DEVELOPMENT OF A P.L. 566 NONSTRUCTURAL PLAN TO REDUCE FLOOD DAMAGES IN THE UPPER FRENCH BROAD RIVER, NORTH CAROLINA

William H. Farmer, Jr.
USDA, Soil Conservation Service

Michael J. Hinton
USDA, Soil Conservation Service

John E. Webb
USDA, Soil Conservation Service

The French Broad River, a part of the Tennessee River drainage basin, originates in Transylvania County, North Carolina. The Upper French Broad River watershed has a history of flooding dating from 1791. Average annual rainfall in the headwaters is 80 inches, the highest in the United States. Twelve major floods have occurred, with the most recent in 1964. Numerous smaller floods have occurred throughout the period. Flooding damages agricultural lands, roads, utilities, businesses, and residences. Flooding on the Upper French Broad River has also resulted in the loss of life.

Elevations in the watershed range from more than 6,000 feet to 2,100 feet. The headwaters of the main stream and tributaries account for most of the elevation differential. The French Broad River downstream of Rosman follows a meandering path through a broad floodplain. The gradient is typically less than most mountain rivers, averaging 3.5 feet per mile.

Approximately 85% of the watershed is forested. Most of the floodplain is cleared and is devoted to agricultural, commercial, industrial, and residential uses. The Town of Rosman, near the confluence of the East, West, North and Middle Forks of the French Broad River, has a population of approximately 500. The City of Brevard lies 21 miles downstream and has a population of approximately 11,500.

Tourism plays an important role in the local economy. Much of the tourism is related to outdoor recreation provided by the lakes, streams, rivers, mountains, and forests of the area. Transylvania County bills itself as the "Land of Waterfalls." Canoeing, rafting, and trout fishing are important recreational activities that take place on the streams and rivers of the watershed.

Average annual flood damages exceed $1 million on agricultural properties and over $300,000 on commercial, industrial, and residential property. Hydraulic and hydrologic studies indicate that over 100 homes, four commercial buildings, and one church would be flooded above the first floor level by a 100-year storm.

Local residents and government have sought assistance to reduce flood damages over the past 30 years. A number of structural plans have been developed, but none has been implemented. A draft work plan was developed in 1963 through Public Law 83-566 by local sponsors, assisted by the Soil Conservation Service. The plan called for land treatment and a number of floodwater-retarding structures. The plan was not approved for installation.

In 1965, local leadership accepted a proposal developed by the Tennessee Valley Authority which would have resulted in the installation of five dams. In 1970, local leaders adopted a resolution supporting an alternative plan developed by TVA. Neither of the TVA proposals was implemented.

In 1988, SCS completed a floodplain management study which identified several flood control alternatives, and in 1990 formally began the P.L. 566 planning process to develop a watershed plan/environmental assessment.

Throughout the planning process, interagency and public involvement was encouraged. In January 1991, the sponsors, with assistance from SCS, conducted an interagency scoping meeting. Potential floodwater-retarding structure sites were visited, as well as areas of the floodplain that had experienced repeated flood damage. Most agency comments expressed concerns about the environmental impacts associated with the construction and operation of floodwater-retarding structures. Impacts to trout waters, loss of aquatic habitat, loss of riparian terrestrial wildlife habitat, potential impacts to threatened and endangered species, and impacts to archaeological and historic resources were primary concerns. Non-agency personnel representing local environmental interest groups were also invited to and attended the scoping meeting.

A public meeting was also conducted in January 1991. The sponsors and SCS personnel discussed the alternatives being considered, and for the benefit of the public showed a video featuring aerial photography and simulated views of the potential floodwater-retarding structures. It was stressed that structures would be only one of the measures considered. Channel improvement, dikes, nonstructural measures, and various combinations would also be evaluated. The public was urged to give both oral and written comments on potential flood prevention measures. A wide variety of comments was received, including some opposed to any flood control measures, some opposed to structural measures, some favoring any means to reduce flood damages, and some suggesting development of additional alternatives. There were also concerns about the loss of stream-based recreation, such as canoeing, rafting, and trout fishing that could be associated with some measures.

In January 1992, the sponsors and SCS held another public meeting to update citizens on the planning process and to discuss both structural and nonstructural measures being considered. Again, a wide range of concerns was expressed. Most concerns were related to potential impacts of floodwater-retarding structures.

In April of 1992, the sponsors and SCS conducted a tour of a nearby operational P.L. 566 watershed project so that local government leaders, local press, and citizens representing a coalition of environmental groups could see several floodwater-retarding structures of varying age and size. The sponsors of the operational project discussed their experiences and answered many questions.

A third public meeting was held in February 1993 to present 12 alternatives that had been evaluated by the SCS planning staff. Only two of the alternatives proved to be cost effective. The nonstructural alternative and the nonstructural with one "dry" dam alternative had positive benefit-to-cost ratios. The structural alternatives that had any significant effect on flooding had less than a 0.75:1.0 benefit-to-cost ratio. The sponsors, with input from the public, chose to pursue the nonstructural plan.

In order to calculate flood damages, over 323 individual properties were surveyed to establish ground level and first floor elevations. They were divided into groups based on the depth of first-floor flooding from the 100-year storm. Groups were: (1) less than 1 foot; (2) 1 to 3 feet; and (3) more than 3 feet. The depth of flooding at the natural ground elevation surrounding the building was determined to evaluate the potential of using floodwalls or levees, and to evaluate the threat of loss of life. A number of road and bridge crossings were also surveyed.

Cost estimates for floodproofing measures were based on a number of factors, including site location; flood depth, velocity, and duration; building foundation type; and building construction. Data from the U.S. Army Corps of Engineers and the Federal Emergency Management Agency were also used to develop cost estimates. Costs of floodproofing were compared to the market value of individual properties and average annual costs for the project were compared to the average annual benefits. Approximately 70 properties will be eligible for floodproofing at an estimated total cost of $618,000. The benefit-to-cost ratio is estimated at 1.8:1.

The existing flood warning system, Integrated Flood Observing and Warning System (IFLOWS), provides adequate flood warning for residents. The system is scheduled for improvement by the addition of additional gauges in the watershed. The North Carolina Division of Emergency Management is in the process of upgrading the Emergency Management Plan for Transylvania County, which will address emergency response to flooding. Because the state has a long-range plan for improved flood warning, it was decided not to include a flood warning system as part of the P.L. 566 plan.

The nonstructural measures will be implemented on a voluntary basis. Measures will be installed through long-term contracts with the owner. The owner will make application through the sponsors, and the contract will be between the owner and the sponsors. The SCS will enter into a project agreement with the sponsors. The P.L. 566 share for the installation of nonstructural measures will be 75% of the total installation costs.

For measures such as elevating properties and others where SCS generally lacks expertise, the applicant will be required to obtain the services of a licensed architect/engineer to develop the plans and specifications. The applicant will submit them to SCS for review and approval. It will be the applicant's responsibility to be sure that the planned modifications meet applicable building codes, are consistent with the floodplain management requirements, and are structurally sound. The applicant will obtain the approval of the plans from local permitting officials. The SCS will check to be sure that they meet the requirements of the plan, such as being elevated above the level of the 100-year flood. The applicant will be responsible for inspecting the installation and assuring that the improvements are structurally sound. The sponsors will provide a certification to SCS that the measure has been implemented. SCS will limit inspection to that necessary to assure that the measure has been installed in accordance with the contract and the plan.

Besides the direct benefits associated with floodproofing, other data developed in the course of the study will also benefit the area. Road and bridge elevation and flood frequency information can be used by local planners to formulate emergency response plans and routes for emergency vehicles. Ground and building elevation information can be used by property owners to be more prepared and knowledgeable about what to expect in times of flooding.

Although the nonstructural plan does not address all of the concerns identified by the sponsors, it does address the damage to commercial and residential buildings and, most importantly, may reduce the threat to loss of life. The innovative approach used and the persistence of the sponsors and other local leaders will result in a plan to improve the quality of life of those affected by flooding in the Upper French Broad River Watershed.

CITY OF TALLAHASSEE STORMWATER MANAGEMENT PROGRAM

John W. Hood
City of Tallahassee Stormwater Management Division

Sam A. Amantia
City of Tallahassee Stormwater Management Division

Introduction

This paper describes the programs that the City of Tallahassee has implemented to manage the complex problems associated with stormwater management in the State of Florida. Tallahassee has implemented several comprehensive efforts to manage the water quantity and quality aspects of stormwater runoff within the city. These programs include the Stormwater Regulatory Program, Stormwater Planning Program, Capital Improvements Program, Surface Water Management Program, and Drainage System Maintenance Program. They are managed cooperatively among several departments within the city: the Stormwater Management Division, Streets and Drainage Division, and Growth Management Department. Funding for the implementation of these programs comes from the Tallahassee Stormwater Utility, permit review fees, and city taxes. The primary source of funding is the Tallahassee Stormwater Utility, which generates in excess of $7 million annually.

Stormwater Regulatory Program

Stormwater runoff within Tallahassee is regulated by the use of three devices: the Environmental Management Ordinance (EMO), the Concurrency Management System, and the Building and Construction Regulations. The Growth Management Department and the Stormwater Management Division are responsible for the enforcement of these regulations.

The EMO (City of Tallahassee, 1993a) is a comprehensive development ordinance that regulates new construction within the city. It includes requirements for rate and volume control, sedimentation and erosion control, wetland construction, floodplain construction, water quality treatment, and open space. Some of the pertinent stormwater regulations include the requirement that peak post-development discharges not exceed pre-development peaks for all durations up to and including the 25-year event, stormwater retention for the difference in peak and post-development volumes in closed basins, soil erosion and sediment control measures for all new development, restriction of development in undisturbed 100-year floodplains, and stormwater treatment measures in compliance with the Florida regulations. The open space requirements of the EMO specify that 25% of the site be landscaped (15% of an industrial site), and an additional 25% of the site be preserved in a natural condition.

The Concurrency Management System (City of Tallahassee, 1993b) is a program implemented within the city to assure that the capacity of public services such as traffic, water, sewer, public facilities, and stormwater are not exceeded when development occurs. To meet stormwater concurrency, it must be shown that the total post-development stream flows downstream of the development are less than the existing downstream capacity of the drainage system; or if an existing drainage problem exists downstream, that there is no increase in this problem. Capacity of streams is defined as bank full conditions. If the downstream drainage system capacity is inadequate, or if downstream drainage problems exist, the development must be designed such that the existing downstream deficiency is corrected or the known problem is not worsened. This analysis must be performed for the 25-year critical duration event. In order to assure that concurrency for a new development is satisfied, a detailed hydrologic and hydraulic model of the downstream drainage system is required for both pre- and post-development conditions. The Environmental Protection Agency's Stormwater Management Model is required for the analysis. If an applicant decides to restrict post-development flows to 2-year pre-development flows, then a concurrency analysis as described above is not required unless there is a downstream drainage problem.

The Flood Hazard Protection section of the Buildings and Construction Regulations (City of Tallahassee, no date) sets forth the minimum building requirements as required for city participation in the National Flood Insurance Program (NFIP). The regulations in this section generally follow the minimum requirements set forth in the NFIP regulations.

Stormwater Planning Program

The purpose of the city's stormwater planning program is to develop a comprehensive plan for the development of stormwater projects to address the existing and future stormwater needs within the city. The Stormwater Management Division is responsible for the development of the short- and long-term stormwater planning needs. To do this, the City is working on two major projects. These include the development of stormwater management plans for the major streams within the city, and the collection of stream and rainfall data throughout the region in order to better define and document the runoff characteristics of the drainage systems. A more detailed explanation of these two projects follows.

The City of Tallahassee, Leon County, and the Northwest Florida Water Management District have recently completed a five-year study of the four major basins that encompass the city. The *City of Tallahassee-Leon County Stormwater Management Plan* (Northwest Florida Management District, 1992) identified numerous problem areas related to flood damages, street flooding, and degraded water quality on the major watersheds that encompass the city. The problem areas were identified by the use of hydraulic, hydrologic, water quality, and economic computer models. These models were developed for the major streams in the four basins. The analysis was completed for approximately 65 miles of stream for a total drainage area of nearly 200 square miles. As a result of this analysis areas of flood damage, street flooding, and water quality problems were identified for the major streams. Approximately 45 structural and non-structural solutions were evaluated to provide both flood control and water quality enhancement. The alternatives included regional stormwater storage facilities, culvert enlargements, wetland restoration, lake preservation, and floodplain preservation. The recommended alternatives amounted to approximately $33 million in design and construction costs. The city is using the results of the plan to prioritize future capital improvement projects.

The city is developing detailed basin plans for many of the problem areas that were identified in the Stormwater Management Plan. These detailed plans will better isolate the problem areas and develop designs for the proposed improvements.

The second major stormwater planning project being implemented by the city of Tallahassee and Leon County is an aggressive monitoring program to develop long-term discharge and rainfall records. This work is being performed by the Northwest Florida Water Management District and was initiated under the Stormwater Management Plan. As part of this effort, 19 stream gages and 12 rainfall gages are located throughout the four basins. The city has an additional 14 stream and 5 rainfall gages being used for specific capital improvement projects. These gages are considered temporary and are relocated as the need arises for specific projects. The gage data collected by these two efforts are used to calibrate and verify the hydrologic and hydraulic models being developed for the detailed basin plans and the capital improvement projects, and to verify existing drainage problems.

Capital Improvement Program

The purpose of the Capital Improvement Program (CIP) is to reduce or eliminate life threatening and damaging flooding throughout Tallahassee. The CIP is implemented through the Stormwater Management Division (SMD).

Tallahassee's CIP has more than 10 stormwater projects in various stages of development, which equates to a design and construction cost of approximately $14 million. The five-year capital budget identifies an additional $25 million needed during the planning period. The highest priority projects from the Stormwater Management Plan are included in the five-year capital budget. Other sources of projects include citizens, city staff, city commissioners, and consultants. Using the various sources, SMD staff will prioritize and select projects for neighborhood, subdivision, and regional levels.

The process followed for the implementation of stormwater improvement projects has three phases; concept design, preliminary design, and final design and permitting. SMD begins projects by developing a conceptual design. The project team typically consists of city staff and consultants. During the concept design phase, the project team attempts to define the extent and location of the problems and then develops multiple solutions to the defined problems. With input from citizens, consultants, and staff a final solution is developed and recommended to the City Commission. A detailed basin plan has been developed at this stage and will be used in the preliminary engineering and final design phases. Preliminary engineering work, which is the next phase, involves further refinement and detailed engineering of the adopted conceptual design. Essentially, all engineering is completed during preliminary engineering. The project team (typically the consultant) provides the sizes, shapes, and sketches for all recommended facilities. They contact the permitting agencies and provide environmental assessments for sites where ponds or lakes are being proposed. The final phase of engineering is the preparation of final construction plans and permitting. Final plans are modified through an iterative permitting process that may take years to complete. Even as the permitting process changes the plans, it is the policy of the staff to inform the public of changes, thus additional community meetings are held to maintain the consensus that was forged in the early phases of the work.

Public involvement is a key part of successfully implementing a project in Tallahassee. To have a successful public process, citizens must be involved from the beginning when the problems are defined. At each step citizens express their views regarding the consultants' work and what the next step should be. The city staff incorporates public comments and ideas into the project solution. There typically is not total agreement among all interested parties with the solutions proposed by the staff, but all ideas are brought to the table during the community meetings. The staff presents its recommendations, along with community meeting summaries, to the City Commission. If there are major disagreements between the staff and residents, the issues will be presented to the City Commission, which will resolve the differences and finalize the direction of the project.

The city has recently completed several stormwater improvement projects: the John Knox Pond, Frenchtown Pond, and the Jim Lee Pond. They provide approximately 150 acre-feet of volume for the storage and treatment of stormwater runoff. The total cost of these facilities was approximately $4.8 million. Some projects in the development stage include the East Branch, Cline Chamberlin, Killearn Lakes, and Trimble Mission projects. They will incorporate various solutions, including regional stormwater detention facilities, stream channelization, bridge and culvert improvement, and home acquisitions.

Surface Water Management Program

The Surface Water Management Program is implemented through the city's Stormwater Management Division (SMD) and has two areas of responsibility: compliance monitoring and surface water body management. Compliance monitoring of surface water quality is a regulatory requirement of the state Department of Environmental Protection (FDEP) that may be required when significantly sized stormwater facilities are constructed. This monitoring is conducted for a specified period of time unless state water quality standards are exceeded. Monitoring may be extended if state water quality standards are violated. Monitoring has begun at three newly constructed facilities and the results will be reported to FDEP. Information obtained from monitoring will also be used to provide insight for future facility designs and for long-term planning of regional stormwater facilities in Tallahassee.

Vegetative monitoring is another aspect of compliance monitoring. When a pond is constructed, aquatic vegetation is planted to enhance water quality, support ecological diversity, and provide environmental aesthetics. Vegetative monitoring is conducted to insure that planted wetlands are successful and invasive species are held to a minimum.

Surface water body management entails the management of water bodies that were originally built or retrofitted for stormwater management. One example of this in Tallahassee is Lake Ella, a small urban lake (12 acres surface area) that was retrofitted to manage stormwater runoff. The pollutants that enter the lake at a high rate are trapped with the use of alum, which is injected in the stormwater runoff entering the lake. Monitoring also promotes good lake operations and management. The management objective is to achieve a balance between a clear pool of water (what the public believes is good water quality) and a healthy aquatic environment (necessary to support fish and some wildlife).

Drainage System Maintenance Program

The Streets and Drainage Division is responsible for the maintenance of stormwater facilities and drainage conveyance systems throughout the city. The drainage maintenance program is driven by routine inspections and requests generated from residents of the city. The city has recently implemented a program in which the major ditches and stormwater facilities are inspected at least twice a year and maintained on the average every two years. In addition to this, known problem areas are inspected after heavy rains. The stormwater facilities maintenance program involves retrofitting facilities to design conditions, slope stabilization, filter cleanup and reconstruction, and removal of accumulated silt. The drainage conveyance system maintenance program includes the removal of weed and brush overgrowth, fallen trees, excessive silt accumulation and other debris.

Conclusion

Through the implementation of these programs the quantity and quality of stormwater runoff are being addressed within the city of Tallahassee. These programs address stormwater needs for both existing and future conditions. The city will continue to develop and modify these programs as future needs require.

References

City of Tallahassee
1993a *Tallahassee Environmental Ordinance.* October.

City of Tallahassee
1993b *Concurrency Management System Policy and Procedures Manual Concurrency.* November.

City of Tallahassee
n.d. Building and Construction Regulations, Article IV, Flood Hazard Protection Inspection Regulations.

Northwest Florida Water Management District
1992 *City of Tallahassee - Leon County Stormwater Management Plan.* September.

THE MC DONALD CREEK FLOOD CONTROL PROJECT, ARLINGTON HEIGHTS, ILLINOIS: A MODEL COMMUNITY FLOOD MITIGATION PROJECT

Cleighton D. Smith and Farrukh Mazhar
Harza Environmental Services, Inc.

Dennis Bowe
Village of Arlington Heights, Illinois

Introduction

The McDonald Creek Flood Control Project is located in Arlington Heights, Illinois, a suburban community approximately 23 miles northwest of downtown Chicago. The project consists of the following components:

- Lake Arlington, a 50-acre recreational lake, which, when fully surcharged, provides 540 acre-feet of flood control storage (Figure 1). A 60-inch gravity outlet sewer provides drainage. Inflow is from two drop-inlet structures connecting the north and south branches of the creek to the lake. A 54-inch bypass sewer (100 cubic-feet-per-second capacity) connects the drop inlets to the original creek. The project also contains a grass-lined emergency spillway.

- 1.5 miles of upstream channel improvements, including channel widening, gabion lining, high-flow channels, and five culvert replacements (Figure 2).

Background

McDonald Creek is a tributary to the Des Plaines River. It drains about 6,800 acres of residential areas, commercial properties, and rapidly disappearing farmland. Since the late 1960s overbank flooding has been a problem along the creek. Like many urbanizing watersheds in this area, flooding seemed to worsen in the 1970s despite introduction of stormwater control ordinances in some of the communities in the watershed.

Several early flood control studies were made by Arlington Heights, U.S. Soil Conservation Service, Illinois Department of Transportation, Division of Water Resources, and the U.S. Army Corps of Engineers. In 1984, Stanley Consultants of Muscatine, Iowa, conducted a study of flood control alternatives that identified a 50-acre lake with 570 acre-feet of storage as the preferred alternative (Harza, 1987). Harza Environmental Services of Chicago, Illinois, was retained by the village of Arlington Heights in 1986 to proceed with preliminary and final design. The selected project included a 540-acre-feet reservoir. A gravity outlet was recommended over a pump station because of lower operation and maintenance costs. Ground breaking took place in September 1988. Construction was completed in the fall of 1990.

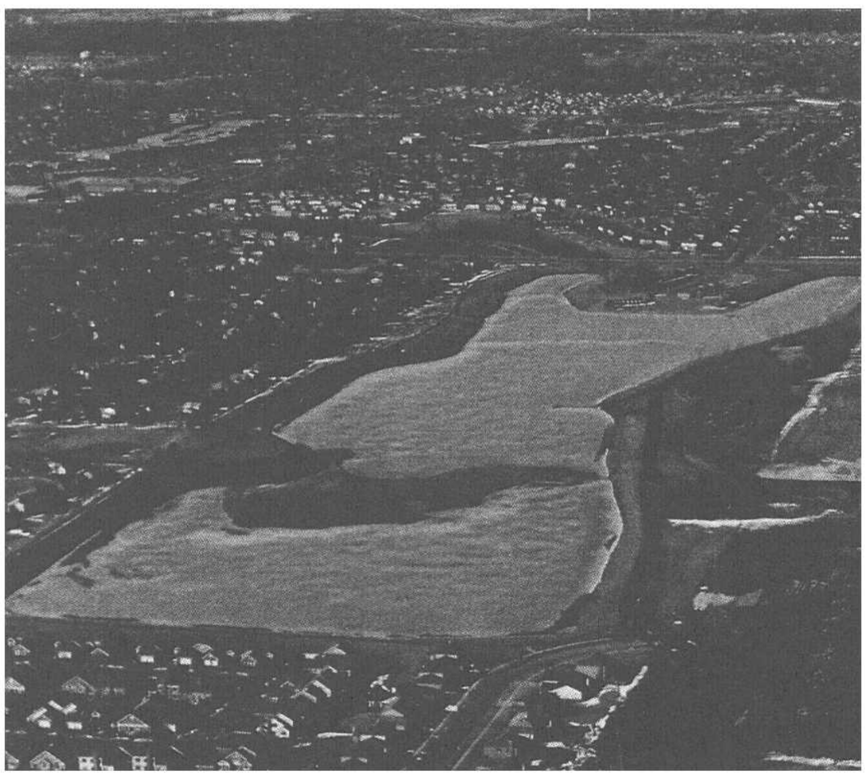

Figure 1. Lake Arlington.

Funding

A detailed benefit/cost analysis was undertaken to determine the dollar value of annualized savings provided by the project. The analysis involved estimating flood damages for every significant structure in the floodplain for a variety of storm events. Analyses were made of scenarios without and with project conditions. Annual flood damages were estimated to be reduced from $198,740 to $1,373 as a result of this project. The equivalent capital cost savings is $2.3 million.

These analyses provided the basis for funding negotiations with the state of Illinois, the Village of Prospect Heights, and the Metropolitan Water Reclamation District of Greater Chicago. These groups contributed a total of $1.25 million out of a total project cost of $13.75 million (ASCE, 1990). These economic analyses showed that reservoir storage of 370 acre-feet would benefit only Arlington Heights, but a 540 acre-feet project would also benefit other downstream communities (Harza, 1990).

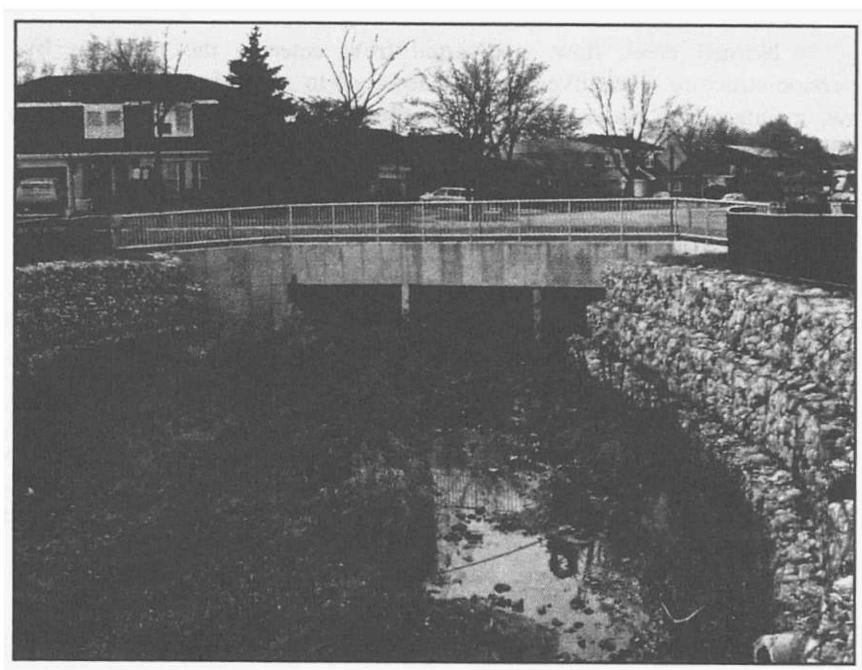

Figure 2. *A typical widened channel.*

Project Construction

Excess materials from the excavation of the reservoir were used for construction of final closure of a municipal sanitary landfill that has been converted to the municipal golf course. The cost savings of this innovative use of excavated fill were estimated to be $5.0 million.

A large number of trees (exact number unknown) were saved through careful selection of reservoir shape and channel widening alternatives. The high-flow channels were designed to save trees along banks of existing channels.

Drop Structures

Cast-in-place drop structures were selected as inlets for the reservoir. The structures are buried for aesthetic reasons and allow limited access for safety reasons. The size and shape of the drop structures promote energy dissipation of flow entering the reservoir.

Normal Flow Diversion

Normal creek flow is diverted from entering the reservoir by a diversion structure. This diversion was designed to maintain a minimum creek flow, maintain high water quality within the reservoir, and limit the sediment load to the reservoir.

Box Culvert Construction

Since construction of portions of the north and south branches of McDonald Creek would be in areas with limited right-of-way, concrete box culverts were specified for portions of the channel improvements. Precast, reinforced-concrete box culverts allowed for quick construction across a busy traffic route. The box culverts also provided adequate flow capacity in areas where right-of-way restrictions limit the use of trapezoidal channels and safety concerns preclude the use of deep concrete-lined rectangular channels. Project construction was completed by Plote, Inc., Elgin, Illinois (reservoir) and La Verde Construction Company, Inc., Wheeling, Illinois (channel improvements and outfall sewer).

Lake Arlington

The lake has proven to be a very beneficial community resource. Recreational uses include sailing, fishing, and paddle boating. A jogging/bicycle path was constructed around the perimeter of the reservoir. Wetland areas were created for bird and animal habitat. Real estate values of homes near the lake have increased. After construction was completed the lake and surrounding areas were turned over to the village's Park District.

Floodplain Remapping

Floodplain re-mapping was complicated by the following factors:

- Illinois adopted a new rainfall-frequency standard after the project was permitted;
- A myriad of prior modelling efforts existed (Stanley study, Flood Insurance Studies, permitting analyses, economic analysis);
- Obtaining Illinois approval prior to submittal to FEMA;
- Certification of with-project discharges;
- Floodplain/floodway analyses to meet Illinois definitions; and
- Outdated topographic mapping.

Approximately 50 homes in three communities were removed from the regulatory floodplain as a result of this project.

Conclusions

- Flood control projects can provide many recreational benefits.
- Quantifying benefits can be helpful in obtaining financing assistance.
- The planning process must involve federal, state, and local agencies.
- Previous studies provide valuable insight into project development.
- Innovation in project layout can save trees.
- Innovative use of excavated material can cut construction costs.
- Floodplain remapping of a major flood control project in Illinois involves considerable effort.

References

ASCE Illinois Section Newsletter
1990 "McDonald Creek Flood Control Project." February.

Harza Environmental Services, Inc.
1990 *The 1990 ISPE Outstanding Engineering Achievement, The McDonald Creek Flood Control Project, Arlington Heights, Illinois.*

Harza Environmental Services, Inc.
1987 "Memorandum of Preliminary Design, McDonald Creek Flood Control Project."