoid these "adverse impacts" . . .

- any flood impact due to the 1% annual chance event;
- acceptance/discharge of flood flows other than at historical points of concentration (both location and direction);
- failure to provide adequate detention onsite for the 1% annual chance event, 2-hour runoff;
- failure to dispose of retained runoff within 36 hours; or
- lessened bank stability beyond the site of the project.

Planning

Since the 1960s Maricopa County has been strengthening its project planning to avoid adverse impacts. It is this comprehensive county-wide planning, responsible for such rapid but controlled growth, that supports no adverse impact (NAI) floodplain management. Because all projects must adhere to regulations and standards, it is essential that the policy and guidance documents provide the background information and reasoning used to create the local laws.

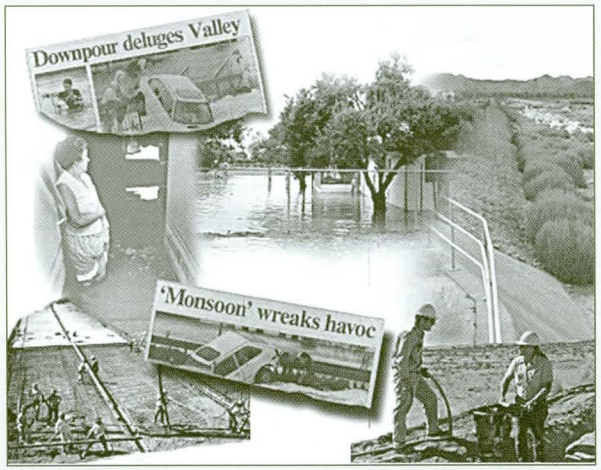
Sub-basin Specific Plan for each Drainage

Defining adverse impacts at the sub-basin level supports NAI floodplain management because it emphasizes the important values (environmental, social, economic) of the specific community. Because planning is accomplished before individual project development, each new project is part of a comprehensive basin-wide solution that does not allow for adverse impacts, as defined by the community.

In the past, floodplain delineation studies have not been completed ahead of development, resulting in structures placed in floodplains and/or floodways. Before 1978, when floodplain mapping was not available for most of Maricopa County, 430 buildings were constructed in the floodway. Until floodplains are defined for all of the watercourses in Maricopa County, additional buildings could be constructed in undelineated floodprone areas.

The Watercourse Master Plan ensures that new construction is not subject to flooding by the 1% annual chance event and that acceptance/discharge of flood flows is at historical points of concentration. After input from the public, the plan is then brought to the implementing jurisdictions for adoption.

- Maricopa County's Watercourse Master Plans include:
  - fluvial geomorphologic investigations,
  - an evaluation of individual watercourses for existing flood problems and the potential for new problems,
  - an analysis of cumulative impacts of both existing and future development, and
  - criteria to minimize potential flood damage.



Even though it lies in the Sonoran Desert, Maricopa County has a history of flooding and flash flooding

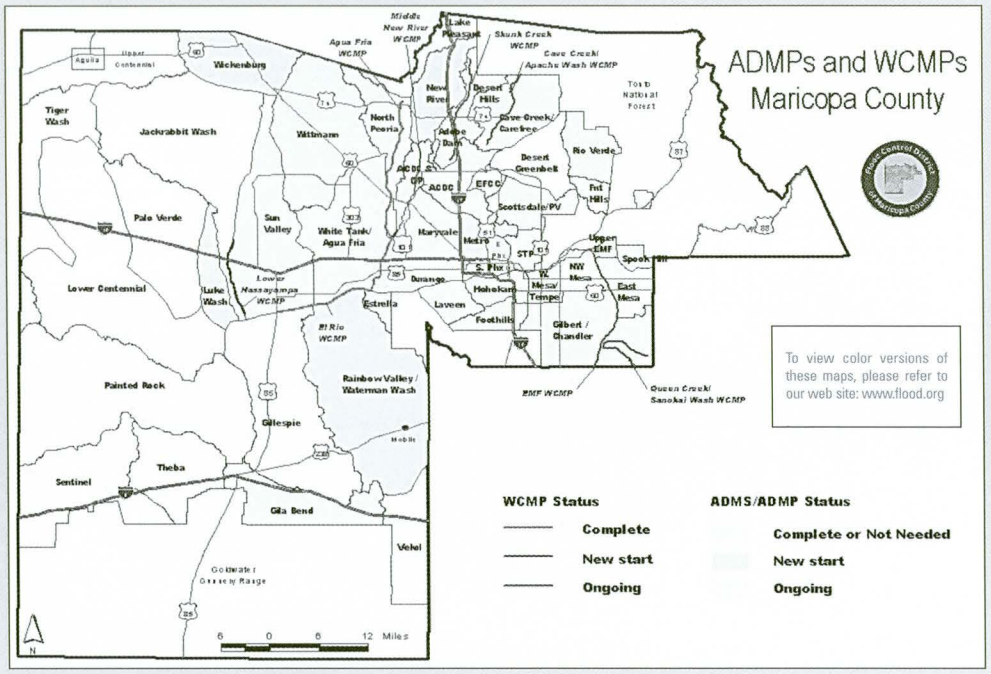
—http://www.fcd.maricopa.gov/

- One emphasis of the Watercourse Master Plan is the inclusion of multiple-use opportunities. In support of this, the Flood Control District of Maricopa County uses multi-disciplinary teams that include engineers, planners, landscape architects, cultural and historical resource specialists, fluvial geomorphologists, and others.
- The District obtained authority from the state legislature to develop specific standards for a watercourse that can exceed the state's standards. In addition, the Watercourse Master Plan can have individual rules for development that are even stricter than the District's standard.
- The District is working with the Corps of Engineers, municipalities, sand/gravel operators, and private non-profit groups to pursue restoration opportunities through the Watercourse Master Plan process. This relatively new effort includes quantifying the risks and establishing maintenance guidelines for restoring vegetation for flood management.
- The Agua Fria Watercourse Master Plan is one example of a basin-specific plan. Planners and landscape architects defined the Agua Fria system, and then the engineers and hydrologists analyzed the system for flood management and impacts. As part of the planning process they defined acceptable levels of impact for the Agua Fria basin, (including an increase in flood velocity; an increase in flood heights; or failure to consider cumulative (rather than individual) impacts on the system). The Plan
  - identified mitigation measures to address specific Agua Fria basin problems, and
  - recommended innovative management strategies based on cumulative rather than individual impacts to
    - enhance the community through multi-use corridors;
    - share costs and maintain flood management projects through partnerships with federal, state, county, city, and local agencies;
    - ensure that all buildings are 1 foot above the base flood elevation;
    - approve no development action that results in an increase in velocity and/or flood heights; and
    - incorporate retention or detention in new development.

The Basin Plan, Area Drainage Master Plan

Having Area Drainage Master Plans completed for all 39 watersheds in the next decade allows the District to address flood and other issues in a cumulative manner, county-wide. This cumulative regional approach supports NAI floodplain management because it requires mitigating adverse impacts of all planned activities.

- In 1988 the District initiated a watershed-based planning approach called an Area Drainage Master Plan. The planning effort is one of the highest



Status of master plans and studies in Maricopa County, as of December 2003

—Flood Control District of Maricopa County

priorities for the District; it intends to complete plans for the developable portions of the County (except for Gunnery range) in the next 10 years. The Area Drainage Master Plan must be adopted into regional planning documents, therefore becoming institutionalized.

- The District uses an Area Drainage Master Plan to

  assess conditions basin-by-basin, including hydrologic assessment, floodplain delineation, and problem identification;

  recommend creative cost-effective solutions for hazards and problems;

  integrate public participation;

  give affected property owners an opportunity to have input; and

  set basin-wide priorities.

Putting It All Together, The District's Comprehensive Plan

A Comprehensive Plan identifies all programs and projects in one document. Although many departments and individual staff are working on innovative solutions, all of the efforts are prioritized and coordinated in this one document. Coordination is crucial to a community's NAI success because all potential projects, and their impacts, are being considered in conjunction, therefore cumulatively.

- The 2002 Comprehensive Plan incorporates the "Growing Smarter Plus" legislation (2000) and requirements of the Community Rating System, making the Plan more compatible with other planning documents for guiding decision making and determining project priorities. The plan is currently being updated and will include the Hazard Mitigation Plan issues.
- The intent is for the Plan to be implemented through the District Strategic Plan, Business and Financial Plans, Planning Studies, Capital Improvement Program, regulations, and policy.
- The Comprehensive Plan addresses all aspects of floodplain management, including

  a summary of each watershed (37 watersheds in the County and two outside), including physical conditions analysis and risk assessment (soils, slope vegetation, development trends, intensity of urbanization), and specific problems;

  progress reports on completed projects;

  evaluation and ranking of appropriate solutions based on risk assessment, considering such factors as extent of land area, linear miles of delineations, structures in the floodplain, floodplain and drainage permits issued, erosion hazard zones, county road closure statistics, remaining land to be developed, and expected population growth;

  future revenue needs;

  floodplain management activities (both structural and non-structural);

  education and outreach (public meetings, website, project updates, and local newspaper advertisements); and

  regulations.

Visual Considerations

The District had identified natural desert open space, community image, "desert greenbelts"(natural open space in the desert region), and new parklands as local resources

that are important to preserve and protect. Implementing standards to protect these local values is a core NAI principle because negative impacts on them affect the way of life that citizens appreciate.

- The implementation of the District's Landscaping and Aesthetic Treatment Policy has been a District focus in the past several years. By integrating landscape aesthetics and multi-use opportunities with flood management projects, the District plans to

  preserve natural desert open space,

  enhance local community image, and

  provide opportunities for desert greenbelts and new parklands.

A Planner's Success Story, Indian Bend Wash

This multi-objective project improved flood management, provided an open space amenity to the community, and has proven to be an economic success. This one project included five of the NAI building blocks. Indian Bend Wash is the result of creative vision, comprehensive planning, and implementation of strict standards—Maricopa County's planning process reaching fruition.

- Today the Indian Bend Wash Greenbelt is 7.5 miles long, and is a system of parks, lakes, and golf courses.
- Because planners envisioned a linear park rather than a concrete channel for the Indian Bend Wash, residents of Scottsdale enjoy the benefits. Scottsdale has made the Indian Wash greenbelt an integral part of its outdoor lifestyle. Due to the city's linear shape, about 80% of Scottsdale's citizens are within walking distance of the Indian Bend Wash.
- About 1 million people use the greenbelt every year.
- The project is considered a socio-economic success because high-end apartment complexes, attractive shopping centers, and resorts are the land uses bordering the Wash.

Private development incorporates Flood Control District of Maricopa County's Rules of Development and Landscape Aesthetics policy to guide new development. The development stays out of the floodway, floodplain, and erosion hazard zones.

Photo by Pat Ellison (Stantec), 2004

Additional Actions

Regulations & Development Standards at the State Level

In 1984, Arizona state lawmakers enacted legislation requiring builders and developers to comply with strict standards for flood control and stormwater management. Having the state require these progressive standards motivated Maricopa County to implement even stricter local standards (see below). These 1984 state standards applied to residential, commercial, and industrial properties; required that all buildings be 1 foot above the base flood elevation; included compliance language for failing to adopt the regulations (an individual can be charged with a class 2 misdemeanor for impacting flow without first obtaining the appropriate permits); and directed each county to establish a flood control district.

Regulations & Development Standards at the Local Level

Maricopa County adopted formal floodplain regulations initially in 1986 and has made six revisions since then. The regulations ensure that adverse impacts, as defined by Maricopa County, are not a consequence of public or private actions and include putting flood-related hazard information on the County floodplain maps; mandatory notification to affected property owners of the results of any delineation study; prohibiting buildings in the floodway; floodproofing for non-residential structures to 2 feet above the base flood elevation in Zone A; lowest floor 1 foot above the depth of flooding, ponding, or shallow flooding areas in Zone AO; and mobile/manufactured homes elevated so the bottom of the frame (not the finished floor) is 1 foot above the base flood elevation (2 feet for unnumbered Zone A). Specific regulations for alluvial fans are based on identified and classified risks, and provide for minimum vegetation removal and mandatory analysis of scour and sediment processes. Maricopa County adopted formal drainage regulations initially in 1984 and produced hydrologic and hydraulic design manuals in 1990 and 1991.

Mitigation

Maricopa County has identified appropriate mitigation solutions for each basin. Although the measures are voluntary, cumulatively they will result in lessened impacts to the structure and to downstream and upstream areas.

Channel wall above McKellips Street during February 2003 flood.

—http://www.asu.edu

The Alternative Flood Control Works Program, (revised and renamed to Floodprone Properties Acquisition Program), allows the District to provide limited funding for voluntary, non-structural flood mitigation measures, such as property acquisition to help residents in flood- or erosion-prone areas where large-scale structural or non-structural capital improvement projects are not feasible. Maricopa County residents pay one of the lowest NFIP premiums in the nation because of the community's class 5 rating in the Community Rating System.

Infrastructure

Although numerous structural flood management solutions have been implemented in Maricopa County, each is part of an overall strategy. Since the 1980s, Maricopa County has emphasized non-structural solutions to flood management, but infrastructure has been established to protect structures built before then. Examples include the Arizona Canal Diversion Channel; dams on Cave Creek, Cassandro, Dreamy Draw, Skunk Creek, and New River; channelization of portions of Cave Creek; flood control and storm drains on Indian Bend Wash (including a linear park and open space); and bank stabilization projects and flow easement acquisition on Skunk Creek, the New River, and the Agua Fria River.

Residents of Wickenburg watch the floodwaters of Sols Wash at U.S. Highways 98 and 9 during the October 2000 storm.

—from Federal Emergency Management Agency, 2000

Community Support

In 1970, local officials were drawn into managing flood problems when the Maricopa County Board of Supervisors complied with land use and management criteria regulations and joined the NFIP. They agreed that all development permits be reviewed to determine whether proposed actions would be reasonably safe from flooding. Then in 1974, the County Board of Supervisors adopted flood control amendments to regulate development and land use, recognizing that flood hazards must always be considered in decisions affecting the floodplain.

There was much support from the residents and business community to implement these early steps to regulate development because of the damage experienced during big floods in the 1970s and 1980s. There was interest in obtaining flood insurance, minimizing flood hazards, and implementing mitigation projects to avoid future damage and expensive recovery.

Multi-objective projects have the benefit of having numerous elements to attract community and individual support. Because washes are dry most of the time, the public isn't focused on flood damage or how to improve flood problems. The damage experienced in the storms of the 1980s and 1990s led to support for implementation of multi-objective projects. Even if the flood control aspect of a project was not of personal interest, there was some other element to encourage community and individual "buy-in."

Between the mid 1970s (when Indian Bend Wash was implemented) and the 1990s, many planning and policy changes took place. Individual development proposals were not addressing cumulative impacts or assessing the overall development of the watershed. Design standards throughout the communities were different, leading to problems in adjoining developments and communities. In response, the District took a greater role in coordinating efforts and mandating standards. In the mid 1990s, the District's Planning Department was created, combining efforts of landscape architects, planners, and engineers, so that coordinated, cumulative watershed-wide approaches are now being implemented. The explosive growth of Maricopa County makes it clear that planning, regulations, and mitigation measures do not have to hinder the local economy.

Background

Maricopa County lies in south-central Arizona, within the Sonoran Desert. The County is 103 miles long and 130 miles wide with a land area of 9,226 square miles. About 16% is incorporated into 24 municipalities, including Phoenix, Mesa, Scottsdale, Glendale, and Tempe.

In 2001, the County had a population of 3 million people concentrated in the urban area. Maricopa County continues to be one of the fastest-growing counties in the United States, and is expected to increase by 80,000 people each year for the next 30 years. This means that there will be twice as many people in 2030 as there are now. The County must anticipate where future development will occur in order to protect residents from flood damage and other adverse impacts.

The major watercourse leaving Maricopa County is the Gila River, with major tributaries including the Salt, Agua Fria, and Hasscyampa rivers. The five major river systems flowing through Maricopa County drain approximately 57,000 square miles (including parts of New Mexico and Mexico), an area six times as large as Maricopa County. These rivers, along with the other watercourses, form 37 different watershed basins.

Flash floods and flooding have long been a part of Maricopa County's history because of the topography and arid lands. Flood records have been kept for more than 100 years, showing major floods in 1891, 1921, 1963, 1965, 1966, 1970, 1972, 1978, 1980, 1983, 1993, 1997, and 2000.

The explosive growth of Maricopa County makes it clear that planning, regulations, and mitigation measures do not have to hinder the local economy.

The Flood Control District of Maricopa County was established by the Arizona State Legislature in 1959 as an entity to keep residents safe from flooding and with an independent funding source to accomplish that mission. The District is responsible for the regulation of new development primarily in the unincorporated regions of Maricopa County, and at the invitation of the incorporated communities. Since 1958, more than 80 major structural projects combined with non-structural approaches have been reducing disaster risk to residents and reducing the cost of disasters. In Maricopa County, the District regulates even small basins (floodplains that have a flow of more than 50 cfs for the 1% chance event).

Today the District's focus is to identify non-structural solutions to reduce flooding problems. During the late 1990s, the District began to rely on floodplain management and drainage ordinances to keep people and structures away from flooding risk. The District has a staff of 200 and an annual operating budget of approximately $80 million. About $58 million is dedicated to the capital improvement program, and $22 million to operations. Over 70% of the District's operating revenue comes from the flood control tax, part of the property taxes.

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http://www.fcd.maricopa.gov

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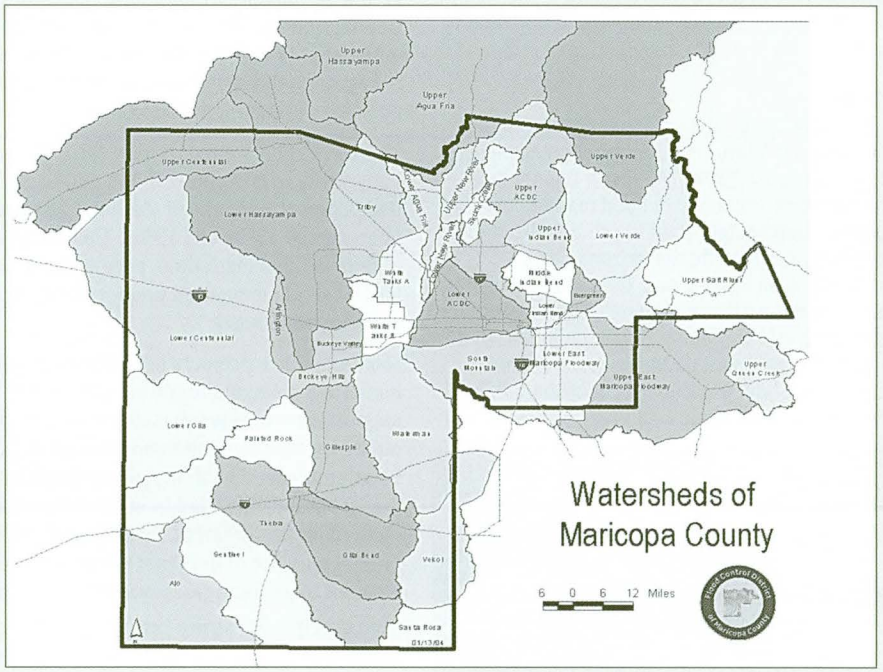


Watersheds of Maricopa County

—Flood Control District of Maricopa County, 2000

Fort Collins, Colorado

Rapidly urbanizing Fort Collins (population 127,000) lies at the foot of the Rocky Mountains in northern Colorado. The city has 11 stormwater drainage basins, most of which are urban in character. Some are susceptible to flash flooding. In 1980, the City established one of the first stormwater utilities in the nation, funded by service fees based on size of lot and amount of impervious surface. This was followed by strict stormwater and flood protection standards that, over almost two decades, have resulted in reduced flooding in the newer parts of the city.

Primary NAI Building Block

Regulations & Development Standards

Fort Collins has had devastating floods in the past few decades, resulting in property damage and, in 1997, five deaths. The City has responded by developing and implementing stricter regulations and standards specifically formulated to minimize risks to life and property while at the same time preserving what the community considers its valuable natural features. Fort Collins has identified community assets; the City's regulations and standards are aimed at avoiding "adverse impacts" to them. The City's regulations apply to both Federal Emergency Management Agency- and City-designated floodplains, based on the cumulative impacts of construction.

Other NAI Building Blocks

- Hazard Identification & Mapping
- Public Education & Outreach
- Planning
- Mitigation

Fort Collins works to avoid these "adverse impacts" . . .

- danger to people upstream, downstream, or in the immediate vicinity;
- degradation of streamside trees, vegetation, or wildlife habitat;
- an increase in flood heights, velocities, duration, or rate of rise due to the individual or cumulative impacts of proposed, existing, and planned uses;
- a decrease in a stream's carrying capacity, channel stability, or sediment transport capability;
- degradation of the visual character of natural features; or
- obstruction of scenic views to and from natural features.

Regulations & Development Standards

Fort Collins emphasizes the importance of cumulative impacts. The City also focuses on avoiding damage to property and people both upstream and downstream. These aspects of the regulations support the main premise of no adverse impact (NAI) floodplain management: do no harm to others now or in the future.

Flood Protection and Prevention

- The City code ensures that "those who occupy the floodplain assume the responsibility for their actions." The code restricts uses that are dangerous to health, safety, and property that result in damaging increases in erosion, flood heights, or velocities. It also regulates the construction of flood barriers that may increase flood hazards in other areas. The code requires maintenance within the watercourse so that the flood-carrying capacity is not diminished.
- In evaluating impacts of new construction, several things are considered. A floodplain analysis of the flood profile, elevation, and velocity (including existing and anticipated uses) must show that the proposed construction will not cause a rise in the elevation of the 1% annual chance event. Other items that must be considered are

  effects upon the efficiency or capacity of the conveyance zone;

  effects upon lands upstream, downstream, and in the immediate vicinity;

  effects upon the 1% annual chance flood profile and channel stability;

  effects upon any tributaries to the main stream, drainage ditches, and any other drainage facilities or systems;

  potential danger to persons upstream, downstream, or in the immediate vicinity;

  adverse environmental effect on the watercourse, including streambanks, streamside trees, vegetation, and wildlife habitat;

  cumulative effect of proposed construction on existing and anticipated uses; and

  adverse effects to surrounding property due to expected flood heights, velocities, duration, rate of rise, channel stability, and sediment transport.

- Development in the 1% annual chance floodplain must be designed so that there is no adverse effect to any other properties from either increased flood heights, flow velocities, flow duration, rate of rise of flood waters, channel stability, or sediment transport. The floodplain regulations include a floodway defined as the channel and the adjacent land area needed to discharge the 1% annual chance event without cumulatively increasing the base flood more than 0.5 foot (the National Flood Insurance Program standard is 1 foot). The regulatory flood protection elevation—the level to which structures must be elevated or floodproofed, as appropriate—is 18 inches above the base flood. The Cache la Poudre River basin has more restrictive regulations, discussed below.
- Because of concern for channel stability, erosion buffer limits have been established on some streams. No development is allowed within the erosion buffer limits.

Storm Drainage Design Criteria and Construction

Since 1984, Fort Collins has implemented strict runoff criteria, requiring that runoff from the 50% annual chance (2-year) flood and the 1% chance event (100-year) be detained on site. This supports the NAI concept that as part of each construction project, impacts should be mitigated.

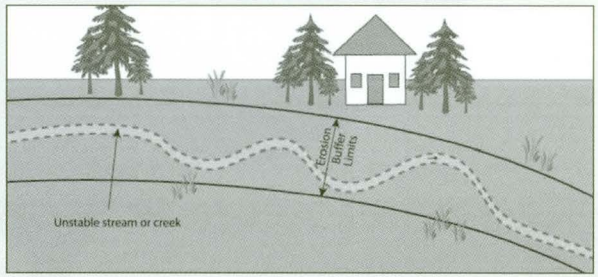
- City code states that all master plans require stormwater runoff not exceed the 50% annual chance event runoff;
- The difference between the 1% annual chance runoff under developed conditions and the 50% annual chance event runoff must be detained onsite; and
- If a release rate is greater than this, a detailed analysis of the downstream conditions must show that no adverse effects will occur.

Protection of Natural Features and Scenic Quality

Because Fort Collins has identified natural resources as significant, the regulations that protect the resource and views to and from the resource are necessary. Having the community identify the important resources is part of the NAI approach. Requiring natural resource restoration that is "equal in function" after disturbance is one example of how Fort Collins maintains a no adverse impact standard for natural resources.

- An Ecological Characterization Study is required if the proposed site of construction is within 500 feet of a natural habitat or feature. The study includes recommendations for mitigation to address the adverse impacts of the project on natural habitats and features.
- A construction project must be designed in accordance with Buffer Zone Performance Standards so that the "use, density, traffic generation, quality of runoff water, noise and lighting, shall minimize the degradation of the ecological character or wildlife use of the affected natural habitats or features."

  The minimum buffer distance is listed in the City's environmental standards for specific resource



Erosion buffer limits

—from Fort Collins Utilities

types and mapped areas;

A buffer typically provides a water quality component to treat runoff; and

A buffer helps minimize damage associated with active channel erosion and encroachment of future development.

- If the development causes any disturbance within the buffer zone, restoration and mitigation measures must restore any damaged or lost natural resource either onsite or off-site. The mitigation or restoration must be at least equal in ecological value. Any disturbed vegetation must be replaced with native vegetation and landscaping.
- Construction near large natural habitats must be designed to complement the visual context of the habitat. Human-made facilities must be screened from off-site observers and blend with the natural visual character of the area. Scenic views across or through the site must be protected through compatible architectural design, site design, native landscaping, color choice, and building materials.

Strict Regulations in the Cache la Poudre River Basin

Fort Collins has an accurate rain gaging system within this basin providing the specific detail needed to manage flooding. Pro-active decisions to maintain open space in the corridor have helped manage flooding and lessen impacts to property and people.

The history of this basin is what has motivated the City to address floodplain management in a cumulative and comprehensive manner. Enforcing the more stringent regulations supports NAI floodplain management by recognizing that negative impacts to the hydrologic system and to affected properties are not acceptable. The history of flooding on the Cache la Poudre River (Poudre River) is well documented: it was the flood of 1864 that caused the relocation of Camp Collins to the present day Fort Collins. Therefore, the Poudre River was the first basin to have a complete review of its floodplain regulations due to its potential impact to the community. In the mid 1970s, the Corps of Engineers did a hazard study on the Poudre River. Based on the results of this study, the City generated restrictive floodplain regulations to reduce the exposure to flood hazards.

Most regulations for the Poudre River are more restrictive than those for other basins in the city. For example, the regulatory flood protection elevation—the level to which structures must be elevated or floodproofed, as appropriate—is 24 inches above the 1% chance floodplain (vs. 18 inches in the rest of the city). The regulations for the Poudre River include a floodway defined as the channel and the adjacent land as needed to discharge the 1% annual chance event without cumulatively increasing the base flood more than 0.1 feet (vs. 0.5 feet in the rest of the city).

The City of Fort Collins divides the floodplain into three zones. The "floodway" is defined as the area necessary to drain the 1% annual chance event. The "corridor" is the area where the product of multiplying the depth and the velocity of the 0.2% annual chance event exceeds six. The "floodplain fringe" is defined as the area outside the corridor. Development regulations for each zone are described below.

Floodway and Corridor

- No modifications (including fill, new development, manufactured home parks, residential development, or encroachment);
- No new development (except public infrastructure, recreation, and natural resources facilities);
- No manufactured home parks or residential development;
- No residential additions to existing structures;
- Remodels are allowed (50% cumulative substantial improvement triggers the requirements for new structures);
- No redevelopment (removing and rebuilding) in existing developed areas;
- No commercial development;
- No variances granted; and
- No critical facilities allowed.

Floodplain Fringe

- New development permitted, but no manufactured home parks or residences;
- No residential additions to existing structures;
- Redevelopment (removing and rebuilding) is permitted;
- Remodels are allowed (50% cumulative substantial improvement triggers the requirements for new structures);
- Commercial development is permitted;
- Fill is permitted;
- Property can be removed from the floodplain fringe with the placement of fill if it complies with freeboard, dry land access, and floatable materials regulations;
- Dry land access from the public road to the structure is required; and
- Variances are possible.

Many types of birds, including the Great Blue Heron, use the Poudre River riparian corridor.

—Fort Collins Utilities (2003, p. 2)

Poudre River Regulations include Property Acquisition

Natural floodplain areas help to reduce flood damage by allowing water to spread over a large area, thus reducing velocities and providing flood storage to reduce peak flows downstream. This supports NAI floodplain management because impacts to downstream neighbors are reduced.

- The Floodplain Property Acquisition Program is included as part of the regulations for the Poudre River basin.
- Either the City Stormwater Utility or the Natural Resources Department can acquire property on a "willing seller–willing buyer" basis.
- Residential floodway and corridor properties are the priority. Properties with the highest risk receive the highest priority for acquisition.
- Once acquired, the structures are removed and the lot is re-vegetated and turned into permanent open space. The City owns a number of parcels along the Poudre River, permanently reserving these areas as open space and reducing the flood hazard.
- Open space along the Poudre River also provides natural erosion control in addition to fish and wildlife habitat.

Additional Actions

Hazard Identification

Mapping to future conditions is part of NAI floodplain management because it addresses the potential cumulative impact of all actions now and in the future. By choosing to extend the regulatory floodplain beyond the FEMA-mapped area, the City addresses the actual flooding impacts, not just those projected based on past studies.

The City has updated all of the floodplain maps to reflect a new higher rainfall standard it adopted in 1999 (except for the Poudre River, which has a separate management scheme, as noted above). Maps developed using the new rainfall standards have resulted in floodplains that are wider and deeper. Remapping of the floodplain has resulted in many properties being included in the floodplain that previously were not. The updated floodplain mapping is shown on the City's Regulatory Floodplain Map. The revised mapping will be submitted to FEMA for revisions to the Flood Insurance Rate Map.

Public Education & Outreach

Public education and outreach have contributed greatly to the success of Fort Collins' floodplain management programs. Because the citizens are aware of historic and current flooding problems, they have supported voluntary programs and structural projects that will reduce future losses. Educating the public about the basin-by-basin approach and cumulative impacts provides the knowledge base for why it is so important to "do no harm to others."

Fort Collins' Customer Connections Group, a section of the Utilities Department, is involved in each floodplain and stormwater management project to assure that public involvement, education, and outreach is integrated into the design and planning. For instance, for a project that includes a habitat restoration component, education addresses the natural and beneficial functions of floodplains and riparian areas. For a project that includes a water quality component, education addresses watershed management and land use techniques that help to purify runoff. The City uses a number of additional techniques to reach the public, including newsletters, open houses, and inserts in the utility bills.

High water mark at Creekside Park upstream of College Avenue, 1997

—Fort Collins Utilities (2003b, p. 6)

Planning

Planning at the basin scale allows for specific regulations and guidelines to respond to the special combination of natural, social, and economic forces in each basin. Setting criteria for each basin supports the notion that a community can determine what is an adverse impact for specific areas.

Each of the city's 11 basins has an individual Master Plan that identifies and maps flood problems, includes development criteria and guidance, addresses water quality and riparian habitat, considers cost effectiveness, and presents solutions to reduce flood damage and risk.

Mitigation

The City of Fort Collins is implementing various mitigation projects, specifically acquisition and floodproofing. By getting structures and people out of harm's way (acquisition), protecting structures from flood damage (floodproofing), and conserving natural and cultural resources (preservation), Fort Collins breaks the cycle of disaster–repair–disaster, and avoids negative impacts on people and structures now and in the future.

Community Support

In the 1970s, the overall community attitude was not favorable toward the federal government's requirements for localities to manage their floodplains. In the early 1980s, the Fort Collins City Council and City Manager were progressive and wanted to take a pro-active role in reducing damage from floods. At the same time, facilities in the field were not being maintained and afternoon thunderstorms would make the phone lines light up with complaints about flooding.

In the late 1980s, Master Plans were developed and regulations were updated in response to citizen complaints. Citizens were very supportive because they were pleased that the City was responding to their concerns. The City did specific outreach with the local developers, agreeing that they would not have to pay more for the Utility Service Fee and Basin Fee.

Today the public shows strong support for mitigation projects, having seen the evidence that taking pro-active measures reduces flood damage and loss of life.

Background

Fort Collins encompasses roughly 50 square miles and is located in northern Colorado at the foothills of the Rocky Mountains. It is rapidly urbanizing with a current population of 127,000. Fort Collins has a strong economic base and has recently received national recognition as one of the "best places to live and work in America," "best economies in the nation," "best places to retire," and "best places to raise a family."

Fort Collins is divided into 11 stormwater drainage basins, mostly urban with some rural or transitional land uses. The smallest is Fox Meadows (2.4 square miles) and the largest is the Cache de la Poudre River (1,890 square miles). Because of flooding problems in the Spring Creek, Dry Creek, and Poudre River basins, the City joined the NFIP in 1979.

The Fort Collins Stormwater Utility was established in 1980 (one of the first in the country) to operate and maintain stormwater facilities, implement capital improvement projects, coordinate acquisitions, and implement a flood warning system. The Utility had been funded by a service fee, different in each basin, based on lot size and impervious surface.

In 1984, the City of Fort Collins adopted progressive stormwater and flood protection criteria. As a result, there is less flooding in the more-recently developed southern part of the City. Criteria (buffers and drainage channels designed with additional capacity) were designed to reduce flood losses. After the City experienced deadly flooding in 1997, it reviewed the stormwater management program.

For the City of Fort Collins, the primary goal of stormwater management is to be pro-active instead of reactive in managing the effects of flooding. The main purposes of the flood hazard mitigation program are promoting public health, safety, and general welfare; reducing public and private losses; reducing emergency response demands; minimizing pollution; and preserving the natural and beneficial functions of the floodplain or river corridor. The City has a four-part approach: floodplain regulations, acquisition of floodprone property, capital improvements, and emergency response.

Fort Collins has participated in the Community Rating System since 1990. As a result of the City's Floodplain Management Program, Fort Collins currently has a class 4 rating, giving floodplain residents a premium reduction of 30%, one of the largest NFIP premium reductions in the country.

The Stormwater Master Plan Executive Summary (Fort Collins Utilities, 2003a) provides a compilation of the conditions and recommendations for each of the 11 basins. Basin-wide priorities were integrated so that city-wide priorities are now listed. Now that city-wide priorities are integrated, the Utility Service Fee is consistent throughout the city. Residents support this approach as being more equitable. Together, the floodplain regulations and Master Plans for each basin provide guidance for development so that current flood losses are reduced and future flood problems are avoided.

If none of the recommended improvements listed in the Master Plan Executive Summary were made, the estimated damage from a 1% annual chance event would be $142 million, affecting 2,600 structures. This would result in $353 million in damage over the next 50 years. The estimated total cost for proposed stormwater management improvements city-wide is about $210 million. Construction of all improvements is expected to occur within 25 years. It is estimated that over 2,300 structures will be removed from the 1% annual chance floodplain and flood damage would be reduced by over $289 million.

1904 flood damage in the Poudre River basin

— http://fcgov.com/stormwater/poudre-history.php

THURSDAY
June 25, 1992

FORT COLLINS
COLORADOAN

'Like opening a faucet'

Relentless hour of rain floods streets, buildings

June 25, 1992, cover photo of the *Fort Collins Coloradoan*

—http://fcgov.com/stormwater/oldtown-history.php

> When it rains in Fort Collins, the newer areas of town have fewer problems than those neighborhoods built before drainage criteria and floodplain regulations were adopted.

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City-wide problems and solution maps, north section of Fort Collins.

—from Fort Collins Utilities, 2003

Legend:

blue =high risk floodplain

green = moderate risk floodplain

yellow dot = 0-1' depth overtopping

orange dot = 1-2' depth overtopping

red dot = 2'+ depth overtopping

To view color versions of these maps, please refer to our web site: www.flood.org

City-wide problems and solution maps, north section of Fort Collins.

—from Fort Collins Utilities, 2003

Legend:

purple = embankments

green dot = culverts

red line = pipes

blue = ponds

yellow and black line = channels

Tulsa, Oklahoma

Hilly topography, a fairly moist climate (average 37 inches of rain annually), the presence of the Arkansas River and many other streams, and conditions perfect for violent thunderstorms and tornados all have combined to make the Tulsa area in eastern Oklahoma the site of repeated and often deadly floods since the City was founded. A 1923 land use plan recommended keeping buildings in the uplands. From the 1950s to the 1980s, various structural and nonstructural measures were applied to the problem with some success. However, the City continued to grow and the flooding did not stop. Over the most recent two decades, Tulsa has tailored a comprehensive floodplain management approach to its particular situation.

Primary NAI Building Block

Mitigation

Devastating floods have affected the City of Tulsa since the early 20th century, but more recent floods in the 1970s and 1980s shifted the City's attention from reacting to each disaster to solving the flood problem through pro-active measures. Tulsa has one of the country's most forward-thinking mitigation programs, including a voluntary acquisition program that is 30 years strong, multi-objective re-use of floodplain properties, and a commitment to getting people out of harm's way.

Other NAI Building Blocks

- Hazard Identification & Mapping
- Public Outreach & Education
- Planning
- Regulations & Development Standards
- Infrastructure

Tulsa works to avoid these "adverse impacts" . . .

- diminished flood storage capacity in the regulatory floodplain;
- insufficient drainage to convey the 1% annual chance flood under conditions of full urbanization of the watershed;
- an increase in frequency of flooding or depth of inundation;
- inundation of unprotected structures in any location not previously subject to flooding; or
- creation of a public hazard for any property within the City or immediately adjacent areas through the obstruction, impairment, sedimentation, blockage, or alteration of a stormwater drainage system.

Mitigation

Tulsa has studied each drainage basin to determine the level of impact that can be mitigated without affecting what has been identified as the most important aspects of flood control (maintaining storage capacity, providing drainage of the 1% annual chance event, and not increasing inundation). This is an example of no adverse impact (NAI) floodplain management in that the local community has determined the level of acceptable impact.

Acquisition Program

In order to accomplish the most important aspects of flood control in certain drainage basins, more open space was needed to provide for storage and conveyance of flood waters. The Acquisition Program benefits all community members, not just those whose properties are bought. This point is emphasized in the City's education and outreach effort and thereby contributes to the success and support of the Acquisition Program.

Tulsa's Acquisition Program began in the mid 1970s and has included more than 900 structures to date. All of the structures have been removed and the land is now managed as open space. Before 1995, Tulsa had acquired, demolished, and removed structures with only local funding. This included more than 300 single-family homes and pads for 228 mobile homes the City purchased after the devastating 1984 Memorial Day flood. Subsequent floods have encouraged further participation in the acquisition program. In the Audubon Creek drainage alone, 60 structures were purchased and removed. Now, the primary source of funding for the Acquisition Program is the Federal Emergency Management Agency's (FEMA's) Hazard Mitigation Grant Program and Flood Mitigation Assistance, so the program has become entirely voluntary. The local match comes from the City's development fees, sales tax, and bond issue packages.

> "You can't solve flooding problems, but you can reduce flooding problems. . . . You either move the water away from the people or you move the people away from the water."
>
> —Ann Patton, City of Tulsa Public Works and Development Department (retired)

A Master Drainage Plan (completed for each of Tulsa's 31 drainage basins) identifies, reach-by-reach, the most cost-effective solutions for that basin's flooding problems. In many cases, where a structural project was not cost-effective, a recommendation was made to acquire or to floodproof properties. The City's floodplain program is gradually reducing its inventory of thousands of floodprone buildings. The City is also including acquisition and relocation recommendations for before, during, and after a flood, as part of the mitigation strategy.

There is a tremendous public outreach effort associated with the Acquisition Program. As part of the Community Rating System planning process, meetings are held throughout the city every three years to update citizens and to get input. At these meetings detailed plan maps, including recommended properties for acquisition, are displayed. Then, after a flood, public meetings are held in the affected areas, and the Acquisition Program is described, with an emphasis on its voluntary nature. Individuals that are interested are mailed a formal letter of notification. If they sign the agreement to participate, their property is included in the City's Hazard Mitigation Grant Program or Flood Mitigation Assistance application. After confirming that the local match is available (25% of the total acquisition costs), potential properties for acquisition are screened to ensure that they meet current state and FEMA criteria. Structures are ranked according to the following criteria established by FEMA (see R.D. Flanagan & Associates, 2000):

- Voluntary participation;
- Single-family residence (commercial and industrial properties are deferred until the high-priority residential properties are acquired);
- Depth of flooding from the 100-year flood;
- Benefit/cost ratio greater than 1.0;
- Delay in master drainage plan implementation (i.e., some structural projects that are not built because of lack of funds or new available data may create properties vulnerable to deep flooding or high velocity flows);
- Neighborhood integrity ("Does it make sense, from a neighborhood perspective, to remove this property?"); and
- Flood insurance (required for Flood Mitigation Assistance funding; properties without flood insurance can only be funded through the Hazard Mitigation Grant Program).

> "The assistance we receive from the Hazard Mitigation Grant Program means more people and property can be helped in Tulsa . . . Tulsans assume the primary responsibility for making our community disaster-resistant, but the effort is too massive to be handled entirely at the local level."
>
> —Charles L. Hardt, Director, City of Tulsa Public Works and Development Department

Mitigation Project 1, Audubon Creek

The combination of acquisition and infrastructure successfully removed 354 properties from the floodplain and created linear open space for recreation while supporting Tulsa's most important flood management goals.

Audubon Creek, a tributary to Mingo Creek, drains 2.64 square miles. In 1984 flooding in the Audubon Creek basin caused $9.8 million in damage, the majority to residential properties. Since then, the channel has had $10 million in flood control improvements, resulting in changes in the floodplain map that "removed" 251 properties from the 1% annual chance floodplain. Completed stormwater projects on Audubon Creek include channel improvements, box culvert construction, and acquisition. A greenway and trail system was constructed along with the channel improvements in certain sections. Funding for the improvements came from the storm sewer facility repair and construction sales tax.

The Mitigation Program's accomplishments include

- Acquiring an easement by plat in 1966 when the area was originally developed;
- Purchasing 50 properties from 1984 to 1985;
- Acquiring 9 easements in 1988;
- Purchasing 10 properties from 1992 to 1995;
- Acquiring 43 repeatedly flooded homes adjacent to the channel; and
- Creating a linear open space and trail system.

Mitigation Project 2, Nelson Detention Facility and Recreation Area

This public-private partnership emphasizes the importance of choosing a location carefully. Because of the potential impact of flood damage downstream, it was essential to preserve this confluence floodplain property to store flood waters and promote conveyance.

The Nelson Stormwater Detention Facility is located at the confluence of Audubon and Mingo creeks. Rockwell International Corporation transferred 20 acres of the Old Rockwell Park to the City in exchange for 20 acres in another part of the drainage. The City of Tulsa and Rockwell also agreed to create a new 20-acre park and 34-acre flood storage facility at this critical location. The City then created the flood detention basin and improved amenities, while preserving the open space of the Old Rockwell Park. The project was completed in 1993 and named for Robert G. Nelson, a former City Councilor who was a strong advocate for Tulsa's flood program.

Nelson Park, a multi-use detention facility and recreation area.

—City of Tulsa Department of Public Works

Mitigation Project 3, Mooser Creek

The design for this multi-objective project was envisioned by a community task force. Assets that were important to the affected residents, such as sound flood management, economic development potential, and social factors, were integrated into the design. This demonstrates how, with NAI floodplain management, the community determines which impacts are acceptable and which unacceptable.

Mooser Creek is one of the last remaining natural water corridors in the Tulsa metropolitan area. About three miles long, it flows through both industrial and residential land uses that presented design challenges in terms of merging recreation with improved floodplain management. A $2.9 million bridge project proposed in 1996 became the springboard for a community task force that envisioned ways to integrate flood control, sustainable development, natural resource protection, and social factors. Technical experts, including staff from the Rivers, Trails and Conservation Assistance program of the National Park Service, helped the general public in a two-year process that culminated in a detailed plan to guide growth in southwest Tulsa. The plan balances the public's desire to maintain the natural beauty of the watershed with engineering and economic considerations that will yield the best, long-term solution to the area's stormwater problems.

Additional Actions

Hazard Identification & Mapping

Tulsa chose to map floodplains based on full urbanization of the watershed, to recognize the cumulative impact of all development that is planned, supporting the NAI concept that all actions should be considered cumulatively. Because the City regulates floodplain property that extends beyond the FEMA-mapped floodplain, it is taking a pro-active role to protect its citizens and property, thereby reducing flood losses.

Tulsa citizens provide input for a floodplain management project

—R.D. Flanagan & Associates

Public Outreach & Education

A comprehensive public education and outreach program is one of the primary reasons that Tulsa's flood mitigation program has been so successful. The 1984 Memorial Day flood became a rallying cry for community members who understood the history of flooding and the options for mitigation. After numerous public meetings, mailings, publications, posters, and other projects, most citizens now support ongoing and new initiatives to mitigate flood losses. In addition, receiving input from community members and City staff has helped decision makers on the City Council to shape the definition of "adverse impact" both for the City and individual drainage basins. The 1999 bond issue for capital improvement projects even included an emphasis on public involvement early in the design process.

Planning

Tulsa began the 10-step planning process that was later adopted by the Community Rating System. The principles of Tulsa's watershed-wide management approach are

reflected in the floodplain and stormwater management policy framework developed in 1974. Since then, all of Tulsa's planning efforts have addressed basin-wide studies, the interaction of the watershed and the urban environment, the desirability of multiple uses of floodplain resources, identification of issues, and management options. Because planning is accomplished before individual project development, each new project is part of a comprehensive basin-wide solution.

Regulations & Development Standards

Tulsa has identified maintaining storage capacity, providing drainage for the 1% annual chance event, and not increasing inundation as the most important aspects of floodplain management. Regulations and standards give "teeth" to those concepts by specifically referencing the avoidance of adverse impacts; requiring management of stormwater runoff and freeboard in new developments, assessing stormwater fees based on impervious surface, and accounting for the cumulative impacts of individual activities.

Infrastructure

The Mingo Creek Flood Control Project, which reduces flooding in the 61-square-mile Mingo Creek watershed and includes 10 miles of channelization and 23 detention basins, is an example of a multi-objective project. At the same time it mitigates flood losses, it also provides recreation and is a valuable aesthetic asset for the community. The amenities incorporated into the detention facilities include landscaping, pedestrian trails, stocked ponds, and recreational facilities. The project was a cost-shared effort between the City and the Corps of Engineers.

> "Always think of multiple use... Stormwater detention facilities should have fishing ponds, soccer fields and baseball fields, and a multitude of trees. People will love them and will want to fund more of them."
>
> —-Mike L. Buchert, Assistant Director, City of Tulsa Public Works and Development Department

Community Support

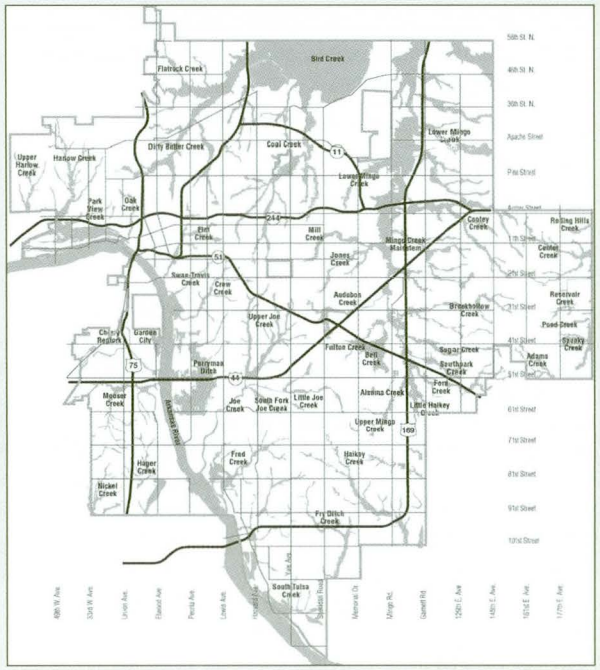
Loss of life and property damage in 1974 and 1976 provided the motivation for Tulsa not only to join the NFIP in 1977, but also adopt regulations that were more stringent than FEMA's.

Further loss of life and property damage from the 1984 flood induced Tulsa to create an institutionalized comprehensive stormwater management program. There is a focused attention on public education. Because the stormwater management fee provides money for operations, maintenance, buyouts, and mitigation, it is essential to inform citizens about the progress and challenges of the various stormwater programs. The community is well aware of the continuing problems and demands that the City take action. Education of community members is key to getting City Council support. Projects are then implemented to reduce flooding and increase economic development, helping to secure more funding for stormwater projects.

Background

The City of Tulsa covers 200 square miles and has a population of approximately 393,000. The city's economic base includes oil, aerospace, technical, scientific, and communications industries. Tulsa is located in "tornado alley," leaving the city vulnerable to thunderstorms and related tornados, particularly in the spring and secondarily in the fall. However, a violent storm can drop 15 inches of rain in just a few hours (annual average rainfall is 37 inches). In addition, the Arkansas River and Tulsa's many creeks are also susceptible to flooding, with approximately 15% of the city designated as floodplain.

Disastrous floods have occurred in Tulsa since the beginning of the 20th century. Major floods occurred along the Arkansas River in the 1920s, 1940s, and 1950s. On June 13, 1923, the river flooded Tulsa's waterworks, causing $15 million in damage, and leaving 4,000 people homeless. In response, City leaders created Tulsa's first land use plan, which recommended housing and streets in the uplands and parks and recreational trails in the lowlands. The waterworks were moved to higher ground near the new



Map of Tulsa's Floodplains.

—City of Tulsa Public Works

2,800-acre Mohawk Park, which became one of the nation's largest city parks. In the 1950s, the Corps of Engineers built levees along the Arkansas River. As growth continued, flooding in the 1960s and 1970s occurred along tributaries throughout the Arkansas and Verdigris basins. The most damage in the 1970s and 1980s occurred along Mingo Creek, which drains one-third of the city but accounts for two-thirds of the damage from more recent storms.

Tulsa joined the NFIP after the 1970 Mother's Day flood caused $5 million in damage. After the June 1974 flood caused $58 million in damage, the community began discussing a better approach to flood management. The City responded with a plan to widen part of Mingo Creek, including clearing 33 houses; the houses were removed just before the next flood. Memorial Day 1976 brought 10 inches

Multi Objective Project along the Mingo Creek

—City of Tulsa Public Works

of rain in three hours, killing three people and leaving $96 million in damage. After that storm, Tulsa enacted a floodplain building moratorium, hired a hydrologist, developed comprehensive floodplain management policies and regulations, implemented drainage criteria, enacted stormwater detention regulations for new developments, instituted a warning system, and began master drainage planning for major creeks. In 1978, an "earth change" ordinance was adopted, giving the City control over changes in the landscape, including floodplains and stream channels.

By the early 1980s, Tulsa had received nine federal flood disaster declarations within 15 years. Then the Memorial Day storm of 1984 hit. The storm resulted in 14 dead, 288 injured, and $292 million in damage. Even while the water was still rising, the leaders of the City of Tulsa began searching for ways to reduce damage in response to the next big flood. They recognized that they must implement a comprehensive flood management program with political and fiscal continuity that would affect all properties within the city from "rooftop to the river."

The Department of Stormwater Management was created in 1985 to centralize flood, drainage, and stormwater programs. A stormwater utility fee was established by ordinance in 1986 exclusively to operate the floodplain and stormwater management activities. The utility fee ensures stable funds for maintenance and management. A new Department of Public Works consolidated all public works services and responsibility for stormwater management was spread throughout the City's organizational structure.

Today Tulsa's floodplain management and stormwater management program is based on respect for natural systems. It includes comprehensive watershed management with watershed-wide regulations, an ongoing Floodplain Acquisition Program, Master Drainage Plans for the entire city, dedicated funds for maintenance and operation through the stormwater utility, a sophisticated forecasting and alert system, an aggressive public outreach program, and a $200 million capital improvements program. The City is implementing multi-objective projects by building parks in the floodplains, sports fields in stormwater detention basins, and greenway trails on creek banks. There is no record of flooding of any structure built since 1987 when Tulsa put its first maps together and adopted comprehensive floodplain regulations. Tulsa has ranked first in the Community Rating System since 1992, when the program was established. Currently Tulsa is rated a class 2, allowing NFIP policy holders to receive a 40% premium reduction—the largest reduction in the country.

> The greatest testimony to Tulsa's program is that since comprehensive regulations were adopted in 1987, the city has no record of flood damage to any building that complies with those regulations.

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City website: http://www.cityoftulsa.org

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Milwaukee Metropolitan Sewerage District, Wisconsin

Milwaukee County lies along the western shore of Lake Michigan, covering about 420 square miles that is largely urbanized. The Milwaukee Metropolitan Sewerage District provides stormwater and flood management services for this area, its six watersheds, and its 1 million people.

Primary NAI Building Blocks

Infrastructure and Mitigation

The Milwaukee Metropolitan Sewerage District (MMSD) is responsible for six separate major watersheds in and around Milwaukee, Wisconsin. Within those watersheds, the MMSD has undertaken extensive design and construction of significant flood management facilities. In these efforts, the MMSD has worked closely with the individual stakeholders, communities, and citizen groups.

Other NAI Building Blocks

- Hazard Identification & Mapping
- Public Education & Outreach
- Planning
- Regulations & Development Standards

The MMSD works to avoid these "adverse impacts" . . .

- An effect that is environmentally unsound;
- An effect that is environmentally unacceptable; or
- An effect that is economically unsustainable.

Infrastructure and Mitigation

The charter of the MMSD is the development and construction of infrastructure to meet the needs of the community within its mandated roles and responsibilities. Mitigation is rolled into this section as a component of the District's primary no adverse impact (NAI) building block, because many of the infrastructure needs arise or are a result of meeting the demands of a growing population as well as correcting or mitigating flood problems associated with that growth. With the responsibility and discretionary authority over six watersheds in the greater Milwaukee area, the MMSD has limited authority for the maintenance of the waterways within those watersheds. This entails repairs, removal of debris and other flow-impeding objects, and deepening and widening channels where necessary for flood mitigation and management purposes.

Several of the watercourses have experienced severe problems with flooding and erosion, creating threats to public health and to private property. This has spurred a strong interest in flood management and flood mitigation. This in turn has caused the regulatory agencies and governing bodies to place a high priority on such efforts. The focus of these initiatives, of necessity, has been on the watersheds, not the political boundaries, thus providing a more effective, comprehensive solution to the problems. Obviously, watersheds do not stop at political boundaries, nor do the problems and need for management and mitigation of those problems. Management of an entire watershed is the only effective means of addressing a system-wide issue.

Flooding on the Menomonee River.

—Photo courtesy of the MMSD

A Watercourse System Management Plan has been developed for each of the six watersheds, through a comprehensive planning process. Various flood abatement alternatives were developed for each watershed. This process was begun in 1998 by the MMSD in concert with the affected communities. Incorporating these flood abatement programs into the planning process enabled the MMSD to more fully employ NAI floodplain management in these projects, assuring that environmental issues were addressed early on.

Lincoln Creek Environmental Restoration and Flood Management Project

The rehabilitation and flood management project associated with Lincoln Creek, an urban stream located within the cities of Milwaukee, Brown Deer, and Glendale, was begun in 2001 and planned for completion in 2004. The stream is 9 miles long and drains about 20 square miles.

The Lincoln Creek project has an estimated cost of about $119 million and includes

- Construction of two floodwater detention basins of 140 acre-feet and 90 acre-feet;
- Widening and deepening of several reaches of channel and the removal of accumulations of silt and sediment;
- Riffles and pools in the new channel to enhance the aesthetics and fisheries habitat;
- The flood elevation lowered in several reaches;
- Removal of concrete channel liners from two reaches; and
- Replacement of four inadequate bridge structures.

The Lincoln Creek project was in answer to over 4,000 separate flooding problems that were reported to the City of Milwaukee between 1960 and 1997. The project has resulted in the floodplains being lowered in many areas, removing 2,025 homes and buildings from the mapped 100-year floodplain.

Reach 6 of Lincoln Creek—before

— Lincoln Creek Flood Management Plan, MMSD

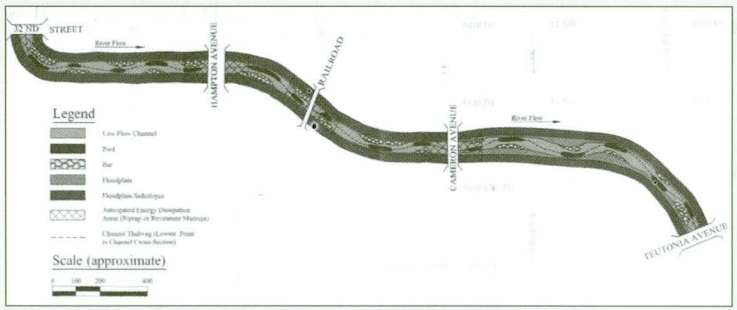
Reach 6 of Lincoln Creek—after

— Lincoln Creek Flood Management Plan, MMSD

Lower Wauwatosa Flood Management Project

This major project, aimed at mitigating flood losses along a 1-mile reach of the Menomonee River, is projected to be complete in 2006. Numerous alternatives were developed and considered by the various interest groups and local stakeholders through a series of meetings. The selected alternative incorporates about 12,000 feet of floodwalls and levees from 5 to 6 feet high along the river. The plan includes acquisition of 79 floodprone structures, 23 of which have been acquired by the City of Wauwatosa. The MMSD will reimburse the City for the remaining 56 structures.

In addition, the project will include expansion of Hart Park from 20 acres to 50 acres and incorporate 9,300 feet of storm sewer construction. Much of the area previously occupied by floodprone homes has now been returned to open space floodplain and made available for recreation. The expected project costs are just under $45 million.



Lincoln Creek—plan view of riffles and pools

— Lincoln Creek Flood Management Plan, MMSD

Greenways Initiative

Through the acquisition of many properties in the course of improving open space and removing structures from the floodplain and in conjunction with the Conservation Plan, a patchwork of small parks and isolated parcels has been created. The Greenways Initiative will provide the funding to purchase additional lands to connect the isolated parcels into linear parks. These parks will enhance the enjoyment of the area along the waterways and provide improved habitat for wildlife. Additionally, the linear park system provides a buffer between the floodplain of the watercourses and the nearby businesses and residences.

The project is anticipated to cost about $12.5 million and will involve the MMSD's working closely with citizen groups and local governments to either preserve or restore riparian zones to their natural vegetation, improve their capabilities to function as stormwater retention areas, and enhance wildlife habitat, recreational areas, and trail systems, thereby reducing adverse impacts to the area created by encroached floodplains and wetland systems. This program was begun in 2002 and is ongoing.

Conservation Easements

As part of the Conservation Plan, the development of conservation easements in the floodplain areas of the MMSD jurisdictional streams will help to preserve the functionality of the floodplains and their unique ecosystems. This approach is considered to be an environmentally responsible method of flood management and is considered an NAI approach because it retains the floodplains in their natural, un-encroached condition. It will preserve ponding areas, undeveloped floodplain lands, and help to restore developed floodplains to their original condition. Further, the easements will encourage land uses compatible with flooding. The program is operating within the watersheds of the Menomonee and Root rivers and Oak Creek. The budget for the Conservation Easements project is estimated at $15.2 million

Hoyt Park Streambank Stabilization

The streambanks of the Menomonee River in the Hoyt Park vicinity have had a long-term erosion problem, depositing more than 6,000 cubic yards of sediment into the stream over the past four years. Restoring and stabilizing the streambanks will prove cost effective in not only repairing the damage but also negating the need for future sediment removal from the stream and improving the overall water quality. In stabilizing the streambanks and removing the sediment from the stream, the project helps to restore a habitat more suited for fish and wildlife and lessens the potential for future adverse impacts to the system. The project involved cutting back the banks to a more optimum slope, installing a stone bank toe filter, and re-vegetating the banks with native grasses and plants. The project was designed in 1999 and funded and constructed in 2001, at a budgeted cost of about $1.3 million.

Funding

The MMSD has several sources of funding for its various projects and initiatives. Most of the funding for the above types of projects comes from the Capital Program for Watercourse Projects. In 2004, this share of the budget totaled $45.4 million. Other sources of revenue are grants, state loans, bonds, and tax levies.

The funding for Watercourse Projects is part of the current budget expenditures and is included in proposed budgets. The Capital Budget is funded through taxes. A strong attempt is made to balance increasing demands to maintain the systems, improve water quality, and address areas of potential flooding with an efficient and effective tax rate.

Authority

The MMSD has been explicitly granted authority to undertake such initiatives. Under Wisconsin Statutes, the district is responsible for collection, conveyance, and treatment of sewage and drainage generated in the service area. The district has permissive authority to plan, design, construct, and maintain floodwater conveyance facilities and watercourse channel modifications on those portions of the watercourses where the District has jurisdiction. Jurisdictional streams have been defined to include all perennial streams that meet one of the following criteria, and all intermittent streams that meet two of the following criteria:

- Currently have District-built channel modifications;
- Have significant risk of flood damage from the 1% chance flood;
- Provide drainage to more than one community; and

Stormwater detention, wildlife habitat area

—Photo courtesy of the MMSD

- The watercourses and storm sewers outside the District jurisdiction are the responsibility of the local communities.

The above actions are only a few of the 24 watercourse projects the MMSD has either recently completed, recently funded, or underway. All are in large part excellent examples of the NAI building block "Infrastructure." However, most must be considered to include many attributes of "corrective action" or mitigation. Even the structural aspects of the MMSD's channel modification projects have restored wildlife and fisheries habitat through the principles of best management practices, incorporating pools and riffles, establishment and enhancement of wetlands, and restoring natural vegetation.

Additional Actions

Hazard Identification & Mapping

The MMSD has worked to ensure that the foundation of good resource management is in place by keeping its primary tools—flood maps and land use maps—up to date, reflecting current and projected conditions.

- MMSD uses updated hydrology and hydraulic models to determine flood hazards for each watershed.
- Flood elevation models incorporate land use projected to the year 2020.
- Stakeholder groups are included in floodplain modeling and revisions.
- All mapped floodplain modifications are updated through the Letter of Map Revision process with the Federal Emergency Management Agency (FEMA).

Planning

MMSD has incorporated NAI floodplain management into its planning process. These principles have been included in all of the major watershed plans within the jurisdiction, making the principle of "do no harm" inherent in considering and analyzing the future needs of an area.

- The MMSD is developing a Facilities Plan for the year 2020.
- The MMSD has implemented the watershed approach to flood management rather than one based upon political boundaries.
- The MMSD considers planning critical to cost-effective and technically feasible projects.

Regulations & Development Standards

Not being a political entity as such, governing rules, regulations, and codes are not a large part of the MMSD's day-to-day operations. It does have operational guidelines and policies and NAI principles have been employed in those areas where possible.

- MMSD has instituted a new stormwater rule for all new development with more than 0.5 acres of impervious surface, requiring on-site detention.
- Over-detention is required, assuring the MMSD of protecting its investments in planning and infrastructure and forecasting flood damage.

Public Education & Outreach

The MMSD's management believes in involving stakeholders, citizen groups, and community representatives into the planning and decisionmaking processes. In this way the benefits of NAI floodplain management and the project itself can be brought to light, achieving early "buy-in" and support from the public. The MMSD maintains an ongoing outreach and education strategy for all flood management and planning initiatives. It has either initiated or participated in

- Watercourse stakeholder groups, providing input to all phases of planning, design, and construction in the floodplain management process for each of their six watersheds;
- The Citizens Advisory Council, providing publicly-inspired goals and objectives for the 2020 planning process and future processes;
- Providing a list of staff and their areas of expertise to the communities and encouraging staff to participate in community-level meetings;
- Working in partnership with the Milwaukee Public Schools in the development of an environmental education curriculum, focusing on water quality and addressing such issues as floodplain management, flooding, and stormwater runoff; and
- Developing educational videos and a CD on addressing flooding issues and assembling a notebook of important information for homeowners on flooding, stormwater, and water quality issues.

Community Support

The MMSD's basic strategy was to protect all damaged structures and prevent future flooding problems for the 1% annual chance flood. It uses strategies that provide for protection or removal of existing flood-damaged structures while at the same time anticipating the impacts of new development within each of its watersheds. Strong efforts are made to protect or enhance the natural and beneficial uses of existing floodplains and, as part of the flood management strategy, restore floodplains to those streams that have been channelized in the past.

The key elements of the plan that provide the strong community support are

- Use of a watershed-based approach to the planning process;
- Development of a watershed-based floodwater and stormwater program;
- Use of future land use conditions;

- Identification of the benefits and costs of each alternative;
- Maintaining a focus on environmental sensitivity and aesthetic ideals;
- Incorporation of regional, state, and local regulatory requirements into the planning process;
- Involvement of stakeholder groups and affected communities in decision making; and
- Promoting and preserving the beneficial values of the existing floodplains and natural flood storage areas.

Ongoing support from the stakeholders and the communities as a whole has been due to the very apparent positive results seen from the projects that have been completed. Parks have been expanded and improved, stream channels and overbank areas have been restored, and wildlife and fish habitats have been enhanced. Once the areas are exposed to flooding conditions, the effectiveness of the projects will be seen in reduced flood levels and reduced structural damage.

Buy-in to the NAI concept was achieved through the formation of stakeholder groups by the MMSD for each of the six jurisdictional watersheds. The stakeholders represented all the municipalities within a watershed, environmental groups, regional and state agencies, and the public. The groups meet to work through planning, design, and construction for each watershed. This process helps the MMSD achieve buy-in from the municipalities and the public because they feel an ownership of the plan. It is also helpful to have the state and regional regulatory agencies at the table to determine quickly which alternatives are acceptable from a regulatory standpoint.

Background

The MMSD serves a population of about 1 million within a 420-square-mile area. It provides flood management services only to Milwaukee County, although some of the planning is based on watershed boundaries and can extend beyond the service area. The overall population of the region has been increasing slightly over the past decade. Even though Milwaukee County has experienced a population decrease of 2% during the 1990s (because of movement of people to the suburbs), about 500 new housing units have been built in the downtown area in the last two years. There has been an overall increase in the educational levels of the population and an increase in real per capita income over the past decade.

The MMSD has used population projections from the communities it serves in developing its 2010 and 2020 facilities plans. One goal of the long-term planning process is to "identify the policies, operational improvements, facilities and programs that are necessary to accomplish the water resources goals inspired by our public." The MMSD has a flood management goal of removing all structures from the 1% annual chance floodplain by 2014. Its environmental goal is to remove a reach of concrete channel every other year.

The most recent significant flooding was in 1997 and 1998, causing millions of dollars of damage. Thousands of homes, businesses, and people were directly affected and countless others had to endure flooded roads and wait for repairs to public infrastructure after flooding on Underwood Creek and the Menomonee River. These kinds of incidents are what the MMSD is trying to prevent by adopting NAI floodplain management and stormwater management.

> The MMSD's flood management goal—Remove all structures from the 1% annual chance floodplain by 2014.
>
> The MMSD's environmental goal—Remove a reach of concrete channel every other year.

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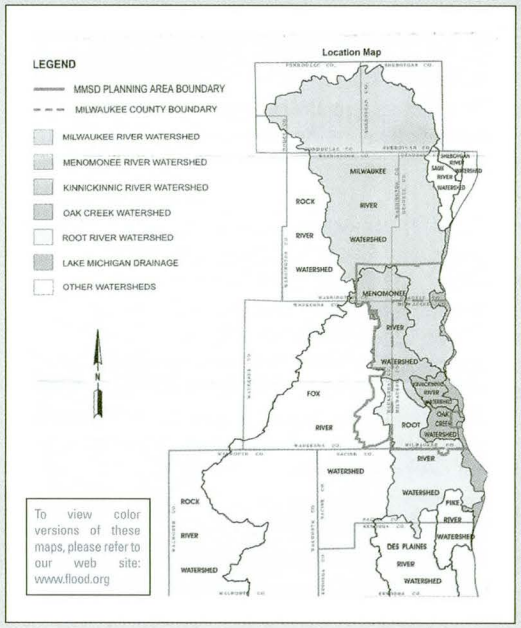


The Milwaukee Metropolitan Sewerage District's six jurisdictional watersheds

—MMSD Jurisdictional Map

Austin, Texas

Austin lies in east-central Texas, where the geography, soil, and the intensity of the rainfall and thunderstorms (over 30 inches per year) produce flash floods along the area's rivers. This has serious impacts on the roads, bridges, stormwater facilities, and other infrastructure, and also poses a significant threat to life. The City has a population of just under 700,000 and has experienced rapid growth periodically.

Primary NAI Building Blocks

Emergency Services and Planning

Austin takes seriously the need to provide not only adequate, but exemplary protection for its citizens and their environment. The City has done this by incorporating public safety goals into its master planning documents and by using an extensive network of flood warning systems.

Other NAI Building Blocks

- Regulations & Development Standards
- Hazard Identification & Mapping
- Infrastructure
- Mitigation
- Public Education & Outreach

Austin works to avoid these "adverse impacts" . . .

- an increase in water surface elevations,
- an increase in downstream peak flow rates,
- an increase in stormwater runoff due to development,
- risks to people and personnel, or
- a decrease in the stability of streambanks within the watershed.

Emergency Services & Planning

Incorporation of the goals and objectives described below into the major planning documents of the City of Austin supports the provision of emergency services to protect the citizens and critical resources, such as the City's major water supply sources and watersheds. Their inclusion in the plans was a major factor in being able to be responsive to these needs. To achieve this component of no adverse impact (NAI) floodplain management, Austin has combined planning and emergency services to become highly responsive to its citizens' needs.

The following goals that have a bearing on emergency services were incorporated into Austin's plans.

- Protect lives and property by reducing the impact of floods.

  Reduce the danger at road crossings (including adequate warning).

  Prevent the creation of future flood hazards to human life and property.

  Reduce the depth and frequency of flooding for all structures and all roads in the 100-year floodplain.

- Protect channel integrity and prevent property damage resulting from erosion.

  Repair current erosion that threatens habitable structures and roadways.

  Minimize the future enlargement of channels that would threaten public and private property.

  Achieve stable stream systems.

- Maintain the integrity and function of utility assets.

  Provide for adequate maintenance of the watershed protection infrastructure system and minimize maintenance requirements for system improvements.

- Optimize the City resources by integrating erosion, flood control, and water quality measures.

  Maximize flood control, pollution removal, and streambank protection for all development, including capital improvement projects.

Austin has determined that providing the emergency services required to protect the citizens and the critical resources required not only a strong emergency services program, but one that was consolidated into a pro-active planning process. This program as well as other floodplain management and resource management programs in Austin were begun about 1974 and have grown and matured since then. Most of the funding for these initiatives comes from a monthly fee for drainage utilities authorized under the Texas Municipal Drainage Utility Systems Act.

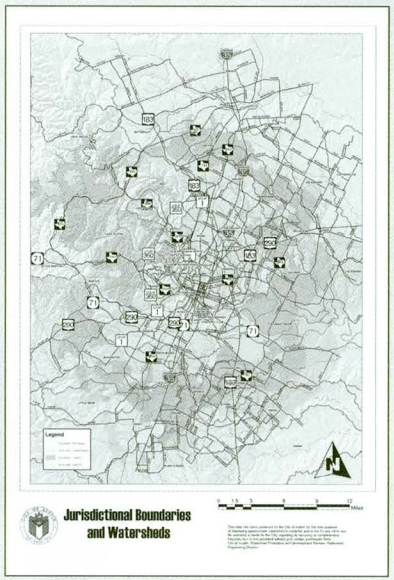
The City has developed a flood warning system with an extensive array of remote sensors in the contributing watersheds. There are 120 rain and stream stage sensors covering the major urbanized watersheds. The engineering staff interprets the real-time data during floods and issues warnings to the Office of Emergency Management, which in turn coordinates with fire, police, and the Department of Public Works for evacuation and road closure.

The City is working with Rice University to develop rainfall-forecasting capabilities using radar-sensing techniques. The predictive system has been developed for the largest watershed (350 square miles) and is based upon acquiring real-time rainfall data via NEXRAD for direct input to a continuous HEC-1 forecast model for the watershed. This will greatly improve flood prediction accuracy for this area, which currently has limited field instruments. The City's all-hazard mitigation plan, Disaster Ready Austin: Building a Safe, Secure and Sustainable Community, was completed in 2003. It addresses all hazards, natural and technological, to which Austin could be expected to be exposed. The plan has six stated goals:

- Protect public health and safety,
- Protect existing and new properties,
- Build and support local capacity and commitment to continuously become less vulnerable to hazards,
- Increase public understanding, support, and demand for hazard mitigation,
- Promote sustainable growth, and
- Maximize the resources for investment in hazard mitigation.

Hazard warning siron

—photo from City of Austin



Early warning system location map

— City of Austin "Flood Early Warning Plan"

Additional Actions

More on Planning

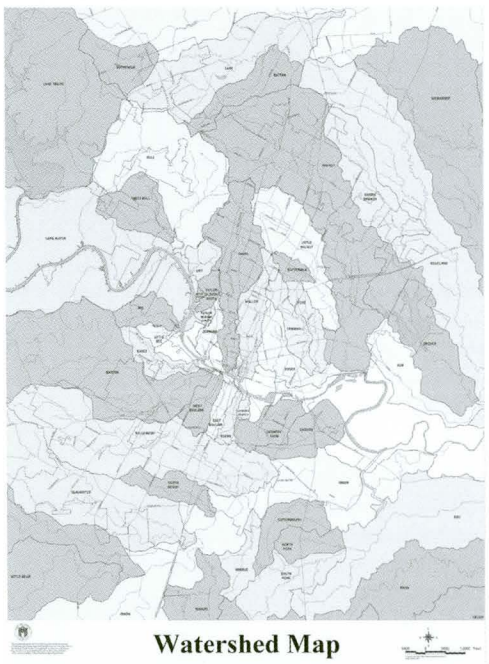
Austin city government recognized the need to address the growing environmental issues associated with the community's growth. It established an overall goal of protecting lives, property, and the environment. One major tool to help achieve these goals has been the development of the Watershed Protection Master Plan, completed in 2001. This plan and the related work are administered in the Watershed Protection and Development Review Department. These excerpts from the plan help explain its overall rationale.

"The mission of the Watershed Protection Department is to reduce the impact of flooding, erosion and water pollution on our community in order to protect lives, property and the environment. To accomplish this mission, the department completed Phase I of a Watershed Protection Master Plan to better prioritize service needs and refine program direction."

"These studies determined that watershed problems are pervasive and will worsen if corrective action is not taken. Creek flooding poses a recurring city-wide risk to public safety and property. For example, a relatively small 2-year storm creates structure flooding in 14 of the 17 Phase I watersheds. Localized flooding also threatens property across the City due to undersized, deteriorated, clogged or inadequate storm drain systems. Over 4000 localized flooding complaints have been logged over the last ten years. New erosion data identifies numerous existing threats to property with nearly 500 sites currently threatened. Increased storm flows from urban development have accelerated streambank erosion, leading to enlarged and unstable creek channels."

Given these considerations, some of the Master Plan recommendations are to

- Integrate watershed solutions,
- Develop collaborative multi-agency partnerships,
- Develop long-range funding proposals,
- Implement integrated capital projects,
- Involve stakeholders in the comment and review process for proposed regulatory modifications,
- Refine watershed protection goals,
- Continue development and evaluation of innovative water quality solutions,
- Update Master Plan information as needed, and
- Expand master planning efforts beyond the Phase I watersheds.



Watersheds in the City of Austin

Regulations & Development Standards

Austin's regulations and development standards have been well planned and are forward-looking, laying the foundation for NAI floodplain and resource management. Development takes place in accord with a master plan and this, in turn, assures the community that the development will not harmfully affect the environment and can even become an attribute. Some of Austin's regulations are summarized below.

Floodplain Regulations

- Fully developed (full build-out) land use conditions apply for all floodplain determinations and infrastructure sizing;
- The owner of floodplain property to be developed must dedicate the 100-year floodplain as drainage easement;
- All development in any portion of the 100-year floodplain must demonstrate no identifiable increase in flood elevations on other properties;
- New buildings and parking areas are prohibited in the 25-year floodplain;
- Substantial improvements and modifications that increase the "footprint" of existing buildings in the 25-year floodplain are prohibited; and
- Single - family and duplex residential structures are only allowed in subdivisions platted before 1983 and must be elevated to 1 foot above the 100-year floodplain.
- In the Central Business Area of the 100-year floodplain,

  Buildings must be elevated to 2 feet above the 100-year flood elevation and have normal access beyond the regulatory flood datum;

  Development must compensate for any floodplain volume displaced by construction; and

  Development must otherwise improve the drainage system.

Stormwater Management Regulations

- Temporary and permanent measures to control erosion and sedimentation are required on all site and subdivision development;
- Extended detention of the 1-year storm is required to mitigate development impacts on streambank stability and water quality; and
- Impervious cover exceeding 20% requires isolation and sand filtration of the first 0.5–1.3 inch runoff to mitigate effects on water quality.

Environmental Regulations

- Subdivisions and site plans must preserve the natural and traditional character of the land and waterway to the greatest extent feasible;
- Environmental criteria are established for floodplain modifications to ensure full and balanced consideration of environmental benefits of floodplains;
- Environmentally sensitive "Critical Water Quality Zones" and "Water Quality Transition Zones" are established within and around the 100-year floodplain; and
- Development is limited within environmentally sensitive zones.

Hazard Identification & Mapping

Austin has undertaken several initiatives to improve its mapping and hazard identification. Some of the more notable activities are

- Austin uses geographic information system (GIS) technology to map storage areas containing hazardous materials, making it easier to pinpoint problem areas during emergencies;
- Many of the other City departments have mapped various resources found with the city boundaries;
- Digital Flood Insurance Rate Maps (DFIRMs) overlaid on digital terrain maps are available on the City's website for public use, making flood zone determinations simpler; and
- A new cooperative agreement between Austin and Travis County provides for joint development of county-wide DFIRMs.

Infrastructure

The City of Austin has promoted and maintained a strong infrastructure program. Many facilities have been constructed to enhance the City's capabilities in assuring that adverse impacts are mitigated. This area experiences some very rapid flooding that has significant impacts upon the infrastructure, especially roads. Much of the work on infrastructure is directed to relieving these impacts. The City maintains 300 miles of open waterways, 400 miles of storm drains, tens of thousands of curb inlets, 430 residential ponds, and trash racks on central business area storm drain curb inlets (which collect over 430 tons of debris, removed yearly). This routine work minimizes adverse impacts to the City's water supply and storm drainage systems.

Mitigation

The City of Austin has taken several steps to correct some poor development practices of the past and to overcome the results of urbanization and increases in storm runoff.

- The City has established a Regional Stormwater Management Program Fee in developing watersheds. The fee is based upon avoided costs of on-site detention and pays for the cost of capital improvements required to handle and control additional volumes of runoff.
- A voluntary buyout program that is now about four years old has begun purchasing and removing the most critical of the more than 7,000 homes in the floodplain. To date, about 50 have been purchased and removed and the sites restored with native vegetation. This is almost entirely paid for by the City, which routinely earmarks from $300,000 to $500,000 per year for it. Initial funds were drawn from the sale of a bond program and are now supplemented by fees from drainage utilities.
- The need for local storm drainage system improvements has been studied and identified, with funding of about $230 million needed to address this problem.
- The City has developed a strong habitat conservation and ecosystem preservation program targeted toward endangered species and water quality. About 15,000 acres of land in the headwaters of the Barton Creek and Lake Austin watersheds that supply many of the aquifers that provide city drinking water, have been purchased with $73 million from the sale of Water Utility Revenue Bonds. This action will protect this vital resource from development and misuse.

Public Education & Outreach

The City recognizes that a strong education and outreach program promotes public support for NAI floodplain management. By keeping the public informed and explaining how specific projects will achieve City goals and public desires, the City makes such projects far easier to achieve.

The City routinely develops and distributes informational brochures for the public about floodplains, stormwater, erosion control, and the National Flood Insurance Program. A new CD focuses on educating people about why flooding occurs, improper uses of floodplain areas, and wise development practices.

Community Support

Major floods in the early 1970s prompted the City to enact floodplain management and land development regulations in 1974, designed to mitigate flood impacts. These regulations mandated that land development activities "not result in additional identifiable adverse flooding of other property" and required the 25-year floodplain to be dedicated to drainage easements. The City's overall approach to NAI floodplain management is to curtail or mitigate adverse impacts such as land-development-related increases in water surface elevations and downstream peak flow rates, increases in stormwater runoff due to development, and the destabilization of streambanks within the watersheds.

Oak Hill regional stormwater detention facility

—photo from City of Austin

1981—Lower Shoal Creek at 6th Street

—photos from City of Austin

1998—Bayton Loop, Williamson Creek

—photos from City of Austin

Support for NAI floodplain management in Austin was made easier by the devastating effects of the 1970s floods. Not only did City government realize the need for a stronger, more pro-active approach to lessening the effects of uncontrolled development, but businesses and citizens also realized that this was paramount to protecting and maintaining the environment in which they chose to live. In addition, repetitive severe flooding and loss of life mandated that the City take strong corrective actions. Big floods drove development of the City flood hazard mitigation programs, while protection of aquifer recharge quality drove the development of the environmental management programs.

The funding that provided the first impetus to Austin's NAI floodplain management came from monthly drainage utility fees implemented in 1982 on all developed commercial and residential property authorized under the Texas Municipal Drainage Utility Systems Act. This funding continues and is supplemented by the funding discussed above.

Background

Austin is a progressive, forward-looking community of about 660,000 in east-central Texas. It was founded in 1839 and is the state capital. Its incorporated area is 230 square miles, but the watershed planning encompasses more than 700 square miles. The area receives about 33 inches of rain annually, with the 1% annual chance flood at 12 inches of rain in 24 hours. The geography, soil, and the intensity of the rainfall produce fast-rising, rapidly moving waters, or flash floods. This has severe impacts on the area's road structures, bridges, and stormwater facilities, and also is a serious threat to life, thus the community's strong emphasis on infrastructure and on emergency services.

Austin experienced rapid growth in the 1990s, about 3.5% per year. The following decade has seen the growth rate lessening to a point that it is more accurately described as flat. The city has a diversified economy as the center of state government, the site of a large and active city government, as well as various local units in the surrounding counties and municipalities. Other sectors of the workforce are found in services, higher education, trade, and manufacturing.

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Portland, Oregon

Located in a state and region known for its innovative approaches to land use planning (as well as its ample precipitation), Portland understandably demonstrates strong links between its handling of its flood hazard and its resource management. The State of Oregon has statewide planning goals (adopted in 1969) that must be addressed in all local comprehensive plans, among them consideration of natural hazards; quality of life; carrying capacity of the land and water; and scenic, historic, and natural resources. Land use planning, open space, parks, and other functions for Portland are the responsibility of the directly elected regional government, known as "Metro," which encompasses 1.3 million residents in three counties and 24 cities.

NAI Highlight
Integrated Management Techniques

Portland's comprehensive planning and regulations, coupled with specific objectives and tools, enable the city to maintain the character and quality of its landscape and preserve its sensitive resources and natural functions. Portland focuses on different functions and features that must be protected in each unique area and significant resource; avoiding adverse impacts to them is reflected in planning, regulations, and mitigation.

Primary NAI Building Blocks
Mitigation, Regulations & Development Standards, Planning

Other NAI Building Blocks

- Hazard Identification & Mapping
- Public Education & Outreach
- Infrastructure

Portland works to avoid these adverse impacts . . .

- A reduction in functional values of significant resources: hydrology, water quality, slope protection, fish and wildlife habitat, and aesthetics.
- Overemphasis on urban uses and activities at the expense of natural resources and other environmental, social, economic, or energy concerns.
- A negative effect on the city's economic health and livability.
- A negative effect on the health, safety, or quality of life of the citizens, particularly from natural disasters, radio emissions, and television broadcast emissions.

Portland allows even fewer adverse impacts within eight identified "unique areas" and a range of "significant natural areas" (such as floodplains, wetlands, steep slopes, and open space).

Management Technique 1: Conserving and Restoring Natural Resources and Functions

Starting in the late 1980s, natural resource inventories were developed for eight planning areas in Portland. Examples of these unique areas are the Balch Creek Watershed, Fanno Creek Watershed, Johnson Creek Basin, Northwest Hills, and Skyline West. These inventories were developed as part of the City's compliance with the Statewide Land Use Goal for Wildlife Habitat (Goal 5). These inventories provide the basis for the City's environmental overlay zoning program. Specifying "adverse impacts" for unique areas, then planning and managing based on the area's characteristics, makes it possible to avoid or mitigate those unwanted impacts.

Specific planning objectives are identified for areas with unique land qualities. For example,

- Special development standards and approval criteria are applied within environmental overlay zones throughout the Balch Creek watershed in order to protect and preserve flood mitigation, fishery, wildlife, and other natural resources.
- The Johnson Creek Basin Protection Plan (including environmental overlay zones) has been implemented to protect and preserve the flood mitigation, water quality, fishery, wildlife, scenic, recreation, and other natural values of the Johnson Creek basin.

Mitigation

Acquisition Program Maintains Significant Resources

The Acquisition Program supports the City's goal of minimizing threats to public safety and maintaining the functional values of significant resources.

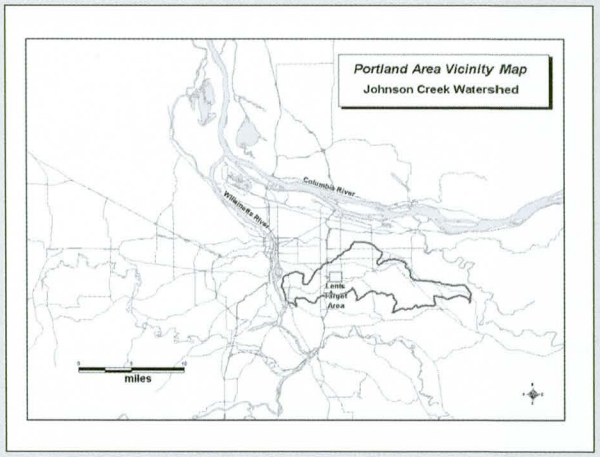
- Portland's Comprehensive Plan recommends maintaining a prioritized list of properties for the Acquisition Program in order to ensure long-term natural resource conservation.
- Through the Johnson Creek Acquisition Program, about 162 acres of flooded property have been purchased since 1997.
- Metro has acquired more than 7,960 acres of land for regional natural areas and regional trails and greenways in 252 separate property transactions. These properties protect 70 miles of stream and river frontage.

Johnson Creek Acquisition and Mitigation Bank

The Johnson Creek Restoration Plan uses a multi-objective, watershed approach to restore natural floodplain functions. The Restoration Plan focuses on nuisance flooding, water quality, and declines in fish and wildlife. A combination of regulatory safeguards and extensive restoration actions will enable the community to avoid or mitigate adverse impacts and restore function in the Johnson Creek Basin over time.

In October 1996, the Portland City Council adopted the Flood and Landslide Hazard Mitigation Plan, which recommends acquisition of the most vulnerable properties from willing sellers for multi-objective projects. The City of Portland Bureau of Environmental Services implements the Willing Seller Land Acquisition Program for the Johnson Creek Watershed. Through this Program, properties are purchased and both structures and impervious surfaces are removed from the floodplain. The acquired properties are used to create constructed wetlands, floodplain terraces, and open space for flood management, habitat, and passive recreation.

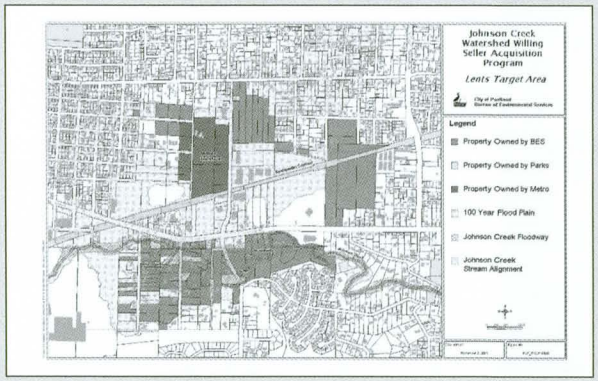
- The Johnson Creek Willing Seller Land Acquisition Program is one implementation tool of the Restoration Plan. As of fall 2004, about $11 million had been invested by a collection of local, regional, and federal partners, including the City of Portland Bureau of Environmental Services and Bureau of Parks, Metro, and the Federal Emergency Management Agency, to purchase approximately 162 acres of frequently flooded Johnson Creek properties in the City of Portland.
- The Johnson Creek Fill Mitigation Bank accepts "fee in lieu" payments for actions that do not balance cut and fill. Any "fill" below the base flood elevation must be accompanied by an equal amount of excavation on the same site so that the storage capacity of the floodway and floodway fringe is retained. Residential property owners may elect to pay into the Johnson Creek Fill Mitigation Bank in lieu of creating balanced cut and fill.



Johnson Creek Watershed map in purple with acquisition target area in yellow

from City of Portland Environmental Services Bureau

To view color versions of these maps, please refer to our web site: www.flood.org



Neighborhood map identifying target areas for acquisition

Johnson Creek Land Acquisition Strategy, June 2001

Regulations & Development Standards

Resource conservation is to be achieved through a combination of techniques such as zoning (and other codes), purchase, intergovernmental coordination, and restoration.

Zoning tools are employed to conserve natural resources and functions by protecting landscape features such as water bodies, wetlands, and significant trees and vegetation. Protecting these features helps maintain stormwater conveyance, flood control, groundwater discharge/recharge, and water quality. For example, slopes are to be protected from erosion and landslides through the retention and use of vegetation, building code regulations, and erosion control measures during construction.

Where adverse impacts cannot be avoided, the preferred mitigation actions would be implemented on the site of the resource subject to impact, addressing the same type of resource.

Floodplain Management

In the City of Portland, flood protection elevation requirements depend on the drainage, zoning, and base flood elevation. Throughout Portland, regulations govern six specific drainage areas, "unidentified" watercourse flood zones, and Metro Flood Management Areas. In most cases, the flood protection elevation is the base flood elevation plus 1 or 2 feet of freeboard. For example,

- In the A Zone of the Columbia River drainage, a 1-foot freeboard reflects the relatively wide floodplain.
- For watercourses that drain more than one acre, and are not identified on the City's Water Features Map, the flood protection elevation is the base flood elevation plus 2 feet of freeboard. In addition, the width of the floodway must be at least 15 feet. These standards are applied to property adjacent to any stream or drainage, even though not formally mapped.

In order to reduce flood hazards, floodway encroachments are prohibited unless it is demonstrated, with a technical analysis from a registered engineer, that the development will not result in an increase in the base flood elevation and that the carrying capacity is not diminished. This requirement is one method of assuring that "adverse impacts," if identified, will be mitigated before development commences.

In all Flood Management Areas and Special Flood Hazard Areas balanced cut and fill is required. All fill placed at or below the flood protection elevation must be balanced by removing an equal amount of soil, or by paying a fee in-lieu.

When a variance is requested, the danger that materials may be swept onto other lands and the injury of others must be considered. Granting the variance cannot result in increased flood heights, additional threats to public safety, extraordinary public expense, nuisances, fraud on or victimization of the public, or conflict with existing local laws or ordinances. The emphasis here on affecting other properties or property owners illustrates one of the core themes of no adverse impact (NAI) floodplain management—a do-no-harm approach.

Regulations for land subject to regular or periodic flooding help to minimize public and private losses from flooding by

- Directing development away from hazardous areas,
- Promoting the safety and well-being of citizens, and
- Protecting property and preserving the natural function of floodplains.

For residential development, all lots must be outside the flood hazard area. If this is not possible, at a minimum, proposed building footprints must be outside of the flood hazard area. All lots must be configured so that development will reduce the impact of flooding and will provide the greatest protection from flooding.

Environmental Overlay Zones

Land use and development in Portland is managed, in part, through the assignment of base zones (residential, industrial, or commercial). These basic zoning designations refer to the primary use established for an area or parcel. To meet special land use needs in some parts of the City, a second kind of zoning is applied as an overlay to address specific community or City goals. In 1988, Portland established

Marquam Nature Park interpretive trail is part of a system connecting downtown to the Oregon Zoo.

http://www.portlandparks.org

environmental overlay zones and regulations to protect and conserve natural resources and the benefits they provide. These special zones are designed to ensure that development results in minimal damage to significant natural resources and that unavoidable impacts are mitigated. Environmental overlay zones benefit the public by protecting water quality, preserving wildlife habitat, preventing erosion/landslides, and reducing flooding. Environmental overlay zones typically cover streams, wetlands, and other water bodies, upland forests, and steep slopes.

One type of environmental overlay zone, the conservation overlay zone, conserves important natural resources where they can be protected while allowing environmentally sensitive development. The conservation zone limits the amount of land area that can be disturbed by development and the extent to which trees can be removed. It also sets minimum distances between development and streams,

wetlands, and other water bodies. About 9,400 acres within the city limits are in the conservation overlay zone. About 25% of these lands are in public ownership.

The second type of environmental overlay zone, the protection overlay zone, provides the highest level of protection to the most important urban natural areas and streams. It typically allows new development only when there is a public need and benefit, such as trails and interpretive facilities. About 9,800 acres within the city limits are in the protection overlay zone. About 70% of these lands are in public ownership.

Transfer of Development Rights to Protect Environmental Resources

In addition, Portland's codes allow development rights to be transferred to areas that can accommodate the additional density without environmental conflict from sites within the Environmental Protection Overlay Zones or sites that include part of the 1% annual chance floodplain.

Johnson Creek Codes More Stringent

Specific areas within the Johnson Creek Basin have different regulations to protect and conserve natural resource values and functions. In areas with significant natural resources, development is subject to standards and criteria to ensure

- No significant reduction in the storage capacity of the floodway and floodway fringe (as defined by the performance standards);
- No significant impediment to the passage of flood waters (as defined by the performance standards);
- Reduction in stormwater runoff;
- Increased groundwater recharge;
- Reduction of erosion;
- Enhanced water quality;
- Equal cut and fill; and
- Retention and enhancement of native vegetation.

For example, one "unique area" within the Johnson Creek basin is the floodplain. In the floodplain,

- Density may not exceed one dwelling unit per lot (no exceptions);
- No more than 50% of any site may be developed in impervious surface; and
- No land divisions or planned developments are permitted within the Johnson Creek flood risk area, which is being redefined by the City as approximately the modeled 10-year flood event.

Setback Requirements in Springwater Corridor of Johnson Creek

In the Springwater Corridor of the Johnson Creek basin, new development and expansion of existing development must be set back with a landscape buffer abutting the Corridor's limit to ensure protection as a transportation, recreation, and scenic amenity. The buffer must be either 10 or 20 feet wide, depending on the zoning.

In the South Subdistrict, where flooding and landslides are common, no more than 50% of any site may be developed in impervious surface. In addition, the maximum allowed density of a development is determined by calculating the number of acres in each land classification (based on natural hazard and slope) by a multiplier. Those areas with relatively shallow slope and no hazards can have the maximum density. Regulations affecting development density, tree removal, and impervious surface protect South Subdistrict watershed health while allowing the safe and efficient development of non-sensitive areas.

Planning

The City's Comprehensive Plan provides policies and objectives to guide development that affects drainageways in order to conserve and enhance the containment of stormwater runoff and to protect, enhance, and extend vegetation.

Whitaker Ponds is a 13-acre restored natural area owned by Metro and managed by the City of Portland Parks Department.

http://www.portlandparks.org/NaturalAreas/Whitaker.htm

Guidelines for Riparian Areas, Floodplain Areas and Stormwater Management

As part of Metro's regional mandate, Portland is adopting the following guidelines for riparian areas, floodplains, and stormwater management.

Avoiding, reducing, and/or mitigating the impact of water resource development on both the natural and human environments;

- Managing watersheds to protect, restore, and ensure to the maximum extent practicable the integrity of streams, wetlands, and floodplains, and their multiple biological, physical, and social values;
- Encouraging the use of techniques relying on natural processes to address flood control, stormwater management, abnormally high winter and low summer stream flows, and nonpoint pollution reduction;
- Protecting riparian and wetland areas by

  avoiding, limiting, and managing development that adversely affects fish and wildlife habitat;

establishing riparian protection zones within which development and land use activities can be prohibited, limited, or managed to protect riparian functions and values;

eliminating, managing, or minimizing soil-disturbing activities and soil erosion in order to reduce the amount of sediment entering receiving streams;

maintaining and protecting riparian vegetation; and

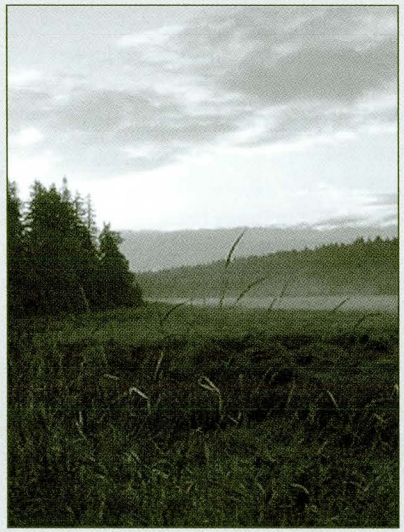
re-establishing riparian vegetation in a timely manner to maintain the functions and values of the riparian corridor and protect water quality.

- Managing stormwater as close as practicable to the site of development in order to avoid negative quality or quantity impacts on adjacent streams, wetlands, and groundwater; and
- Maintaining the quantity of stormwater leaving a site after development has occurred (equal to or less than the quantity leaving the site before development).

Open Space Management

Protecting, conserving, and managing open space supports Portland's goal of maintaining the functional values of significant resources (groundwater recharge, slope protection, wildlife, aesthetics and visual appearance, and views).

- Portland's Comprehensive Plan recommends the conservation and enhancement of drainage ways and linear parkways that have value as wildlife corridors by connecting parks, open spaces, and other large wildlife habitat areas. This will also serve to increase the variety and quantity of desirable wildlife throughout urban areas.
- Regulations protect parks, cemeteries, and golf courses through an Open Space base zone designation.
- Recognition and protection of open spaces, both inside and outside the urban growth boundary, are reflected in Metro's 2040 Growth Concept.



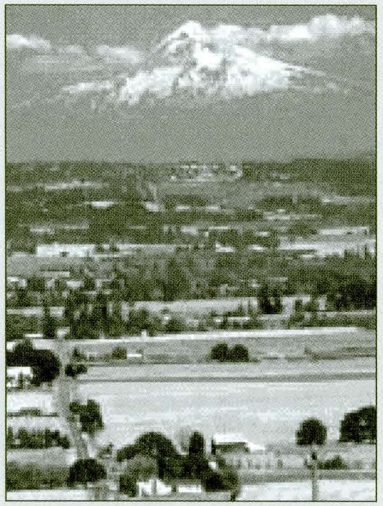
Aesthetic resources add to the quality of life in Portland, Oregon.

http://www.metro-region.org/article.cfm?ArticleID=144

Management Technique 2: Urban Growth Boundary

Setting guidelines and managing resources at the regional level helps the City maintain the functional values of water resources and their corridors, helping assure that adverse impacts to their value will not occur.

- State law requires every city and county in Oregon to have a long-range growth plan that includes using urban land wisely, setting urban growth boundaries, and protecting natural resources.
- It defines land that can support urban services such as roads, sewers, and water lines. Keeping development inside the boundary protects farms and forests from sprawl.
- Open spaces are important to the success of the urban growth boundary and the ability of the region to accommodate housing and employment. Areas on Metro's 2040 Growth Concept Map are designated as regional Open Space, removing these lands from the inventory of urban land available for development. So rural reserves, already designated for farms, forestry, natural areas, or rural-residential use, remain protected from development pressure.



Urban Growth Boundary "on the ground"

http://topaz.metro-region.org

Management Technique 3: Interagency Coordination

Portland's Comprehensive Plan identifies policies that emphasize interagency coordination at the federal, state, and regional level. Flood hazard regulations dictate that Portland's Bureau of Environmental Services must notify adjacent communities and the Department of Land Conservation and Development before any alteration or relocation of a watercourse and submit evidence of the notification to the Federal Insurance Administration. Portland has proven that an emphasis on coordination and notification helps lessen adverse impacts.

Additional Actions

Hazard Identification & Mapping

- The Johnson Creek Program contracted with the Corps of Engineers to update floodplain maps for Johnson Creek based on current development. A Physical Map Revision for the City of Portland went into effect in October 2004. The new maps use a USGS quadrangle format and include updated jurisdictional boundaries, roads, and the Johnson Creek floodplain revisions.
- A hard copy map showing the 1% annual chance floodplain based on 2040 full build-out is used as a reference for land use reviews. There is little difference between it and the current development scenario used for the updated maps because the development standards for the Johnson Creek are so stringent.

Public Education & Outreach

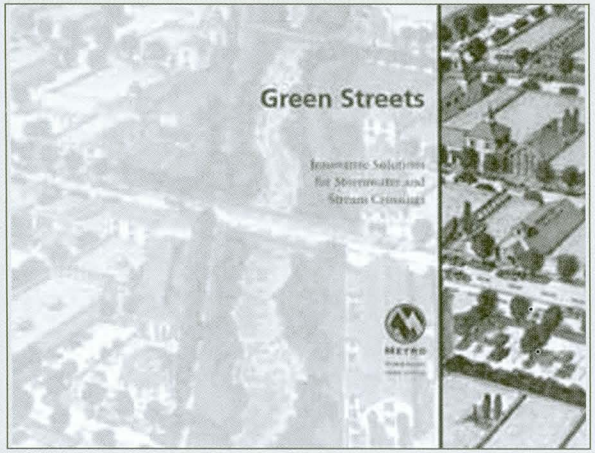
Materials for education and outreach to further the NAI floodplain management approach are primarily available through Metro, the regional government.

- Educational materials on watershed planning, stream buffers, urban growth boundaries, and natural resource-based planning are on Metro's website. In addition, there is a newsletter that describes how one person's actions affect another's.
- Hazard maps for the entire region are available on Metro's website.
- Metro's "GreenScene" describes current nature activities and volunteer opportunities, including events at regional park facilities.

Infrastructure

- In 1997, City of Portland Bureau of Environmental Services constructed the Brookside Wetland, the first floodplain restoration project on Johnson Creek. The 14-acre wetland can store up to 20 million gallons of flood water. The wetland also provides habitat for fish, amphibians, reptiles, birds, and small mammals.

Metro's Green Streets handbook describes stormwater management strategies and includes detailed illustrations of designs that allow infiltration and limit stormwater runoff. The design and construction of "green streets" is one part of a larger watershed approach to improving the region's water quality.



Metro's Green Streets handbook

—Metro Regional Government

Community Support

The passage of the 1969 statewide land use planning goals was supported by urban-based environmental activists, the farming community, and forest harvesting industry. Then-Governor Tom McCall railed against sprawl "with religious fervor." His efforts helped to gain broad support from the legislature. Within the Willamette Valley (the most fertile farmland and the largest percentage of the state's population) there was much support for the state regulations that provided the backbone to say "no" to development. However, communities and individuals in rural Oregon considered the statewide land use planning goals to be heavy handed and "top down."

The Endangered Species Act was also a motivating tool for communities to implement the statewide planning goals. It provided the backbone to implement habitat restoration. Funding for habitat restoration has been increasingly available when it is related to endangered species protection. Because Steelhead was listed as a threatened species in 2000, some local jurisdictions got much more involved with inventory, analysis, and planning.

Because citizen participation is essential (Statewide Land Use Planning Goal #1), there has been a tremendous effort to educate and involve the people in decision making. One outcome is that citizen support for various programs is high. For example, Metro was successful in getting bond measures passed to implement the Greenspaces Program. Portland makes extensive use of tax-increment-financed urban renewal. The City and the region have been awarded numerous innovative planning grants from the State Transportation Department for implementing programs that get people to use auto-alternative transportation.

Background

Johnson Creek

Although only 6% of Portland's 1% annual chance floodplain area is in Johnson Creek, it accounts for 78% of Portland's repetitive flood loss claims. Seven major floods occurred on Johnson Creek in the last 35 years. The 1996 flood caused $4.7 million in damage, including lost business revenue. Since 1997, more than $10.5 million has been secured to move people and structures out of harm's way in frequently flooded areas. Funding was provided through the Federal Emergency Management Agency's (FEMA's) Hazard Mitigation Grant Program, Department of Housing and Urban Development's Community Development Block Grant Program, Portland's Bureau of Environmental Services Capital Improvement Program funds, Portland Parks, and Metro's Regional Bond Measure for the purchase of greenspaces.

Because of flooding and water quality issues, Johnson Creek basin was the City's first priority. Johnson Creek is located on the southeast side of Portland, the eastern side

of the Willamette River basin. It runs through six different jurisdictions, making interagency coordination essential. The City is working on detailed watershed action plans for the Columbia Slough, Tryon Creek, Fanno Creek, and Willamette sub-basins.

Metro

Portland is within the jurisdiction of Metro, the only directly elected regional government in the country. Metro protects open space and parks, plans for land use and transportation, and manages garbage disposal and recycling for 1.3 million residents in three counties and 24 cities. Metro's work includes designation of environmentally sensitive land such as floodplains, wetlands, and stream corridors.

2040 Growth Concept

The Metro 2040 Growth Concept makes recommendations to manage growth, protect natural resources, and make improvements to facilities and infrastructure while maintaining the region's quality of life. The Growth Concept

- Places strong emphasis on the protection and management of natural resources within the Urban Growth Boundary and surrounding the metropolitan region;
- Identifies key natural features of the landscape for protection as greenspaces to be used as parks, open spaces, protected areas, or low-density residential development;
- Recommends that protection and management of water quality be achieved by managing "how and where" development and land use activities occur throughout the region; and
- Recommends protection and enhancement of water quality through coordinated growth management emphasizing integrated watershed management, technical assistance, and public education.

State Goals

Oregon Statewide Planning Goals, adopted by the legislature in 1969, address water quality, human health, and safety in the context of land use planning. Local comprehensive plans are required to comply with the 19 statewide planning goals. The goals that specifically support NAI floodplain management are

- Statewide Land Use Planning Goal 5 addresses open spaces, natural resources, scenic areas, and historic areas. Goal 5 is intended to protect natural resources in order to promote a healthy natural landscape that contributes to Oregon's quality of life;
- Statewide Land Use planning Goal 6 addresses the requirement that local comprehensive land use plans provide for the maintenance and improvement of air, land, and water resources, including the carrying capacity of these resources; and
- Statewide Land Use Planning Goal 7 addresses protection of life and property from natural disasters and hazards. It strives to ensure that development will not be located in disaster- and hazard-prone areas without appropriate safeguards. Goals 6 and 7 are linked through the connection between carrying capacity of land and water resources, and natural disasters/hazards associated with exceeding the carrying capacity of the resources.

Contact Information

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http://www.portlandonline.com

http://www.metro-region.org

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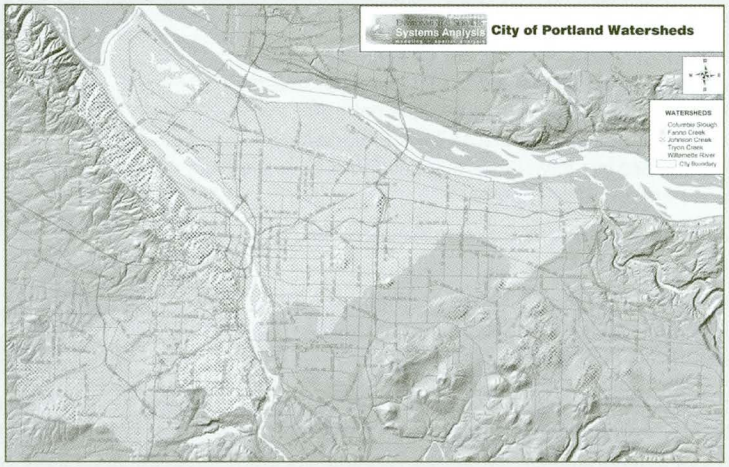


Watersheds of the City of Portland

from City of Portland Environmental Services Bureau

Village of South Holland, Illinois

Even though it is a small town (population about 23,000), the Village of South Holland has found a way to tackle its flood problems whole-heartedly, and adopt forward-looking strategies to protect itself and its citizens—and their quality of life—into the future. A suburban community on the southern side of Chicago, South Holland experiences slow rising, slow-moving, and slowly receding floods from the Calumet River. Its techniques, success, and Community Rating System rating (class 5) demonstrate that a large staff and large budget are not needed to be successful with no adverse impact (NAI) floodplain management.

NAI Highlight

A Small Town's Comprehensive Approach

In South Holland, every NAI building block is an essential part of the whole and is continually addressed, reviewed, and enhanced. South Holland has no extensive hazard identification and mapping program, essentially following the mandates of the National Flood Insurance Program to assure that Flood Insurance Rate Maps are up to date and accurate. In its work and implementation of the NFIP Community Rating System, the Village views all floodplain management issues as of essentially equal importance for a composite program.

South Holland works to avoid these "adverse impacts" . . .

- any increase in flooding caused by new development;
- any removal of floodplain carrying capacity;
- any removal of floodplain storage capacity;
- an increase in the amount of runoff from impervious surfaces; or
- a negative impact to fish and wildlife through the loss of habitat or supportive ecological systems.

Planning

South Holland has developed a hazard mitigation plan, which is reviewed annually to incorporate newly identified needs. It indicates which activities have been completed and how this was accomplished. All statutes and ordinances are reviewed annually to assess the need for change and to assure that loopholes have not manifested themselves that would allow circumvention of the ordinance's intent, which is to provide an environment for growth yet protect the health, safety, and welfare of the citizens and also protect natural resources and the environment.

A Flood Liaison Committee was formed to assist in the development of a floodplain management plan. This committee is very active and made up of citizens from the community and appropriate community staff. The plan was developed in 1994 and subsequently updated in 2000. It calls for a variety of flood and stormwater management activities, especially public information programs and technical and financial assistance for property owners to retrofit their homes. Specifically, the plan identifies the following issues and recommendations:

- A discussion of problems that were found throughout the community, focusing on the types of flooding to be expected and the areas of the Village that are the most susceptible to flooding;
- Suggestion that the Village assist property owners through various means in protecting their properties from flooding;
- Recommendation that various flood-related duties, offices, or committees be maintained or established within the Village government; and
- Identification of a proposed flood control reservoir, levee, and diversion tunnel as potential future mitigation projects.

Mitigation

Several mitigation activities have taken place that are directly related to NAI floodplain management. Many buildings have been removed from floodprone areas and the sites returned to open space, and allowed to function as a natural, un-encroached floodplain. Other activities have fostered growth and ancillary projects that will improve the quality of life for the South Holland residents through park and open space expansion and wildlife habitat.

- As noted above, the Village established the Flood Liaison Committee composed of village residents and staff persons to act as an advisory group on issues related to the flooding problems in South Holland. This group continues to be active.
- The Village is a leader in the promotion of floodplain and stormwater management. It has worked with nearby communities to get them involved with floodplain management, stormwater management, and the Community Rating System.
- South Holland maintains an Urban Forestry Commission as well as a full-time arborist to assure that protected trees and vegetation are maintained and guarded from indiscriminate development.
- The Village developed a plan to help property owners protect their properties from flooding. Known as the Flood Assistance Rebate Program, it was begun in 1994, after some of the area's worst flooding in 1990. The program offers owners of owner-occupied single-family residences a 25% rebate (up to $2,500 for each home) for flood control projects they undertake, such as installing overhead sewers, drain tile, or elevating landscaping for improved drainage patterns around homes. Eligible projects include

  Surface water projects, such as diversions of downspout water or floodwalls;

  Sewer backup projects, such as overhead sewers (repair and installation), removal of sump pump and downspout connections from sanitary sewers, and backflow valves and;

  Subsurface projects, such as installing interior or exterior drain tile, repairing cracks in foundation walls, or waterproofing foundation walls.

Thornton Ditch undergoing work

—Photos from Village of South Holland

Thornton Ditch repaired

—Photos from Village of South Holland

Begun in 1995, the program has helped floodproof about 500 homes. The rebate project in South Holland received the John R. Sheaffer Excellence in Floodproofing Award in 1997, given annually by the Association of State Floodplain Managers.

- As part of a recommendation in a 1992 Comprehensive Flood Study, a diversion channel siphon and flood storage reservoir were constructed. The Village was an active supporter of the construction, using the Thornton Quarry. The project was constructed by the Metropolitan Water Reclamation District and is a huge flood storage reservoir. It was determined in the study to be the best way to control flood waters without causing increased flood levels upstream or down. There is no dam. It is a reuse of the stone quarry, rather than an in-line reservoir that could adversely affect the quality of the stream. Flood waters are stored in the quarry and pumped out over the next several days after the flood. The water is sent to a treatment plant before it is returned to the river system.

Public Education & Outreach

South Holland makes good use of education and outreach in its NAI floodplain management approach. The Village government has been a strong advocate of keeping its citizens informed of not only what their government was proposing and doing, but in the various actions that might be required of a community to protect itself from the adverse effects of flooding.

- In the early 1980s, the State of Illinois began a series of flood information open houses throughout the Chicago suburbs. This was continued and reformatted into floodproofing open houses by South Holland, beginning in 1991. The first open house followed the heavy flooding of 1990, thus creating an interest in attendance, with 150 households present.
- The South Holland open house was publicized in newspaper articles and with handouts distributed door-to-door. The open house gave citizens information that helped them make decisions about floodproofing or lessening their exposure to flood damage. Attendees received written materials and saw a slide show on flood protection and a video on floodproofing. They were able to meet with state and local staff and with contractors to discuss their individual flooding problems and potential solutions. Afterwards, questionnaires were distributed to the attendees (their addresses were recorded upon entering) to determine their overall impressions of the open houses, what they thought they learned, and what protective actions had been taken.
- The Village has produced and distributes brochures, booklets, and community maps that detail the services of the community government and the local area. Emergency phone numbers are provided to help new residents find the right offices for help.
- South Holland publishes a monthly community newsletter, *South Holland Today*. Besides items of general interest, articles often discuss flooding issues, flood reduction projects, and summaries of committee meetings, such as the Flood Liaison Committee. A recent issue focused on why flooding sometimes occurs in South Holland, giving the Village government an opportunity to remind people that flooding has and will occur and refresh their memories about things they can do to protect themselves and their property. Many of the articles are motivated by the Village's participation in the Community Rating System. Other newsletter articles have covered

  The Flood Hazard in South Holland,

  South Holland's Flood Warning System,

  Flood Safety in South Holland,

  Flood Insurance in South Holland,

  Property Protection Measures for South Holland,

  Floodplain Development Permit Requirements, and

  Drainage System Maintenance.

Community warning sign along river

—Photo from Village of South Holland

- The addresses of all residents within the floodplain in the Village are maintained. Periodically the Village mails a letter to these people discussing the National Flood Insurance Program and the importance of purchasing flood insurance.
- In cooperation with two other nearby communities, the Village of South Holland conducts a Flood Awareness Week on an annual basis. Part of this week includes a Business Breakfast for real estate agents, lending institutions, and insurance agents, to better educate them about flooding issues and the National Flood Insurance Program.

Infrastructure

As noted previously, the Village was instrumental in the floodwater diversion siphon construction in conjunction with the Thornton Quarry stormwater retention area. Other infrastructure work includes a twice-a-year inspection of all riverine systems to assure they are clean, not in need of maintenance, and free flowing. The Village also responds to citizens' requests for maintenance of the stream systems. This not only promotes flood mitigation through better flow characteristics of the streams, but it enhances the fish and wildlife environment by removing sources of erosion and sediment and improving habitat.

Streambank stabilization project

—Photos from Village of South Holland

Emergency Services

South Holland employs various forms of flood warning-related services for the community. Because of the history of past flooding, the Village government has determined that it is imperative that the citizens and businesses receive as much warning as possible in order to institute various flood protection measures. Flood warnings are based upon information received from the National Weather Service and monitoring of the river gage at Cottage Grove Avenue. The Emergency Services Disaster Committee issues flood warnings once the river stage reaches 592.0 on the gage.

The Village has developed a wide-ranging distribution system to assure as wide a coverage as possible for its warnings. Typically, once a warning or watch is issued some or all of the following are deployed:

- Public address announcements are issued by the Emergency Services Disaster Committee members and the fire and police department vehicles.
- Fold-down signs reading "Flood Warning in Effect" are opened by the Public Works Department. The signs are located near all entrances to the lower-lying floodprone areas of the community.
- Door to door notification of residents in the more floodprone areas. The Emergency Services Disaster Committee and the Village Fire Department conduct this notification.
- The Village Emergency Cable TV Interrupt is instituted. This is a live audio interrupt on all cable TV channels.
- Critical facilities and businesses that will be affected early in the flood are telephoned. The following are the anticipated warning levels, 1 through 4, and the related community response.

Warning Level	Community Response
1. Conditions favorable for flooding.	All primary participants alerted. Maintain watch on the river and make sandbags available.
2. Streams are rising, additional rain expected.	Mayor assumes operational control. Advance preparations to combat flood. First public notice. Maintain river watch. Provide reports to other responsible agencies.
3. Streams are rising and flood stage will be exceeded by a considerable margin.	Full staff in the Public Coordinating Center. Prepare to evacuate. Close factories/businesses along River. Encourage voluntary evacuation. Maintain river watch and reports to other responsible agencies.
4. Extreme floods expected.	Open shelters. Activate traffic control measures. Evacuate in 2 phases: 1) sick & infirm and 2) remainder. Maintain river watch and provide reports to other responsible agencies.

Regulations & Development Standards

The Village of South Holland has a pro-active floodplain management ordinance. Chapter 14, Planning and Development, addresses all of the criteria, rules, and regulations governing construction and reconstruction within areas affected by flooding. Not all NAI activities are meant to focus on the natural environment. South Holland has recognized that a clean and safe built environment, constructed in accord with the natural environment, is equally important to sustain a community. Some of the NAI features of the ordinance that address these issues are

- Protection standards for critical facilities;
- One-foot freeboard for new construction; non-residential construction must be floodproofed to at least 1 foot above the base flood elevation;
- Any development proposed within the floodway or within a floodplain area that does not have elevations must be reviewed by a professional engineer to assure that all requirements of the village and the NFIP are met;
- Fill in the floodplain must be compensated for with an excavation 1.5 times the volume of the fill, in an area opposite or adjacent to the filled area. All floodplain storage lost below the 10-year flood level must be replaced at or below that elevation;
- A lower substantial improvement threshold that accelerates the requirement that a structure meet current codes;
- The prohibition of hazardous materials in the floodplain;
- Use of the state's 0.1 foot floodway standard for evaluating encroachments; and
- A stormwater management ordinance that requires retention of runoff from new developments from all storms up to the 100-year storm.

Community Support

The heavy flooding of the 1990s provided an impetus for the community, businesses, and private citizens to buy into NAI floodplain management. This was presaged by the early participation of the Village in the Community Rating System.

The development of the Floodplain Management Plan provided an inherent outreach/education tool because the community then formed the Flood Liaison Committee to develop the plan. This required public hearings and resident involvement in the process, which has essentially formed an established procedure or "NAI style" of resource management.

Resident concern and public pressure provided the initial motivation for planning and implementing an NAI development and management approach to South Holland's flooding problems. They began by enrolling in the Community Rating System of the NFIP. It provided the roadmap for their initial efforts. Since the beginning of the program, the village has been further motivated by the desire to improve its Community Rating System rating. It started with a rating of 7 and now is rated class 5. Community pride has become a major motivating factor. Resident approval is high and only a few communities in the United States have a better Community Rating System rating.

"Buy in" to the NAI concept was eagerly given by the affected property owners and business owners when the Village began responding to their concerns and taking action on flood-related issues. Community leaders bought in when they quickly recognized the concept as a workable organizing tool to tackle these important issues.

The residents have regular opportunities to address their concerns to the mayor and the Village board. Flood concerns have consistently declined over the years and indications of satisfaction are commonly heard. The Village of South Holland is pleased with all aspects of its NAI style of floodplain management.

Community flood tour

—Photos from Village of South Holland

Community response to flooding

—Photos from Village of South Holland

Background

South Holland is located about a half-hour's drive south of Chicago and is a suburban community with most big city amenities, priding itself on being "Far from the Crowd, but Close to Chicago." The 2000 census put the population at 22,147 but it is probably nearing 23,000 now. Most of the community is developed and the population and development trends remain fairly constant.

South Holland was initially settled by Dutch immigrants in 1846. By the early 1940s, the primary focus was on farming with over 1.5 billion pounds of onion sets grown per year. Most of those farms are no longer present, having given way to residences and light industry. In addition to having a sizeable light industry park, the Village is home to three of the country's largest meat processing/packing plants.

Because of its location, transportation in all forms is readily available to the businesses and citizens of South Holland. Multiple north/south and east/west freeways are close at hand, as well as freight and passenger rail service. One of the busiest airports in the country is an hour away.

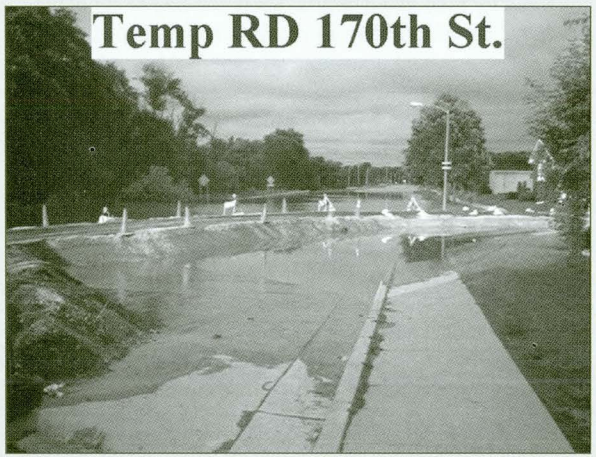
South Holland is committed to being a model community. It works hard to provide regional leadership on municipal issues. In addition to consistently improving flood-related activities, one goal is to encourage surrounding municipalities to proactively address those issues for the benefit of their residents and for the region.

Due to the very flat topography throughout the community, flood velocities are low, with the Flood Insurance Rate Map showing the average velocity for the 100-year flood at about 2.5 feet per second. This lack of slope also accounts for floods having a longer-lasting effect than would ordinarily be expected. The 1990 flood, less than a 50-year event, inundated buildings within 24 hours. The river continued to rise for 24 more hours. It was another 2 to 3 days before the Little Calumet River receded back within its banks.

The original sources of funding for the Village's flood-related activities came from the general budget, and funds for ongoing activities continue to come from that source.

Past floods in South Holland, Illinois.

—Photos from Village of South Holland



Past floods in South Holland, Illinois.

—Photos from Village of South Holland

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Illinois Association for Floodplain and Stormwater Management. 1993. "Analysis of the 1991 and 1992 Floodproofing Open Houses." Park Forest, IL: IASFM.

French & Associates, Ltd. "Floodplain Management Plan 2000 Update." 2000. Park Forest, IL: French & Associates, Ltd.

Village of South Holland website at http://www.southholland.org.

Town of Southern Shores, North Carolina

As a small community on a barrier island off the coast of North Carolina, Southern Shores wants to protect the area's natural features—marshlands, open space, maritime forest, and protective dunes. It also must ensure the safety of its public and provide access to the services its citizens need. The town employs NAI floodplain management in a comprehensive local program that faces challenges both from the flood hazard posed by hurricanes and Nor'easters and from the necessity of preserving the fragile natural environment. This is complicated by the fluctuation in population through the year—2,300 year-round residents swelling to 10,000 during tourist season.

NAI Highlight

Coastal Regulations & Development Standards

The Town of Southern Shores uses regulations and development standards, tailored to the coastal zone, as its primary NAI building block even though the town uses all the building blocks in a comprehensive program. The Zoning Ordinance, Waterway Ordinance, Flood Damage Protection Ordinance, and the Dune Protection Ordinance all work together to provide a safe environment that not only protects the area's rich resources but also allows for controlled and intelligent development.

Other NAI Building Blocks

- Mitigation
- Hazard Identification & Mapping
- Planning
- Infrastructure
- Emergency Services
- Public Education & Outreach

Southern Shores works to avoid these "adverse impacts" . . .

- an alteration of the natural environment;
- risks to human safety and property.

Regulations & Development Standards

The Town of Southern Shores considers its regulations and development standards to be its strongest and most effective tool in no adverse impact (NAI) floodplain management. The most easily recognized payoff to the property owners and the community comes from this activity. For example, enforcing a 30% limit on lot coverage in the residential zone, and requiring increased open yard area and setback areas have helped to enhance the feeling of open space within the community.

- The Zoning Ordinance, adopted May, 1979—Restricts the type of development and the manner in which it is constructed. In any area affected by special flood hazards, the zoning ordinance specifies how new or substantially improved buildings shall be constructed to be flood-resistant.
- The Waterway Ordinance, adopted April, 1984—Provides a mechanism to assure that canals and waterways are maintained and kept free of debris. This in turn promotes proper drainage during floods. This not only keeps flood losses to a minimum, but reduces soil erosion and sedimentation as well as protects the barrier dunes.
- The Flood Damage Protection Ordinance, adopted November, 1999—Requires that all new or substantially improved residential construction in special flood hazard areas have the lowest floors no lower than 2 feet above the base flood elevation. All new or substantially improved non-residential construction must have the lowest floor either elevated or floodproofed 2 feet or more above the base flood elevation. (Basements are not permitted within the flood zone). In addition, the local interpretation of the ordinance requires the bottom of all untreated floor joists, floor insulation, wiring, and mechanical equipment to be above the base flood elevation plus 2 feet of freeboard—a level known as the "design flood elevation."
- The Dune Protection Ordinance, adopted April, 1980—Protects the dunes from encroachment by development and crossing by pedestrians at other than approved crossing points. The barrier dunes are the single best protection against wind-driven flood waters coming off the ocean during Nor'easters and hurricanes.

Other provisions from the Town Code of Ordinances that minimize adverse impacts to the natural environment are

- Chapter 7, Planning & Development

  Section 7-70(4)—Building Permit Application, requires a plan or survey of the property by a state registered land surveyor showing the proposed location of the structure and the elevation of the building site for flood purposes.

  Section 7-167(3)—Preliminary Plat, requires flood hazard areas to be shown.

  Section 7-168(13)—Final Plat, requires the flood hazard area to be shown with the effective date of the Flood Insurance Rate Map.

  Section 7-192(a)(1) Coastal Area Management Act (CAMA), requires a permit application to be filed for minor development with site plans showing areas of environmental concern, relating to coastal flooding and water quality issues.

- Chapter 11, Zoning

  Section 4.12—Ocean Dune Platforms, Walkways and Steps, limits the size of uncovered structures permitted on the dune and their location.

  Section 6.09—Lot Disturbance, assures that before any clearing, grubbing, or topographic change occurs on any unimproved lot, the building inspector shall conduct an on-site meeting and evaluation of conditions. This is meant to protect as much special vegetation and protective landforms as possible, as well as address potential stormwater management and flooding due to development.

Additional Actions

Mitigation

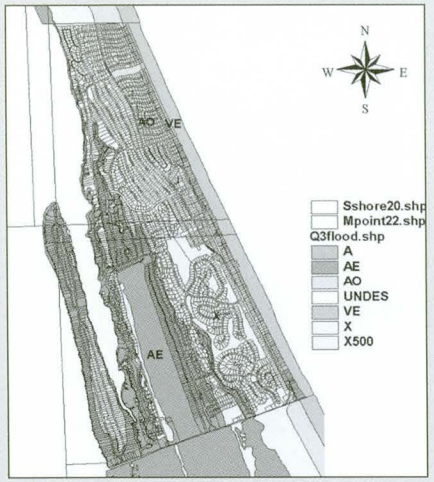
The 2002 Hazard Mitigation Plan has identified and assessed all of the natural hazards to which Southern Shores might reasonably be expected to be exposed. Flooding and hurricanes are ranked the highest in likelihood to occur, with a Nor'easter closely following in both probability and potential for damage.

The Hazard Mitigation Plan identifies the following activities being conducted by the town:

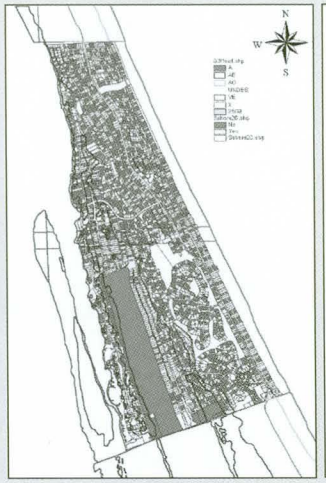
- The protection of various natural resources through erosion and sedimentation control, coastal barrier protection, and wetlands protection. Of primary importance to the community is the protection of the dune barrier system, which helps to break up storm-driven waves and dissipate the effects of hurricanes and coastal storms;
- The various codes, ordinances, open space preservation, stormwater management plan, and drainage system maintenance programs all mitigate future disaster damage;
- Maintenance and improvement of the town's participation in the Community Rating System, currently a class 6;
- Implementation of property protection measures, including the National Flood Insurance Program and building elevation requirements, for new and substantially improved structures above the minimum; and
- Formation of the Reconstruction Task Force after storms to identify areas of need and prioritize and coordinate reconstruction.

Hazard Identification & Mapping

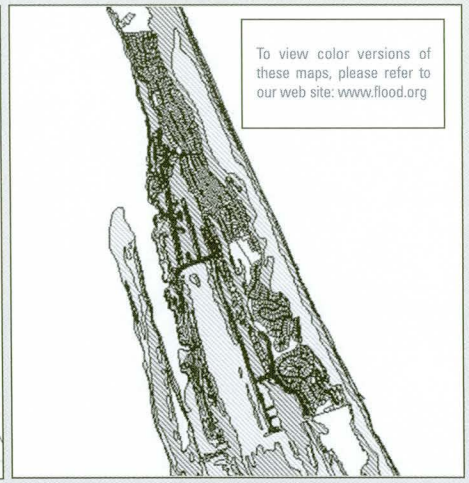
Several different maps have been developed to help manage the coastal environment and development, providing the necessary tools to identify critical environmental areas and hazard areas and to track development trends.



Q3 Flood Map



Map of flood insurance policies



SLOSH mapping of various categories of hurricanes

—Town of Southern Shores

- Q3 flood maps are maintained in the Building Inspection Department. They are a handy reference that shows that nearly 50% of the town has been mapped in the 1% floodplain.
- Geographic information system (GIS) maps and aerial photos provided by Dare County are used extensively by the town, with ESRI ArcView software. Of particular value is the overlay of property boundaries on these images, which can then be provided to property owners. Southern Shores has used the services of a nearby college to train their students in GIS mapping, identifying, and locating many of the environmental features of the island, such as specific vegetation that needs to be protected from clear-cutting.

Planning

Planning is a strength of necessity with Southern Shores. The community relies heavily on volunteers for various committees and other needs, including but not limited to, the volunteer fire department, the Town Planning Board, Board of Adjustments, and the Vegetation Advisory Committee. In fact, the Town of Southern Shores is quite proud of its motto, "A Town of Volunteers." Almost all of the town's governing and advisory boards are staffed by citizens volunteering because of their past experience or a desire to contribute to the community. Thus, most of the planning done in the community is affected to a high degree by volunteer staff.

Committee Planning Meeting

—photo from Town of Southern Shores

Some relevant planning documents that help keep the town on the course it has plotted are discussed below. The plans have ensured that the NAI philosophy of "do no harm" is incorporated into the actions of the community at almost all levels when new initiatives are considered and projects undertaken. This focus protects the environment and natural resources, while still allowing for proper development—the stated mandates of the citizens.

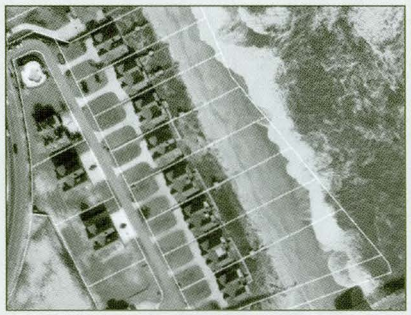
- The Land Use Plan maintains the overall residential flavor of the community, with commercial establishments significantly controlled and reduced in number. There are no hotels or motels with the town and the Commercial Zoning District limits such enterprises to the southern boundary area and not along the oceanfront. Since oceanfront development has been limited to single-family residences, they meet the classification of "small structure." Thus, the minimum setback of 30 times the annual erosion rate of (2 feet per year) is imposed rather than the rate for larger structures (60 times). Photos on the next page show the importance of the protective dune structures along the coastline.
- The Hazard Mitigation Plan, completed in 2002, includes an analysis of property owners' perceptions about the risk of flooding resulting from a questionnaire. Well over two-thirds of the residents responded to the questionnaire, providing insight into the overall knowledge and beliefs of the general population, which enabled the town to mold the hazard mitigation plan around the needs of the community and provided an excellent "needs statement" on where to focus future educational initiatives.
- The Long Range Plan was completed in 2001. The town periodically forms a long-range planning committee to look at the needs of the community now

and into the future. The latest session looked at nine different subjects, analyzing them and developing a consensus that then went to the Town Council for consideration and adoption. Among the issues reviewed were

- Continuing to promote volunteerism;
- Promoting the development of standards for preserving and managing vegetation;
- Maintaining the canals and waterways to assure navigability, hydrologic functionality, and ecological integrity;
- Opposing beach nourishment as a central element to beach management; and
- Maintaining Southern Shores' zoning without change.

Infrastructure

The primary infrastructure activity might be the beach nourishment program that is implemented on an as-needed basis. Although it is not favored as a central element of proper beach management, the town does recognize that "non-natural" deposition of sand is a way of supplementing the sand that is lost due to littoral drift or severe storms. Repositioning the sand through "beach push" activities helps to ensure the stability of the dune systems. The beach nourishment program supports NAI floodplain management because of the importance of the barrier dunes. Without a healthy beach with sufficient sand, the dunes themselves would become vulnerable to the erosive velocities of wave action, littoral drift, and tides.



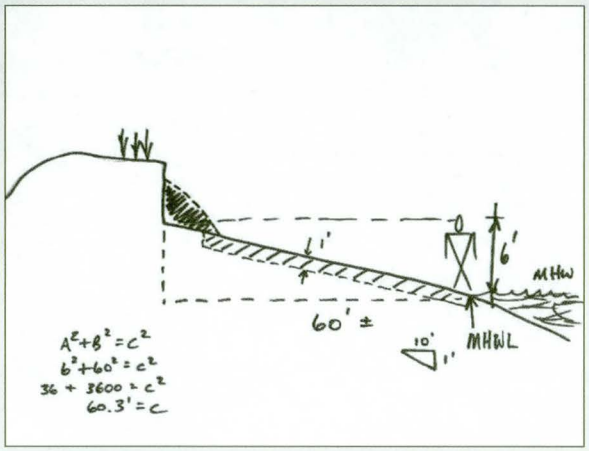
Pelican Watch, aerial view

Pelican Watch after Isabelle

Pelican Watch protective dunes

—Photos from Town of Southern Shores

After a "beach push"



Sketch of "beach push"

—from Town of Southern Shores

Emergency Services

- Southern Shores has adopted and participates in the Dare County Hurricane Evacuation Plan, providing for the dissemination of emergency warnings.
- The town has the capability of producing GIS maps to convert a forecast from the National Hurricane Center into a predicted area of inundation throughout the community.
- The town participates in preparedness training programs and disaster drills, including warning and coordinating with disaster facilities.

Public Education & Outreach

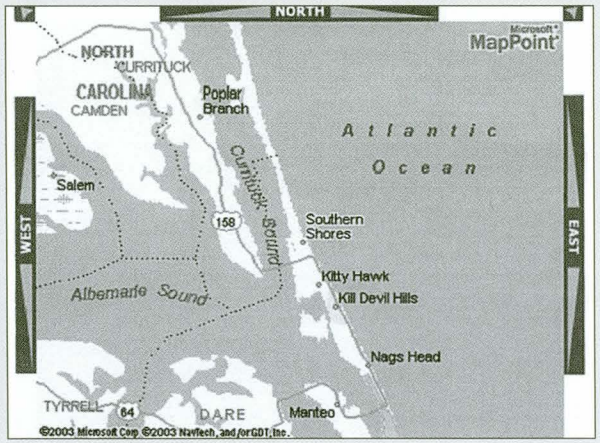
Each new resident of Southern Shores receives a packet of information upon arrival that includes

- Information about the protected or critical environmental areas,
- How to protect the dune system,
- The importance of the using the designated beach access routes over the dunes,
- Maps of the floodplains,
- Hurricane preparedness information,
- Hurricane evacuation routes, and
- Information about participating in one of the many volunteer committees or work groups.

A monthly newsletter, *News From Town Hall*, focuses primarily on articles or discussions of various environmental or natural resources issues. When informational needs are determined, brochures or other forms of media are employed to provide information to the citizens.

Community Support

Coastal communities are always watching for strong, wind-driven storms (Nor'easters) during the winter and hurricanes during the summer and fall. Both types have affected Southern Shores as recently as the Ash Wednesday Storm of 1962 (a Nor'easter) and Hurricane Isabelle in 2003. After



Location of Southern Shores, North Carolina.

Isabelle, many people in town were without electricity for up to five days and water restrictions were in place for three. There was flood damage, but it was kept to a minimum because of the dune systems that have been protected and nurtured by the citizens and the Southern Shores Civic Association.

Because of the threat of experiencing one or more of these types of storms, there is strong motivation on the part of the Town Council, the Southern Shores Civic Association, and the citizens of Southern Shores to employ and follow wise development practices and to protect and enhance the natural environment they already enjoy. The community leaders are generally well educated and have served in various technical or management positions in private industry or government throughout their careers. They understand the value of this type of approach and the value of well-thought-out regulations.

The Town Code provides for the establishment of the Reconstruction Task Force after severe storms. This group has been assembled over the past few years as the Flood Plain Management Plan Committee and the Hazard Mitigation Plan Committee, and has representation from a broad range of interests, including the building trades, real estate, and homeowners associations. The Town Zoning Ordinance limits the type and location of local businesses. Most new businesses are aware of flooding problems that other localities have experienced and understand the flood elevation requirements. It is not a "hard sell" to seek concurrence and practice with the tenets of NAI floodplain management. Buy-in was most easily achieved through the Reconstruction Task Force committee meetings, which is active after major storms, when the need for "do no harm" practices is most apparent. Southern Shores is noted for its residents who work with the community to improve the environment, not only in the manner in which they live, but also in active protection of the natural resources of the area, including wetlands, the beach, canals, and vegetation. The town is known as the "community of volunteers."

Transfers of real estate often result in new buyers' undertaking work without permits or an understanding of the regulations. Adopting a rule of "no enclosures" below the base flood elevation would simplify enforcement and minimize possible future violations.

Background

Southern Shores is a small community encompassing approximately 4 square miles (about 4 miles long and 1 mile wide). Its is bordered on the east by the Atlantic Ocean, the west by Currituck Sound, the south by Kitty Hawk, and the north by Duck. It was incorporated as a town in 1979, by petition of its citizens. The Southern Shores Civic Association maintains ownership of all common properties, including marinas, parks, and accesses to the ocean and the sound. The Association maintains these areas as a community resource.

The Town of Southern Shores has a winter population of about 2,300 people. It grows substantially during the tourist season to about 10,000. From 1980 to 1990, the population grew at a rate of almost 11%. The subsequent decade has seen this slow somewhat, but the growth rate is still just over 4%. The great majority of the structures are residential. The community depends almost totally on commercial establishments in surrounding communities for goods and services. The primary "industries" are tourism and real estate. The population consists largely of people retired

from government, academia, business, and the military. The mean income is somewhat higher than that of most nearby communities.

The Southern Shores Civic Association plays a pivotal role in the day-to-day affairs of the town. Its business is conducted by a nine-member board with meetings held twice a month in the Town Hall, and its work is done primarily by volunteers. Membership dues are charged with the funds being used for maintenance and improvements to the common properties and construction of new facilities. Another organization, the Chicahauk Property Owners Association, is also active in education and outreach activities, getting vital information to the residents.

The current trend in Southern Shores is to demolish older homes in the 1950–1970-vintage and rebuild with large single-family homes with as many as 6 or 7 bedrooms. These then are rented during the high-occupancy tourist season. All new oceanfront homes must be constructed on pilings, as required by state law. The primary environmental goals of the town are to remain a single-family-oriented community rather than multi-family; and to educate the property owners about the natural hazards and "best" practices versus "code minimum" construction. The community wants to maintain natural features such as the marshlands, open space, maritime forest, and protective dunes. Most of the town's population supports building a bridge that would span the area between the Currituck mainland and the beach communities, thus relieving traffic congestion and shortening the hurricane evacuation times. There is strong opposition to widening Route 12 or providing bypass routes through internal streets.

Contact Information

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http://www.southernshores-nc.gov

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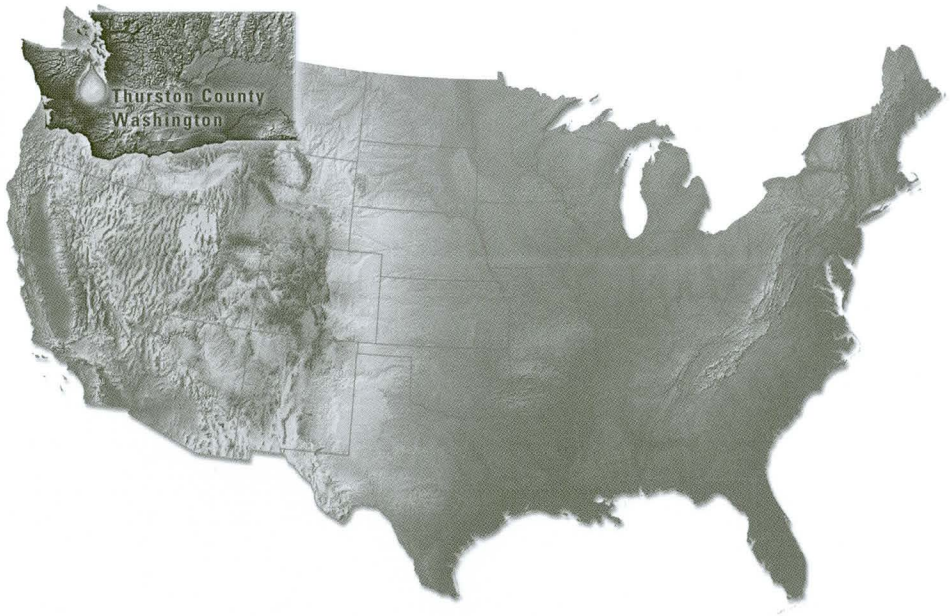
Thurston County, Washington

Thurston County lies along the southern part of Puget Sound in western Washington and has the state capital, Olympia, as its county seat. The area receives heavy rainfall between October and March and intense storms plus snowmelt from the Cascades combine to cause floods. For decades predominantly rural, the unincorporated parts of the County now are seeing more development. Thurston County contains a huge inventory of natural resources, including large, free-flowing rivers, many trout and salmon streams, forests, mountains, and shoreline along miles of Puget Sound.



NAI Highlight

Habitat-based Watershed Planning

Thurston County's no adverse impact (NAI) floodplain management is in large part geared toward avoiding harm to its invaluable natural features by using all of the NAI building blocks. Through its plans, maps, and regulations, the County gives special attention to endangered species, wetlands, and habitat preservation and restoration.

Planning is the key to meeting the needs of the people, protecting the County's resources, and minimizing risk from a myriad of natural hazards, including floods, earthquakes, volcanic eruption, severe storms, and landslides. Plans have been developed for flood hazard management, drainage basin management, hazard mitigation, and shoreline protection.

Other NAI Building Blocks

- Mitigation
- Hazard Identification & Mapping
- Regulations & Development Standards
- Infrastructure
- Public Education & Outreach

Thurston County works to avoid these "adverse impacts" . . .

- harm to critical resources;
- harm to wildlife habitat;
- unwise development in critical areas (floodplains, wetlands, erosion areas, landslide zones);
- an increased risk to any individual or developed property as the result of an increase in elevation of any watercourse;
- a redirection in flow of any watercourse; or
- diminution in the natural character of the shoreline.

Habitat-based Watershed Planning

Several major rivers run through Thurston County on their way to the Puget Sound, which borders the County on the north. Plans have been developed to manage these river basins and the natural resources within the County:

- The Natural Hazards Mitigation Plan for the Thurston County Region, published in 2003, addresses the impacts of the potential natural hazards and has as goals:

  To provide a methodical approach to mitigation planning,

  To enhance public awareness and understanding of natural hazards,

  To serve as a tool for policymakers and decision makers,

  To promote compliance with state and federal program requirements,

  To assure inter-jurisdictional coordination of mitigation-related programs, and

  To create jurisdiction-specific hazard mitigation plans.

- The Shoreline Master Program for the Thurston Region, developed in 1990, plans for the regulation and protection of the shoreline along Puget Sound. The goal of the Master Program is "to preserve to the fullest possible extent the scenic, aesthetic and ecological qualities of the Shorelines of the Thurston Region in harmony with those uses which are deemed essential to the life and well-being of its citizens." The Shoreline Master Program priorities are

  To recognize and protect the statewide interest over local interest,

  To preserve the natural character of the shoreline,

  To seek long-term benefits over short-term ones,

  To protect the resources and ecology of the shoreline,

  To increase access to publicly owned areas of the shoreline,

  To increase recreational opportunities for the public on the shoreline, and

  To protect life and property from flood hazards.

Looking east at the marine edge of the delta as the Nisqually River enters the Puget Sound. The Nisqually and its watershed are among the most ecologically significant resources in Washington State. The Nisqually is the most natural and undisturbed river entering Puget Sound.

—photo from Thurston County

- The 1999 Flood Hazard Management Plan is the County's official long-term plan for dealing with floods. By statute, the plan must

  State short- and long-term objectives,

  Address potential impacts upon various natural resources,

  Evaluate the benefits and costs of alternatives, and

  Contain recommendations that are supported by clear rationales.

County administrators have recognized major benefits of the Plan to be

  Acknowledgement that preventing problems is often the most cost-effective solution,

  Improved mapping that makes existing development regulations more effective,

  Lower private flood insurance rates obtained by joining the Community Rating System, and

  Allowing the County to apply for federal or state grants for plan implementation.

Other plans of significance developed and adopted by the County are

- McAllister/Eaton Creek Comprehensive Drainage Basin Plan (1994)
- Salmon Creek Comprehensive Drainage Basin Plan (2004);

Pre-FIRM homes that are substantially improved must meet current flood zone development regulation. Each of these homes required a significant elevation change to become compliant. The elevation requirement is 2 feet above highest known historical flood elevation. In these cases, this added 3 feet to the BFE.

— photo from Thurston County

- Chambers/Ward/Hewitt Comprehensive Drainage Basin Plan (1995);
- Woodland and Woodward Creek Comprehensive Drainage Basin Plan (1995), and
- Green Cove Creek Comprehensive Drainage Basin Plan (1998).

All plans

- Include endangered species work,
- Identify flooding issues,
- Plan wetland and habitat preservation and restoration, and
- Outline the public involvement process, grants, and funding.

Additional Actions

Mitigation

An integral part of the Natural Hazard Mitigation Plan focused on these goals for its implementation.

- All sectors of the community work together to create a disaster-resistant community.
- Local and state government entities have the capabilities to develop, implement, and maintain effective natural hazards mitigation programs in the Thurston region.
- The communities in the Thurston region have the capacity to initiate and sustain emergency operations during and after a disaster.
- Neither local government operations nor infrastructure would be significantly disrupted by disasters from natural hazards.
- Vulnerability to natural hazards is reduced to protect the health, safety, and welfare of the community's residents and visitors.
- Local governments support natural hazards mitigation planning and implement mitigation initiatives for their jurisdictions.
- Residents would understand the natural hazards of the Thurston region and be aware of ways to reduce their personal vulnerability to those hazards.

Demolition of damaged home at Hayco Lane

—Photo from Thurston County

Nisqually Pines home pushed off its foundation

—Photo from Thurston County

Hazard Identification & Mapping

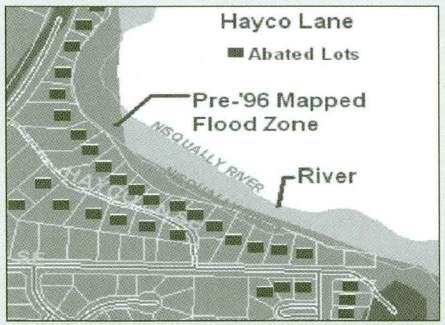
Thurston County has an extensive hazard identification and mapping program. Planning officials are particularly proud of the Thurston Geo Data Center, which allows the County to plan and effectively regulate through the compilation of spatial data and map generation. An enhanced level of information is available to all County staff. Much of the information is presented in a simplified format on the County's website.

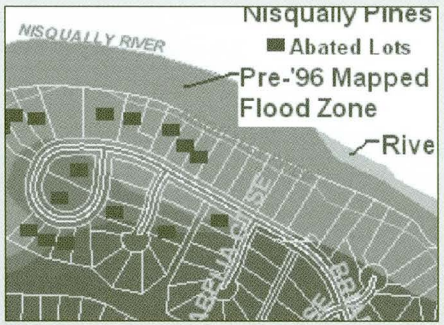
Of the broad coverage provided by Geo Data, parcel boundaries, water bodies, flood zones, contours, and aerial photos are those most often used in developing flood regulations. The flood zones are available in all areas and allow for a quick assessment of whether more investigation will be necessary. Spatial data and mapping have become the backbone of regulations and planning research and development in the County.

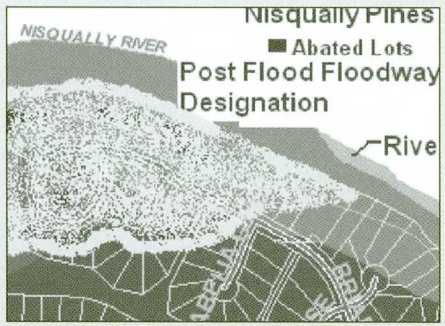
After the severe flooding on the Nisqually River in 1996, about 30 flooded homes were removed from what was then determined to be floodway. During the assessment of those properties it was observed that the flood waters rose and flowed well above what would have been expected from current estimates and existing maps. Based on a restudy by the County and a forensic hydrologist from the Washington State Department of Ecology, the County remapped the affected areas as floodway (see maps on the next page).

The Thurston County Geo Data Center has produced exceptionally high quality maps of

- Sensitive wildlife habitat,
- Critical aquifer recharge areas,
- Anadromous fish presence,
- Areas of known groundwater or soil concerns,
- High groundwater hazard areas with a 300-foot buffer,
- Wetlands and their 300-foot buffers,
- Wellhead protection areas,
- Zones of geologic hazards,







Maps by Thurston County

- Shoreline management plan,
- Noxious weed control zones, and
- FEMA 500- and 100-year floodplains and flood-damaged buildings.

Regulations & Development Standards

Thurston County has adopted rules and regulations that address development in and near the existing natural hazards. As part of the development and adoption of the 1994 Critical Areas Ordinance, all of the anticipated critical areas within the County were identified and ordinances enacted to regulate development within those areas. The Ordinance identified

- 100-year floodplains, floodways, and volcanic hazards,
- Landslide areas,
- Marine bluff hazards,
- Important habitat and species,
- Streams,
- Wetlands, Classes I through III, and
- High groundwater.

The ordinance then provides examples of acceptable and unacceptable uses in each of the designated critical areas.

The foreground and right bank of this reach of the Nisqually River were developed at one time. In 1997, Thurston County Development Services required removal of flood-damaged homes from this section of the riverbank. The County placed development restrictions on these parcels and they will remain vacant in perpetuity. —Photo from Thurston County

In 1994, the County revised and updated its *Drainage Design and Erosion Control Manual.* The manual defines policies, minimum requirements and standards, and procedures for the design, construction, and maintenance of drainage facilities and for the control of erosion on construction sites. Where structures are necessary to treat runoff and to control flow, the manual promotes the construction of drainage facilities that not only are functional but also will provide recreational opportunities and be pleasing to the eye.

Infrastructure

The County's *Drainage Design and Erosion Control Handbook* promotes the construction of multiple use drainage facilities that not only control problems of stormwater and erosion and maximize infiltration and groundwater recharge, but also provide recreational uses, are aesthetically pleasing, and take into account the space, water quality, and other factors that allow for the protection—and if necessary, restoration—of fish, plant, and animal habitat. In some instances, structures are needed to treat runoff and to control flow.

The Capital Facilities Plan of the County Comprehensive Plan is reviewed and updated every year. Some of the recent high-priority projects were

- Pacific Avenue Wetland—habitat preservation/restoration, water quality protection, and flood control;
- Mallard Pond—habitat preservation/restoration, water quality protection, and flood control;
- Lake Forest—flood control and water quality protection;
- McAllister Treatment Upgrades—water quality protection; and
- Hidden Forest—flood control and water quality protection.

Public Education & Outreach

The County publishes the *Thurston County Flood Bulletin* several times each year. This newsletter is mailed directly to all owners of property within either the 100-year floodplain or areas that have been determined to be susceptible to high groundwater flooding. The newsletter has articles that cover such topics as

- The NFIP's Community Rating System and how County residents can expect a 25% reduction in their flood insurance premiums;
- Basic flood insurance questions and answers;
- The benefits of floodplains and wetlands;
- The River Flooding Warning System and how to subscribe;
- Home preparedness for flooding;
- Actions to protect a home; and
- What to do in case of dam failure.

Community Support

The motivation for Thurston County to begin the practice of NAI floodplain management came from some of the negative experiences of nearby counties. Thurston County administrators realized they did not have the financial resources to undertake large initiatives to protect people and property within the 100-year floodplain. With the increase in development pressure, the County has been able to use "avoidance" as a guiding principle.

To obtain buy-in for planning initiatives, multiple efforts and small steps were made at the start. County officials believe that planning is a process that should be done "with" the community, as opposed to "for them" or worse, "to them." It worked out that the two main interests, the developers and the environmental groups, were fairly evenly matched. Elected officials continually sought collaborative decisions, even though this meant higher costs and more staff time and lengthened the review process.

Final success was achieved when community planning work groups were designed to include development and environmental interests as well as the local property owners and other governmental entities as needed (such as adjacent cities and Native American tribes). All interests and expertise had to be adequately represented in the planning process to ensure that valid points were not overlooked. The outcomes of this process have included

Development is increasing in the unincorporated sections of Thurston County

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- Critical resources are identified for protection in the regulatory process;
- Plans are in place to protect people from property and personal loss due to flooding;
- Species that depend on wetlands and floodplains are identified and steps taken to protect, repair, or enhance their habitat;
- Comprehensive plans identify the best use of developable areas and provide well-researched guidance for regulation; and
- Development and design performance requirements are in place for newly identified sensitive areas.

The County-wide planning process and the NAI floodplain management approach are institutionalized in Thurston County's implementation. The departments for Current Planning, Development Services, Advanced Planning, Regional Planning, Roads and Transportation, and Storm Water work in unison to create a County-wide picture that serves the people and the community. The combined planning, projects, and regulations of these agencies have produced a scenario of development with as little impact as possible using the best available science.

Background

Thurston County lies within western Washington, abutting Puget Sound to the north. Five major rivers traverse the County: the Nisqually, the Deschutes, and the Black and the Skookumchuck, which are major tributaries to the Chehalis. The state capitol, Olympia, is also the county seat. At the Olympia gage, the average annual rainfall is 52 inches, of which 42 are received between October and March. Major floods typically occur during this heavy rainfall season, and are the result of intense rainstorms often exacerbated by snowmelt from the surrounding mountains. The land itself is mostly lowland prairie moving into the foothills of the Coast Range Mountains on the west and the Cascade Mountains on the east.

Only recently has there been a significant trend to urbanization of the County, which remains predominantly

rural outside the cities themselves. The unincorporated parts of the County are now seeing increased development of commercial as well as residential properties. There were over 1,200 single-family housing starts in 2003. Even though rural zoning regulates one residence per 5-acre lot, there were still over 3,000 proposed new single-family lots near incorporated areas scheduled to be built in 2004.

The County's floodplain management program is funded and managed by the County Development Services Department, Division of Fire and Building Safety. The County believes that through the application of good planning and appropriate floodplain regulation, development can be achieved along with safety from floods and protection of natural resources.

Contact Information

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http://www.co.thurston.wa.us/em

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Terms & Acronyms

ASFPM: Association of State Floodplain Managers

Base flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "1% annual chance flood" (or the "100-year" flood). The base flood is a statistical concept used to ensure that properties are protected to the same degree against flooding.

BFE: Base flood elevation. The elevation of the crest of the base or 1% annual chance flood.

cfs: cubic feet per second

CDBG: Community Development Block Grant

Critical facilities: Buildings or locations vital to the disaster response and recovery effort, such as police and fire stations, telephone exchanges, water treatment plants, vehicle and equipment storage facilities, and emergency operations centers. The term also includes buildings or locations that, if damaged, would create secondary disasters, such as hazardous materials facilities, hospitals, nursing homes, and housing likely to contain occupants who are not very mobile.

CRS: Community Rating System of the National Flood Insurance Program

CRS classification: A rating of a community's floodplain management program according to the Community Rating System Schedule. Class 1 is the highest rating and class 10 is the lowest. A community that has not applied for CRS classification is a class 10 community.

DFIRM: Digital Flood Insurance Rate Map

Detention: Storing runoff for release at a restricted rate after a storm subsides.

Discharge: The amount of water that passes a point in a given period of time. Rate of discharge is usually measured in cubic feet per second (cfs).

FEMA: Federal Emergency Management Agency

FIRM: See Flood Insurance Rate Map.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A Flood Insurance Rate Map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area.

Floodproofing: Protective measures added to or incorporated in a building that is not elevated above the base flood elevation to prevent or minimize flood damage. "Dry floodproofing" measures are designed to keep water from entering a building. "Wet floodproofing" measures minimize damage to a structure and its contents from water that is allowed into a building.

Floodway: The channel of a river and the portion of the overbank floodplain that carries most of the base flood. The floodway must be kept open so that floods can proceed downstream and not be obstructed or diverted onto other properties. The National Flood Insurance Program regulations allow construction in the floodway provided that it does not obstruct flood flows or increase flood heights.

Flood fringe: The portion of the floodplain lying on either side of the floodway.

Flood hazard mitigation: Sustained actions taken to reduce or eliminate long-term risk from floods and their effects.

Flood Insurance Rate Map: An official map of a community, on which FEMA has delineated both the Special Flood Hazard Areas and the risk premium zones applicable to the community.

Flood Mitigation Assistance Program: A grant program funded by the National Flood Insurance Program.

Freeboard: A margin of safety added to the base flood elevation to account for waves, debris, miscalculations, or lack of data.

GIS: Geographic information system

Hazard mitigation: See Flood hazard mitigation.

Hazard Mitigation Grant Program: A FEMA disaster assistance grant that funds mitigation projects.

HMGP: See Hazard Mitigation Grant Program.

HUD: The U.S. Department of Housing and Urban Development

LOMR: Letter of Map Revision

MOM: See Multi-objective management.

Multi-objective management: An approach to planning and funding local programs that incorporates a variety of local interests and concerns.

Natural and beneficial functions of floodplains: The functions associated with the natural or relatively undisturbed floodplain that moderate flooding, retain flood waters, reduce erosion and sedimentation, and mitigate the effects of waves and surges from storms. Additional beneficial functions include maintenance of water quality, recharge of ground water, and the provision of fish and wildlife habitat.

NFIP: National Flood Insurance Program

Non-structural flood protection measures: Administrative tools for minimizing flood damage, including regulations on development, building codes, property acquisition and structure relocation, and modification of existing buildings.

Project Impact: FEMA's initiative to change the way America deals with natural disasters. The goal of Project Impact was to reduce the personal and economic costs of disasters by bringing together community leaders, citizens, and businesses to protect themselves against the ravages of nature.

Public/Infrastructure Assistance: A FEMA disaster assistance grant that helps public agencies and nonprofit organizations finance repairs and reconstruction.

Relocation: A non-structural mitigation measure that includes physically moving a structure out of a floodprone area.

Repetitive loss community: A community with one or more repetitive loss properties.

Repetitive loss property: A property for which two or more National Flood Insurance Program losses of at least $1,000 each have been paid within any 10-year rolling period since 1978.

Retention: Storing stormwater runoff for later use in irrigation or groundwater recharge, or to reduce pollution.

Retrofitting: Retrofitting techniques include floodproofing, elevation, construction of small levees, and other modifications made to an existing building or a property to protect it from flood damage.

Riparian ecosystem: A distinct association of flora, fauna, and soil occurring along a river, stream, or other body of water and dependent upon high water tables and occasional flooding to maintain its viability. These areas often exhibit high biological productivity and species diversity. Although riparian ecosystems are closely associated with a body of water, they may extend beyond the Special Flood Hazard Area.

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. It is mapped as a Zone A or Zone V. The Special Flood Hazard Area may or may not encompass all of a community's flood problems.

SFHA: See Special Flood Hazard Area.

Stormwater detention: Storing stormwater runoff for release at a restricted rate after the storm subsides. See Detention.

Stormwater retention: Storing stormwater runoff for later use in irrigation or groundwater recharge, or to reduce pollution. See Retention.

Structural flood control: Measures that control flood waters by construction of barriers or storage areas or by modifying or redirecting channels.

Substantial damage: Damage of any origin sustained by a structure whereby the cost of restoring the structure to its undamaged condition would equal or exceed 50% of the market value of the structure before the damage occurred.

Watershed: An area that drains into a lake, stream, or other body of water.

NAI Reference Materials

The following publications and training materials have been produced by the ASFPM to educate local officials and the general public about the NAI approach to floodplain management. All are available through the Executive Office. Most are available on line at http://www.floods.org.

- *A Toolkit for Common Sense Floodplain Management, A Guide for Using No Adverse Impact Approaches*, 2003
- NAI Toolkit Training PowerPoint, 2003 • NAI Introductory PowerPoint, 2003
- *Government Liability and NAI Floodplain Management*, tri-fold brochure, 2003
- *Floodplain Regulations in the Courts*, tri-fold brochure, 2003
- *NAI Legal Issues Flyer*, glossy flyer, 2003
- *NAI Status Report*, newsletter, 2002
- NAI Poster, glossy 24x36 poster, 2002
- NAI Status Report, newsletter, 2001
- NAI "tabloid," a glossy large-format newsletter introducing NAI concepts, 2001
- "No Adverse Impact: A New Direction in Floodplain Management Policy," by Larry A. Larson and Doug Plasencia, original white paper published in *Natural Hazards Review*, November 2001
- *No Adverse Impact Floodplain Management and the Courts*, by Jon A. Kusler, Esq. 2004.

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