To the Graduate Council:

I am submitting herewith a thesis written by Alice Elaine Ogg entitled "Harrill Heights: A Case Study in Problem Solving." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Planning.

George E. Bowen, Major Professor

We have read this thesis and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

HARRILL HEIGHTS: A CASE STUDY IN PROBLEM SOLVING

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

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August 1982

3063034

ABSTRACT

The topic of this study is the Harrill Heights subdivision in the northeast section of Knoxville, Tennessee. The Harrill Heights subdivision was developed in the mid-1950's while it was an unincorporated area in Knox County. A sinkhole existed in the subdivision and under county regulations in the 1950's, development of single family residential homes was allowed within the sinkhole. Consequently, due to development of the area causing increased runoff, abnormally high rainfall in the 1960's, a finite capacity in the underground water system in which the sinkhole drained and the simple fact that the homes were located in a flood prone area, flooding repeatedly occurred in the sinkhole damaging houses and personal property.

The case study traces the political decision making process and the limited interdisciplinary problem solving process which the municipal government of Knoxville utilized in the resolution of the Harrill Heights flooding problem. The processes are diagnosed and the strengths and weaknesses are analyzed.

Using the example of the City of Knoxville's decision making process, an interdisciplinary problem solving model was developed. The purpose of the model is to present a problem solving process that may be applicable to problems faced in the future by other local governments attempting to solve urban flooding problems.

In this inquiry a breakdown of the costs incurred as a result of flooding problems in the Harrill Heights sinkhole is shown. These

costs ranged from public costs to the City of Knoxville for consultant fees and land acquisition costs, to private costs of former residents of the Harrill Heights sinkhole for flood insurance.

In conclusion, the case study examines whether or not the Harrill Heights flooding problems could have been avoided had current land use controls been in effect in 1955. The case study also focuses on whether current regulations in Knoxville are preventing flooding problems similar to Harrill Heights from occurring in the future. Opinions of former and current public officials are used as professional opinions on the effectiveness of these regulations. In addition, specific examples of recent development are cited which demonstrate the effectiveness of current regulations in preventing future flooding problems.

Federal mandates since the mid-1960's have been aimed at an integrated system of land use regulations and engineering practices to control flooding. The study demonstrates how land use tools, in this instance land acquisition, saved taxpayers of the City of Knoxville money by solving the Harrill Heights flooding problems by means of acquiring homes in the sinkhole as opposed to a more costly means of constructing a storm sewer to drain the sinkhole.

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CHAPTER I

STUDY IDENTIFIED

Justification for an Inquiry into Flood Plain Management

In the last 15 years an increased public awareness about environmental concerns has resulted in passage by Congress of extensive legislation for environmental protection. A considerable amount of this legislation has dealt with flood prevention measures. Due to the requirements of federal legislation, flood plain management has become a rapidly growing field. Land use planners need to understand land use control tools in order to create and implement viable flood plain management policies. For this reason an inquiry into flood plain management is justified in that the study will be available to planners as a model to demonstrate how land use tools can solve an urban flooding problem.

An added and related justification is that planners need to understand the mechanics of flood plains due to the quantity of urban land which is designated as flood plains in the United States. "It is estimated that 16 percent of the Nation's urban area could be subjected to flooding by a 100 year flood. Over one-half of these identified flood plains are presently developed."[1]

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[1] James E. Goddard, An Evaluation of Urban Flood Plains, ASCE Urban Water Resources Research Program, Technical Memorandum No. 19 (New York: American Society of Civil Engineers, 1973), p. 2.

"Currently in the field of flood plain management, emphasis is shifting from the reliance on structural measures of flood control to an integrated program of engineering practices, natural solutions and land use regulations."[2] With a change from engineering means to land use controls comes a shift in the responsibility for regulation of flood plains. Therefore, the third justification for this inquiry is that land use planners should develop competency in flood plain management in order to assume their role as administrators of flood plain regulations.

Study Area

The area of interest for this study is a residential subdivision located in the watershed of First Creek, a tributary of the Tennessee River. The Tennessee River is formed at the confluence of the Holston and French Broad Rivers in Knox County, Tennessee (see Figure I-1). According to 1978 figures, Knox County occupies 528 square miles and has a population of 322,531, while the city of Knoxville, the county's principal community, measures 77.6 square miles with a population of 181,151. The Tennessee River meanders through the city of Knoxville and flows southwesterly through the county.

First Creek's watershed extends beyond the present city limits of Knoxville into northeastern Knox County. The drainage area of First Creek is approximately 22.1 square miles. Included in the watershed is

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[2]James M. Wright, Some Future Challenges in Flood Plain Management (Knoxville, Tennessee: Tennessee Valley Authority, Flood Plain Management Services, 1976), p. 1.

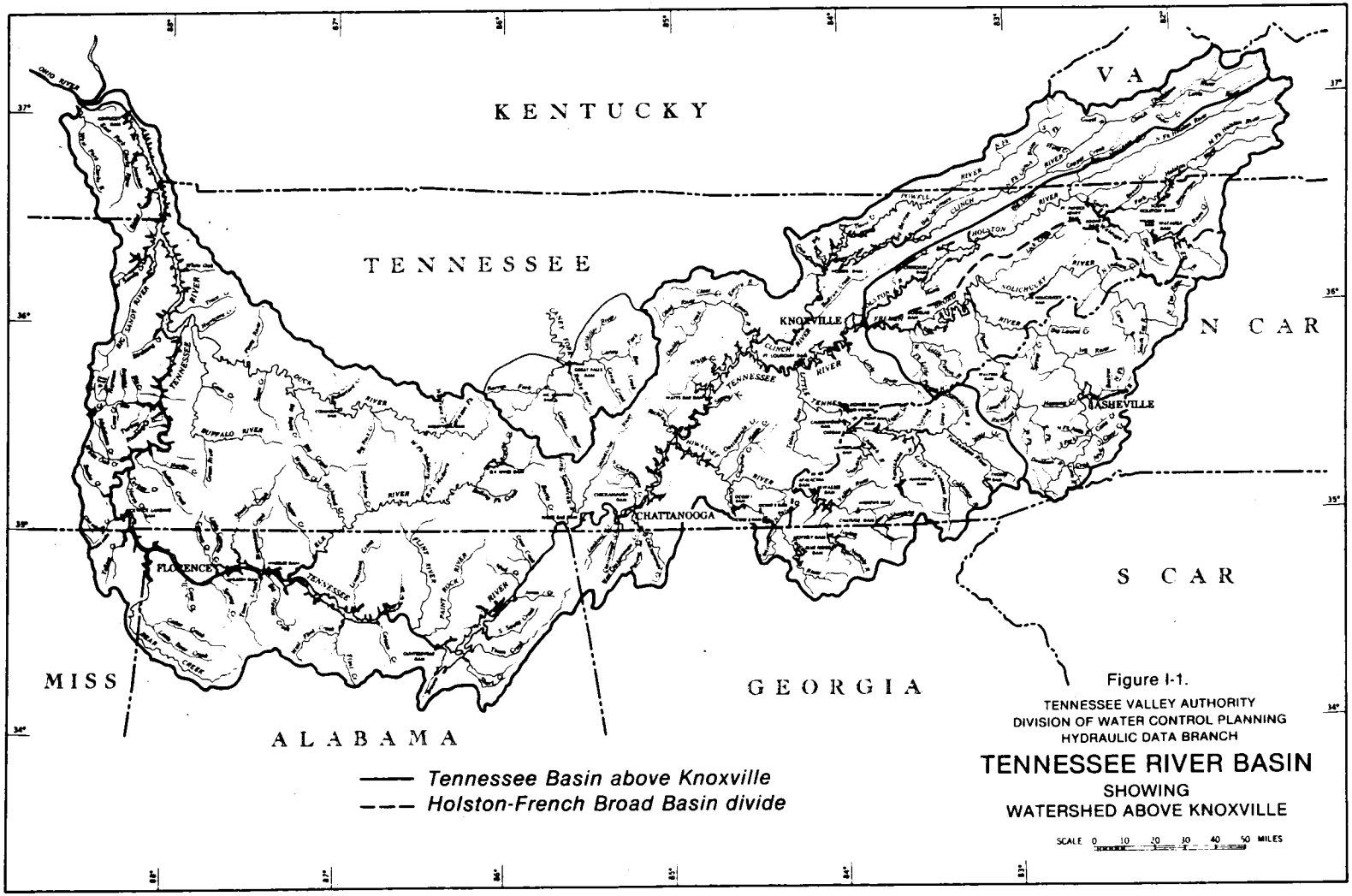


Figure I-1

Tennessee River Basin

White's Creek, one of First Creek's tributaries. The mouth of First Creek empties into the Tennessee River within the portion of the river running through the city (see Figure I-2).

Harrill Heights, situated in the Harrill Hills residential area, is a subdivision within the First Creek Watershed, located in the Fountain City sector of Knoxville. Harrill Heights is a single family residential subdivision similar to other residential subdivisions in Knoxville and Knox County except for its flooding problems.

From the initial development of Harrill Heights in 1955, to the acquisition of the land by the city of Knoxville in 1977, residents suffered numerous floods. Harrill Heights is unique in that it has no actual river or creek running through it to cause flooding. The recurring incidents of flooding resulted when storm water runoff backed up within a sinkhole. A sinkhole is defined as a pocket of terrain that has lowered in elevation due to a shift in the underlying subsurface rock. Figure I-3 depicts the lowering of land in the sinkhole at the Harrill Hills subdivision. Drainage in a sinkhole is either by seepage into soils or by openings at the bottom which allow water to drain into underground caverns and on to groundwater springs. Figure I-2 shows a waterway flowing into the Harrill Hills area. This waterway represents the drainage pattern of storm water runoff that empties into the sinkhole. In heavier rains this drainage swale would be known as a wet weather stream.

While the Harrill Heights sinkhole exhibits many of the problems commonly encountered when dealing with low areas that flood, it also

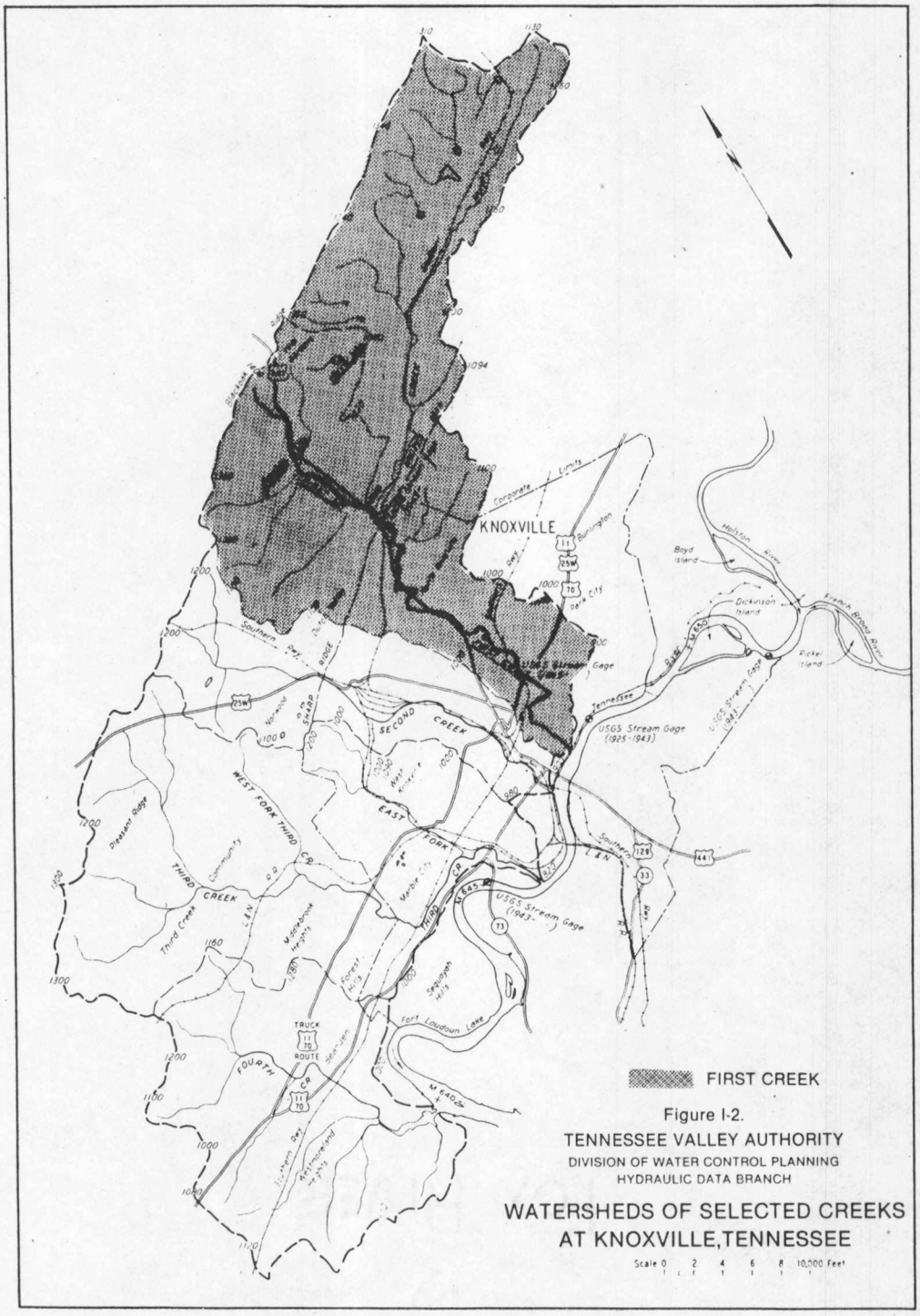
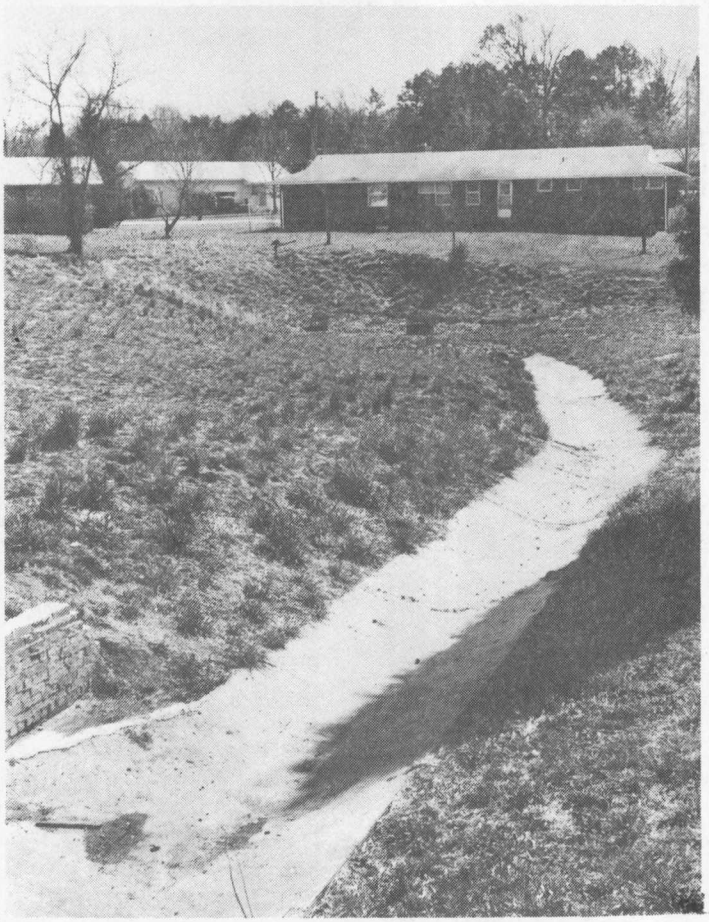


Figure I-2

Watersheds of Selected Creeks at Knoxville, Tennessee



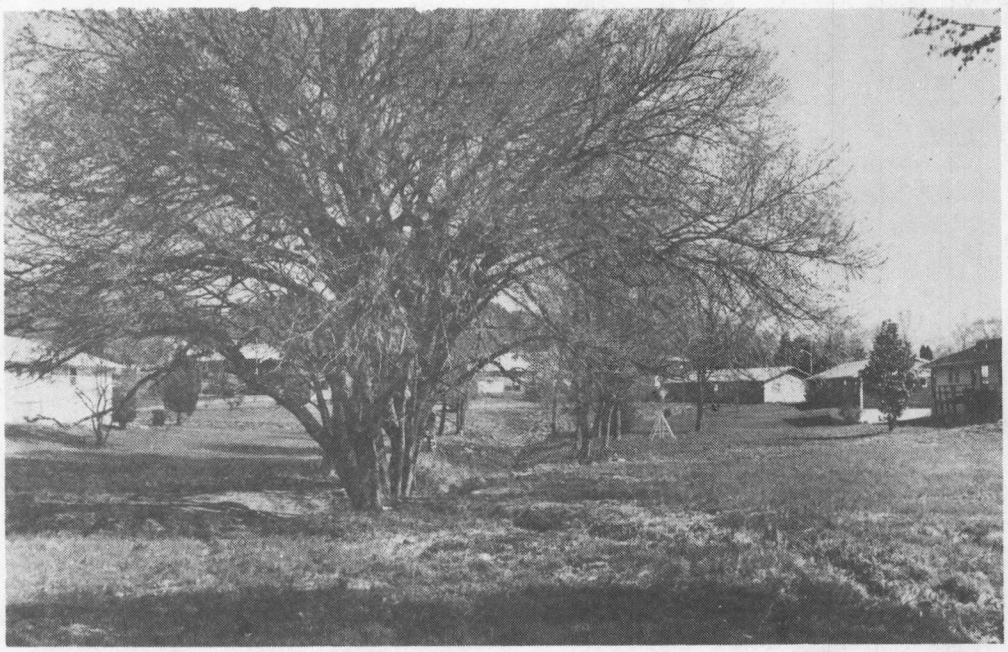


Figure I-3

Sinkhole Depression in Harrill Heights Subdivision

has unique characteristics which add to the complexity of the problem of flooding. Sinkholes, under certain soil and geological conditions will collect water, cause flooding, and drain poorly. Widely accepted definitions of flood plains, however, create technical complications when attempting to identify and define flood plains for flooding sinkholes. A flood plain is "a relatively flat area or low lands adjoining the channel of a riverway, lake, or other body of standing water, which has been or may be covered by flood water."[3] In the Harrill Heights case there exists no clearly defined, above ground, continuous water; therefore, there is technically no designated floodway. A designated floodway is "the channel of a stream and that portion of the adjoining flood plain designated by a regulatory agency to reasonably provide for the passage of flood flows."[4]

Objectives

In this inquiry three research questions concerning the effectiveness of land use controls in preventing flooding and the methods involved in a cooperative interdisciplinary approach in the solution of flooding problems will be investigated. The research questions are:

1. Could the flooding problem of Harrill Heights have been avoided had current land use controls been in effect at the time of development?

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[3]American Society of Civil Engineers, "Guidelines for the Development of Flood Plain Regulations," Journal of Hydraulics Division 89 (1962):108.

[4]Ibid., p. 107.

2. Can current land use controls prevent similar flooding problems from occurring in the future? What are some examples in which land use tools were effective or noneffective in preventing flooding problems?
3. How could the political decision making process and the interdisciplinary problem solving process used by the municipal government of Knoxville in solving the Harrill Heights flooding problem be used as a method to solve urban flooding problems encountered by other local governments?

Statement of the Problem

Three problem areas will be the subject of this inquiry. First, this is a case study which traces the history of flooding occurrences that plagued a residential subdivision. The development of the Harrill Heights subdivision will be studied in light of the land use controls that were in effect at the time of development in 1955. A geological description and hydrological explanation of the groundwater flow receiving the sinkhole drainage will be included. Technical reports by the Tennessee Valley Authority (TVA), Office of the City Engineer of Knoxville, and private consultants on various possible solutions to the flooding problem will also be reviewed.

The purpose of studying the history of development and flooding of Harrill Heights is so that other city and county governments, and water regulatory agencies (TVA, Corps of Engineers, other Regional River Basin Management Agencies), will be aware of and able to identify potential

flooding problems in sinkhole areas. The adoption of limited development policies in sinkholes by local governments could save taxpayers significant sums of money by preventing future flooding problems.

Secondly, this case study will follow the political decision making process and the interdisciplinary problem solving process which the municipal government of Knoxville used in solving the flooding problem of Harrill Heights. Various departments of city government were involved in the solution and the implementation of the resolution: the City Council, the Office of the Mayor, the Office of the City Engineer, the Knoxville-Knox County Metropolitan Planning Commission, the Waste Water Control Department, the Legal Department, the Finance Department, and the Service Department. The different roles each department played will be reviewed to offer an example of a process that was successful in solving a special type of flooding problem. The strengths and weaknesses of the process will be analyzed with explanations as to this method's eventual success.

Using the example of the city of Knoxville's decision making process in this instance, an interdisciplinary problem solving model will be developed that may be applicable to problems faced by other local governments attempting to solve urban flooding problems. After display and discussion of the model, the research question concerning the applicability of the model will be reviewed. Such discussion will satisfy Research Question 3.

In this inquiry a breakdown of the costs incurred as a result of flooding problems of the Harrill Heights sinkhole will be shown. A

variety of expenditures related to the Harrill Heights subdivision were a direct public cost to the city of Knoxville. These costs ranged from rescue services to the purchase of homes and property within the 100 year flooding boundary. Although an exact estimation of the total cost to the city of Knoxville cannot be determined, such as an exact estimation of man-hours used for various work tasks related to the problem, other cost figures that the flooding problem of Harrill Heights has imposed upon the city and its taxpayers can be documented. Of particular interest are the costs of the land acquisition and consulting services for postulated solutions to the problem.

Added to the above costs are federal taxes which support subsidies to the federal flood insurance program as well as private costs to the former residents of the Harrill Heights subdivision. Direct costs include the cost of leaving one's home during a flood and the cost of damages not covered by insurance payments. Although many of the private costs are unassessable, some are assessable; for example, the rates for homeowners for flood insurance.

In conclusion, this case study will examine the first two research questions. The first question deals with whether or not the Harrill Heights flooding problems could have been avoided had current land use controls been in effect in 1955. The discussion of this research question is based upon the opinions and observations of the public officials who were interviewed. The second question focuses on whether or not current land use controls in Knoxville will prevent flood problems similar to Harrill Heights from occurring in the future. Specific

examples of recent development will be cited. These examples will hopefully provide some indication of the effectiveness of current land use controls in the city.

Methodology

The methodology to be employed will consist of a case study in which the series of events concerning the Harrill Heights subdivision, its flooding problem, and its resolution will be documented. Two research techniques will be used in order to study the problem. The first technique will be a literature search involving the use of technical publications on flood plain management, and then more specifically, publications and data concerning the Harrill Heights subdivision and its flooding problems. The second source of information will be derived from personal interviews of past and present public officials. The officials and former officials listed in Table I-1 were chosen for interviews because, in one professional capacity or another, they were involved with the Harrill Heights subdivision, its problems and the resolution of those problems. These men can provide valuable data and insights into the many facets of the Harrill Heights issue. Their names and positions in the City government are listed in Table I-1.

Data for studying Harrill Heights was gathered from various sources. In order to study the development and flooding of Harrill Heights, a historical review was undertaken. The historical data used includes records of flooding dates and depths; a geological and hydrological review of the study area; an analysis of the approved plat of Harrill Heights; the minutes of the Board of County Commissioners when the

Table I-1

Names and Positions of Interviewed Officials

Name	Position
Mr. John Murrian	Assistant to the Mayor
Mr. Robert Bowers	Present City Engineer
Mr. Don Mauldin	Former City Engineer
Mr. Don Porter	Former Assistant City Engineer
Mr. John Kincaid	Waste Water Control Director
Mr. Milton Roberts	Councilman, Fourth District (District for Fountain City Area)
Mr. Ken Pruitt	Metropolitan Planning Commission Staff
Mr. Robin McNultrey	Former Planning Commission Staff Metropolitan Planning Commission
Mr. Mitch Cramer	Deputy Law Director
Mr. Lewis Walton	Former Assistant City Attorney
Mr. F. E. Kimball	Floodplain Management Specialist Tennessee Valley Authority

plat was approved; a historical neighborhood analysis; and a review of the land use controls (zoning ordinances, subdivision regulations, and building codes) which were in effect at the time of development and how they were applied to Harrill Heights. Also, various technical reports retained by the city which were written by TVA, Office of the City Engineer, the Metropolitan Planning Commission of Knoxville-Knox County, and private consultants will be examined in order to evaluate the feasibility of their proposed solutions.

The model formation is a result of the study of the political decision making process and the interdisciplinary problem solving process used by the city of Knoxville. The steps of this model are outlined for possible use by other local governments attempting to solve urban flooding problems.

Many of the public costs involved in solving the Harrill Heights flooding problem are on record in the city law and finance departments. The financial aspects of the land acquisition operation began with the request for a bond issuance by City Council to cover the full range of costs of improvements to the First Creek watershed. These costs include actual payment for property as well as relocation allowances paid to each household. Other public costs included the payment for consulting services related to the Harrill Heights flooding problem. These financial statistics are a matter of public records and give an important indication of the magnitude of the cost involved in rectifying a situation that should never have been allowed to occur.

The opinions and observations of past and present public officials are an indication of whether current land use controls, had they been in effect in the 1950's, could have prevented the Harrill Heights flooding problem. Specific examples of how current land use controls have prevented or limited development of a flood plain or flooding sinkhole are also cited.

Various definitions related to flood plain management are used throughout the study. These terms and their definitions have been placed in Appendix A.

Justification for an Inquiry into the Harrill Heights Flooding Problem

The Federal Government's role in flood plain management has given local governments direction and consolidated their efforts for a unified approach to the problem. Without federal mandates, a void existed in flood plain management, in which local governmental responses floundered leaving problems often unresolved. Initial assimilation of flood plain policies was not an easy task, given the mechanics of local government. The continual process of updating policies places increased demands on various professionals in local government. Public officials, that is planners, engineers, lawyers, economists, sociologists, geographers, and others, have acknowledged that interdisciplinary cooperation is needed to solve flooding problems. However, in many cases, after the recognition is made, implementation of policies is carried out in a fragmented and ad hoc manner.

One of the major justifications for this thesis inquiry is based on the need for a study that shows how an urban residential flooding problem was identified and resolved. The study of the decision making process used by public officials of Knoxville to solve the flooding problem of Harrill Heights is an example of a methodology that has been successful. This methodology may be applicable to other problems of a similar nature faced by other local governments.

During the literature search for this case study, various urban flood plain management studies and flooding resolution studies were discovered. However, there were no flood studies found that dealt with the resolution of an urban flooding problem that resulted from the residential development of a sinkhole. This inquiry proposes to analyze the uniqueness of Harrill Heights and document the case study of that development, its flooding problem, and the resolution of the problem. Since no other known studies have been completed on the residential development of a flooding sinkhole and the consequences of that development, the study topic merits inquiry.

CHAPTER II

INTRODUCTION TO FLOOD PLAIN MANAGEMENT

Urban flood plain management is concerned with the role of the flood plain as an integral part of the urban community and of the total riverine or coastal system.[5] Using the 100 year flood frequency variable, an estimated 16 percent of the urban areas in the United States could be subjected to flooding. Furthermore, greater than 50 percent of these areas are presently developed.[6]

Since the beginning of the agricultural period in history, man has regarded the flood plain as a most desirable piece of land to own. The tillable flat land, the fertile soil, and the proximity to moving water for transportation, for a power source or for a water supply, have caused the ownership of the flood plain to be held in high esteem. The same was true when the early settlers established the first cities in colonial America. The first large cities became centers for commerce and transportation and consequently grew tremendously in size over the years. Eventually, most of these communities paid the price of accessibility to the river and suffered the penalty of flooding. Many of these communities have been, and continue to be, under pressure for

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[5]United States Water Resources Council, A Unified National Program for Flood Plain Management (Washington, D.C.: United States Water Resources Council, 1976), p. II-1.

[6]Goddard, An Evaluation of Urban Flood Plains, p. 2.

land use changes which would permit more intensive uses. Much of this pressure results from the fact that, as these areas grow, accessible undeveloped lands in urban areas are becoming less and less abundant.[7]

On the other hand, government officials and urban residents are becoming increasingly aware of the value of an undeveloped urban flood plain.[8] Such an area may be designed in a manner to not only function as a water storage area during periods of flooding but also provide recreational amenities. Many cities, for example, Maryville, Tennessee, have enhanced the beauty of the city by providing a passive park along the banks of an urban river.

Development of Flood Plain Management

"The primary cause of flood losses is the encroachment of development on the flood plain."[9] Traditionally, flood losses have aroused public awareness only during or shortly after a flooding experience. The normal reaction of the public to a flood has been to control the flooding and to favor relief decisions based on expediency to offer aid to flood victims. However, in the recent past, public awareness has increased concerning flood plain development decisions and the resulting public cost of these decisions.[10]

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[7]Ibid., p. 3.

[8]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. II-2.

[9]Glenn R. Wall, Establishing an Engineering Basis for Flood Plain Regulations (Knoxville, Tennessee: Tennessee Valley Authority, 1969), p. 18.

[10]United States Water Resource Council, A Unified National Program for Flood Plain Management, p. II-2.

The philosophy of flood plain management has matured to recognize that the conditions at one flood plain location are interdependent with locations and events occurring elsewhere on the waterway and in the community in which the flood plain lies. The current philosophy of flood plain management requires a unified program of the "evaluation of alternative purposes, management strategies and intensities of utilization and is a program consistently sensitive to flood hazards and the need to work toward keeping flood losses at an acceptable level."[11] Management plans should not only be for the reduction of flood hazards but useful as a management guide for interrelated community actions concerning the waterway system, the flood plain, and the land area adjacent to the flood plain.[12]

Federal Flood Plain Management Directives

Federal legislation prior to 1966. Congress took its first step in flood control by the passage of the 1917 Flood Act following a major flood disaster on the Mississippi River that year.[13] Another major flood in 1927 on the Mississippi and Ohio Rivers caused massive destruction and loss of life.[14] Because of the nature of the federal government in the 1920's, the general tendency of the federal government was to leave responsibility for regulation of health and welfare matters almost entirely to state government.

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[11] Ibid., p. II-4. [12] Ibid. [13] Ibid., p. V-1.

[14] The World Book Encyclopedia, 1975 ed., s.v. "Floods."

By the time of the next major floods of the Mississippi and Ohio Rivers in 1936 and 1937, the federal government had broadened its administrative roles as a result of the New Deal programs passed by the Congress during Roosevelt's presidency.[15] In the 1930's "Flood Control Acts" delegated responsibility to the Corps of Engineers for construction of flood control works. These "Flood Control Acts" were expanded to include hurricane flooding as well. In addition to their role as builders of flood control works, the Corps was required to provide flood plain information services to the public.[16]

The most massive federal response to flood control was created in 1933 when Congress passed legislation creating the Tennessee Valley Authority (TVA). TVA was to be a "regional resource development agency, whose duties included flood control through the construction of dams and reservoirs."[17] TVA harnessed the Tennessee River, the largest tributary of the Ohio River, by eventually constructing 51 dams which converted the river into a virtual chain of lakes.[18]

Three years later the Flood Control Act of 1936 instituted a five-year program which called for the construction and maintenance of

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[15]William Manchester, The Glory and the Dream, A Narrative History of America, 1932-1972 (Boston, Massachusetts: Little, Brown and Company), 1:95,117.

[16]United States Water Resource Council, A Unified National Program for Flood Plain Management, p. V-1.

[17]Ibid.

[18]The World Book Encyclopedia, 1975 ed., s.v. "Floods."

reservoirs, levees and flood walls along the Mississippi River.[19] Later in the 1930's Congress expanded the authority of the Bureau of Reclamation and mandated additional construction of reservoirs for flood control.[20]

During the 1940's, Congress authorized the Department of Agriculture to construct eleven projects for flood control. In the 1950's, a nationwide program was authorized for upstream watershed projects.[21] In 1952, TVA created a program to assist government in flood plain management. The program relied on TVA's extensive flood information, the state government's planning assistance, and the local government's administrative powers.[22]

The 1960 Flood Control Act authorized the Corp of Engineers to provide states and localities with assistance in the regulation of flood plain lands. This informational assistance predominately advocated the use of engineering structures such as dams and levees to modify floods.[23]

Federal directives in 1966 and thereafter. The Presidential Task Force on Federal Flood Control Policy in 1966 listed their recommendations

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[19]Ibid.

[20]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. V-1.

[21]Ibid.

[22]John W. Weathers, ASCE, TVA's Experience in Flood Plain Management (Knoxville, Tennessee: Tennessee Valley Authority, Division of Water Control Planning, 1972), p. 5.

[23]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. V-2.

for flood control policy in House Document 464, A Unified National Program for Managing Flood Losses.[24] This document, and the associated Executive Order 11296, issued along with the Task Force Report, directed federal agencies on how to evaluate potential flood hazards (1) before there was any funding for construction of new buildings, (2) for the purchase of new land, or (3) for the disposal of land already owned by the federal government. The Task Force Report recommended the need for new planning attitudes to deal with the complexities of regulating the flood plain. It also supported a unified approach for flood plain management but failed to describe such a framework in the report.[25]

Implementation of some of the Task Force's recommendations have been achieved. These implementation programs are stated in the following quotations.

> A direct response to several recommendations is found in the National Flood Insurance Act of 1969 (P.L. 90-448). The National Flood Insurance Program applies to coastal and riverine flood plains and consists of two phases; emergency and regular programs. In the emergency program, rates are subsidized and actuarial for residents in those communities which enact and enforce flood plain management and development measures consistent with program regulations.[26]

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[24]Communication from the President of the United States transmitting a Report by the Task Force on Federal Flood Control Policy, A Unified National Program for Managing Flood Losses, House Document #465, 89th Congress, 2nd session (Washington, D.C.: U.S. Government Printing Office, August 10, 1966), p. 1.

[25]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. V-2.

[26]Ibid.

> In Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234), the Act requires the purchase of flood insurance in communities where such insurance is available in connection with any form of financial assistance for acquisition or construction located in identified special flood hazard areas. . . . Financial assistance is broadly defined as any form of loan, grant, guaranty, insurance, payment, rebate, subsidy, disaster assistance loan or grant of any form of direct or indirect Federal assistance other than general or special revenue sharing or formula grants made to States. The construction referred to in this section is essentially confined to walled and roofed buildings affixed to a permanent site, including mobile homes. Communities identified by the Secretary of Housing and Urban Development as flood prone communities have a one-year period in which to enroll in the National Flood Insurance Program or thereafter be denied both Federal financial assistance for acquisition or construction purposes and federally related financing by private lending institutions in identified flood hazard areas. Although implementation of the National Flood Insurance Act and related legislations is in the early stage, it is apparent that the rate of progress in defining flood prone areas and risk zones for the 22,000 potentially eligible communities is crucial to program implementation.[27]

In 1974, Congress passed the Water Resource Development Act (P.L. 93-251). This legislation provided "guiding principles, standards, and procedures for Federal participation in preparation of comprehensive plans and for formulation and evaluation of Federal and federally assisted water and related land resources, programs, projects and activities.[28] Application of these principles and standards was a step toward consistent and critical evaluations of flood plain management measures. The act included an evaluation process for proposals for costly public works investments as dams and levees.[29]

In the National Flood Insurance Act of 1968 (P.L. 90-448), Section 1302, "Congress enacted legislation providing new tools to cope with

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[27]Ibid., p. V-6. [28]Ibid., p. V-8. [29]Ibid., p. V-9.

flood risk and called for 'A Unified National Program for Flood Plain Management.'"[30] Predicated on this legislation, the Water Resource Council in 1976 issued their report defining the unified approach:

1. Sets forth a conceptual framework for flood plain management,
2. Identifies available management strategies and tools for reducing flood losses to an acceptable level,
3. Assesses the implementation capability of existing Federal and State agencies and programs; and
4. Makes recommendations at the Federal and State level for achieving "A Unified National Program for Flood Plain Management."[31]

The conceptual framework is developed from and based on accepted, broad national objectives for water and related land resource planning. In dealing with management strategies and tools for flood loss reduction, three strategies are directed at modifying "susceptibility to flood damage, the impacts of flooding, and flooding itself. There are a wide variety of tools ranging from land acquisition, land use and development regulations, floodproofing and flood control works."[32] Implementation of a unified program first recognizes the initiating role of local government, but also focuses on the Federal and State regulatory and supportive roles. Recommendations are directed on how to get the conceptual framework accepted at all levels of government.[33]

The most recent policy related to flood plain management is Executive Order 11988, signed May 24, 1977, replacing Executive Order 11296, issued in 1966. The order requires federal agencies

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[30] Ibid., p. I-1.

[31] Ibid.

[32] Ibid.

[33] Ibid.

"to avoid to the extent possible, the long-term and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid the direct or indirect support of flood plain development wherever there is a practicable alternative."[34] Executive Order (E.O.) 11988 also mandates implementation of the conceptual framework and recommendations of the U.S. Water Resources Council detailed in that body's document "A Unified National Program for Flood Plain Management."[35] The U.S. Water Resources Council has since published guidelines for the interpretation and implementation of E.O. 11988.

Various other recent acts of Congress have affected flood plain management. These include the National Environmental Policy Act (P.L. 91-190); the Coastal Zone Management Act (P.L. 92-583); the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500), and the Disaster Relief Act of 1974 (P.L. 93-288).[36]

A Change of Attitude in Flood Plain Management

Since the passage of the early Flood Control Acts of the 1930's the traditional strategy for modifying floods and flood loss reduction is one

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[34]United States Water Resources Council, Flood Plain Management Guidelines for Implementing Executive Order 11988 (Washington, D.C.: Federal Register, vol. 43, no. 29, Friday, February 10, 1978), p. 6032.

[35]Ibid.

[36]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. V-9-11.

of keeping water away from people by the use of engineering structures. Protection from the threat of flooding has been provided by levees, channel improvements and diversions, and the construction of flood control dams.[37] However, the "reliance on structural measures alone can produce a false sense of security. Engineering works merely lower the level of flooding for a specific design discharge which in turn reduces the flood damage potential."[38] Structural measures have even resulted in further encroachment into the flood plain by a misunderstanding of the limitations of structural devices.

The main reason that a flood plain management program based solely on engineering structures is undesirable is due to the large capital investments required for such projects. Funds have been provided by the Federal government but "these funds are not likely to be available to meet all situations for which flood modifying measures would be both effective and economically feasible."[39] Another expense to the Federal government is the cost of maintenance and operation of these facilities.

Currently, emphasis is shifting from reliance on structural measures to an integrated program of engineering practices and land use regulations.[40] Land use regulations are a tool of the police power of

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[37]Wall, Establishing an Engineering Basis for Flood Plain Regulations, p. 19.

[38]Ibid., p. 21.

[39]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. IV-11.

[40]Wright, Some Future Challenges in Flood Plain Management, p. 1.

government. Land use regulations can be applied effectively only by state and community actions. However, the Federal government can encourage state and local use of the police power by attaching land use performance specifications to various Federal assistance programs.[41] In this manner land use controls which are designed specifically for flood damage reduction, termed Flood Plain Regulations, are put into effect by the state and local communities wishing to qualify for various federal funds. The ordinances which result from this process attempt to mold flood plain development to lessen the damaging effects of floods.[42]

Flood plain boundaries follow the natural or man-made topographical contours, as opposed to man-made demarcation lines of property or streets. Boundaries can be established, but a technical basis is also needed in order to implement or enforce flood plain regulations. Information necessary for implementation and enforcement includes the frequency, duration, depth, and velocity of flood waters at specific return frequencies and the estimated effects of additional development in the flood plain on existing flood patterns.[43] "Regulations usually prohibit development in certain portions of flood plain and place tighter controls on development that is allowed in the remainder of the

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[41]United States Water Resources Council, A Unified National Program for Flood Plain Management, p. IV-3.

[42]U.S. Corps of Engineers, Guidelines for Reducing Flood Damages (Vicksburg, Mississippi: U.S. Corps of Engineers, 1976), p. 3.

[43]Wright, Some Future Challenges in Flood Plain Management, p. 2.

flood plain by provisions in zoning ordinances, subdivision regulations, building and health codes."[44]

To summarize the change in Federal mandates concerning flood plain management, Federal directives since 1966 have been aimed at integrated system of land use regulations and engineering practices. Such Federal measures have changed the philosophy of flood plain management from keeping water away from development to keeping development away from water.

Flood Plain Management in Tennessee

The efforts of regulatory and advisory agencies operating in Tennessee are discussed in this section to familiarize the reader with flood plain management programs in Tennessee. Most of the agencies discussed assisted in some capacity in the solution of the Harrill Heights problem. For example, these agencies aided by providing public records of pertinent flooding information, regulating federal flood insurance activities, and providing information on the applicability of land use tools to solve flooding problems.

The Tennessee state legislature addressed flood plain management when the planning enabling legislation was enacted, giving local governments increased zoning powers in 1955.[45] Specific legislation in

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[44]Ibid.

[45]Harold V. Miller, Flood Damage Prevention for Tennessee (Nashville, Tennessee: Tennessee State Planning Commission, 1960), p. 14.

Code Sections 13-401 (County Zoning Regulations—grant of zoning power) and 13-701 (Municipal Zoning Regulations—grant of zoning power) defines the authority of cities and counties to take cognizance of flood plains in devising and enforcing their zoning regulations. The grant of power states:

> Special districts or zones may be established in those areas deemed subject to seasonal or periodic flooding, and such regulations may be applied therein as will minimize danger to life and property, and as will secure to the citizens of Tennessee the eligibility for flood insurance under Public Law 1016 . . . . .[46]

The State Planning Office and three Federal agencies, the Tennessee Valley Authority (TVA), the U.S. Corps of Engineers, and the Department of Housing and Urban Development, have guided flood plain management in Tennessee.

Participation of TVA is predicated on the fact that Knoxville lies in the Tennessee River Valley. The Tennessee Valley Act of 1933 gave TVA "the responsibility for controlling destructive flood water in the Tennessee River Basin and also charged TVA with the broad task of planning and implementing programs for development of the resources of the Tennessee River Watershed."[47] By 1953, TVA had 20 years experience in flood control operations and had accumulated a vast amount of information about storms and flood levels within the Tennessee River Valley. In that same year, TVA initiated its flood plain management assistance program. This

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[46]Tennessee Code Annotated (79th General Assembly, chapter 6, Public Acts 1955), vol. 3A. 9-101 to 15-513, pp. 196, 312-13.

[47]Weathers, ASCE, TVA's Experience in Flood Plain Management, p. 2.

program incorporated factual flood information provided by TVA, planning assistance provided by state planning agencies, and the administration of land use controls through local governments.[48]

The Corps of Engineers has also aided in the development of flood plain management in the state of Tennessee and has two district offices in Tennessee. The Nashville District controls the Cumberland River Basin in both Tennessee and Kentucky. The Memphis District manages the Mississippi River in that region. The U.S. Corps of Engineers has followed the example of TVA's flood plain management services. The Flood Control Act of 1960 (P.L. 86-645) authorized the Corps of Engineers to make flood studies and to report them to responsible state and local requesting agencies.[49]

The National Flood Insurance Program under the Department of Housing and Urban Development entered into flood plain management services with the passage of the National Flood Insurance Act of 1968 (P.L. 90-448). The National Flood Insurance Program (NFIP) is a vast project that identifies flood hazard areas throughout the country. Part of the identification process involves mapping flood hazard areas. Maps produced fall into two categories: flood hazard boundary maps and insurance rate maps.

In Tennessee, TVA and the Corps of Engineers have been under contract to the NFIP to furnish information on flood hazard areas. The finished

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[48]Ibid., p. 3.

[49]Miller, Flood Damage Prevention for Tennessee, pp. 52-53.

flood hazard boundary maps and insurance rates, however, are prepared by the NFIP.

Capitalizing on flood studies done by the Corps of Engineers and TVA, the Tennessee State Planning Office (TSPO), formerly known as the Tennessee State Planning Commission, began in 1957 to write local flood planning programs. These publications outlined flood damage prevention recommendations and advised specific zoning and subdivision controls for various communities throughout the state. TSPO supplemented the publications by assisting the local governments with flood plain management advice.

The 1960 statistics shown below illustrate the poor status of flood plain management at that time (Table II-1):

Table II-1

1960 Urban Flood Plain Statistics in Tennessee

Category	Number
Incorporated towns in the State	275
Towns with local flood problems	128
Towns for which flood data is available	39
Towns which have been implemented flood plain regulations based on TVA or Corp of Engineers flood studies	15

Source: Harold V. Miller, Flood Damage Prevention for Tennessee (Nashville, Tennessee: Tennessee State Planning Commission, 1960), p. 16.

The regional Tennessee State Planning Offices have continued this cooperative work with TVA and the Corps. Also, TSPO provides local assistance planning in flood plain regulations in order to prepare communities for entry into the National Flood Insurance Program.

By 1978, the facts reflected in the above 1960 statistics had greatly changed. Much of this change was due to a clause in the Flood Disaster Protection Act of 1973 (P.O. 93-234).

> Section 102(a) of this Act requires the purchase of flood insurance by owners of identified flood hazard lands in communities where such insurance is available in connection with any form of Federal financial assistance for acquisition or construction located in identified special flood hazard area.[50]

This requirement has resulted in adoption of flood plain management practices by local governments. Communities, in order to be allotted federally related loans, must have flood insurance and, in order to receive flood insurance, communities must make certain commitments. These requirements are further defined in the following quotation.

> When flooding data are provided and risk zones identified on a flood insurance rate map, the community is required to enact floodway boundaries as encroachment limits, to restrict effectively any development in the floodway, and to regulate carefully development in special high hazard areas for which base flood elevations are provided.[51]

In essence, a community must adopt flood plain regulations to be accepted into the program.

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[50] United States Water Resources Council, A Unified National Program for Flood Plain Management, p. V-6.

[51] Ibid., p. V-7.

Therefore, due to the cooperative action of TVA, the Corps of Engineers, the National Flood Insurance Program and the Tennessee State Planning Office, conditions regarding flood damage prevention are much different now than they were in 1960. As of 1978, there were 164 incorporated communities in Tennessee that were in either the emergency or regular National Flood Insurance Program, as compared to the 1960 statistics which listed merely 39 towns as having flood data available to them. In addition, there were 123 incorporated communities which have had hazardous flood areas identified by the insurance program, but as of 1978 had not joined the program. In summary, 164 communities are actively regulating their flood plains at this time and, because of Federal requirements, eventually more of the other 123 communities will come into the program.[52]

Flood Plain Management in Knoxville, Tennessee

Harrill Heights, the subject of this inquiry, is a residential subdivision within the city limits of Knoxville, Tennessee. Before the subdivision was annexed into the city in 1962, it was an unincorporated section of Knox County. This section will trace the development of flood plain regulations in these jurisdictions.

In 1958, TVA published a flood studies report entitled Floods on the Tennessee River in the Vicinity of Knoxville, Tennessee: First Creek,

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[52]U.S. Department of Housing and Urban Development and the Federal Insurance Administration, Communities Participating in the National Flood Insurance Program (Washington, D.C.: 1978), pp. 286-89, 429-31.

Second Creek, and Fourth Creek. As a result of these flood studies, flooding and flood fringe areas were established and adopted by the city in 1963.

The Metropolitan Planning Commission of Knoxville and Knox County revised the subdivision regulations of the city and county in 1966. These regulations were the first to require individual lot drainage:

> Lot drainage and topography shall meet the following requirements:
> 1. Lots shall contain building sites which are well drained.
> 2. Lots shall not be excessively steep or contain excessive amounts of surface or near-surface rock.
> 3. Building sites, and sites for drain fields shall not be traversed by water and/or drainage courses and ditches.
> 4. Fill dirt shall not be placed upon sites which will be used for drain fields.[53]

Also in the revisions was a section on standards for the design of storm drainage systems. The regulations required submittal of storm drainage plans to include "accurate existing and finished contours, indications of existing and proposed water courses, the system of open channels, pipes, culverts, drains, inlets, catchbasins, and similar facilities designed to handle stormwater in times of rainstorms."[54] The standards also require the submittal of the design calculations of the storm drainage systems. Previous mention of storm drainage in earlier subdivision regulations only alluded to road construction and

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[53]Metropolitan Planning Commission of Knoxville, Knox County, Tennessee, Minimum Regulations for the Subdivision and Development of Land (Knoxville, Tennessee: Metropolitan Planning Commission, 1966), pp. 6-7.

[54]Ibid., pp. 6-9.

the provision of engineering specifications for open ditches, pipes, culverts, etc., that would provide for the proper drainage of all surface water within the subdivision tract. This latter regulation did not refer to individual lot drainage.

The 1966 subdivision regulations included a new policy of limited development in sinkholes and other low places.

> Property containing sinkholes and other low areas may be subdivided; however, the subdivision shall be designed so as to yield lots with building sites and subsurface sewage disposal facilities which shall be free of the danger of flooding.[55]

The final standard under the new storm drainage section deals with flooding of subdivisions located along watercourses:

> Land within any Floodway District shall not be platted for residential occupancy or other building site and shall not be raised by fill. Other land subject to flood may be platted for use only if filled to such a height as will secure a flood-free site based on data submitted by the subdivider and prepared by competent engineers, provided such use does not endanger health, life, or property, or restrict the flow of water or increase flood heights.[56]

Knoxville entered the emergency program of the National Flood Insurance Program in 1970, and entered the regular program in 1971. Federal legislation has made certain revisions of the original mandatory requirements. In order to comply with the new requirements, City Council adopted the necessary ordinances. The first was a stormwater retention ordinance. This ordinance required that contractors build stormwater retention ponds on newly subdivided land to insure proper drainage of

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[55] Ibid.

[56] Ibid.

stormwater into holding ponds that slowly release water to flow downstream. Stormwater peak flows can then be minimized and water movement towards the downstream area can be at a more even flow. The second ordinance adopted by City Council was the flood damage prevention ordinance. This ordinance states general standards for flood hazard reduction. For example:

1. All new construction and substantial improvements shall be constructed with materials and utility equipment that is resistant to flood damage, and
2. All or new replacement water systems must be designed to eliminate infiltration of flood waters into the system.

Adoption of these two ordinances by City Council has allowed Knoxville to remain eligible for flood insurance.

CHAPTER III

A HISTORY OF HARRILL HEIGHTS

The purpose of this chapter is to document the sequence of events that led to a decision by the Mayor of Knoxville to use land acquisition to solve the flooding problems at the Harrill Heights sinkhole. As stated in the introductory chapter, Harrill Heights is a residential subdivision within the First Creek watershed, a subbasin of the Tennessee River drainage basin. By jurisdictional boundaries, the Harrill Heights subdivision was located in the Fountain City section of Knoxville, Tennessee. Harrill Heights was developed in 1955. At the time of final plat approval for Harrill Heights, Fountain City was an unincorporated village in Knox County, Tennessee.

Planning Efforts in Knoxville-Knox County Prior to the Mid-1960's

Planning efforts by citizens' committees and the local governments of Knoxville and Knox County during the 1950's provided a framework for development of the Harrill Heights subdivision. Analysis of those planning efforts furnishes an insight into the opportunities and constraints of the existing development regulations in effect at that time. Also, a study of the planning efforts provides an indication of the scope and sophistication of the planning process and its implementation procedures for that time period. This section describes how the development of the Harrill Heights subdivision fit into the

scheme of comprehensive planning for Knoxville-Knox County during the mid-1950's and early 1960's.

The Tennessee Code, Chapter 43 of the Public Acts, was adopted by the legislature in 1935. Chapter 43 was the enabling act which permitted and defined regional and municipal planning commissions. The act empowered the planning commissions to:

1. Make and adopt an official general plan for the physical development of the area including location, character and extent of streets, bridges, viaducts, parks, waterways, playgrounds, airports and other public ways;
2. Location of public utilities and terminals;
3. Handle changes of land use;
4. Formulate a zoning plan for the regulation of the height, area, bulk, location, and use of private and public structures and premises;
5. Plan the extent and location of community centers and neighborhood units;
6. Replan blighted and slum areas;
7. Make reports and recommendations to public officials and agencies; and
8. Have the powers as may be necessary to enable it to perform its purposes and promote municipal planning.[57]

The Knox County Planning Commission was created in 1940 by the Knox County Board of County Commissioners. The Planning Commission was composed of four citizen members, three members of the County Court, plus the Highway Commissioner and the Chairman of the City Planning Commission.[58] Based on the powers granted to the Planning Commission

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[57]Tennessee Code Annotated (Chapter 43, Public Acts, 1935).

[58]Metropolitan Planning Commission of Knoxville-Knox County, Tennessee, "Unnamed Report on the History of the Metropolitan Planning Commission" (Knoxville, Tennessee: Metropolitan Planning Commission, undated), p. 1.

by Chapter 43 of the Public Acts of Tennessee, the Commission adopted its first zoning ordinances in 1941. These ordinances were general area and height zoning regulations. In 1945 the Board of County Commissioners adopted a set of subdivision regulations and the major road plan. There was an official adopted master plan in the 1940's; however, its date of adoption was unobtainable. The design of the Harrill Heights subdivision was subject to the regulations of these three ordinances.

During the 1940's and 1950's, growth in Knox County was concentrated in the northeast section in the Fountain City area which, at the time, was unincorporated. Within the five-year period between 1950-55, 56 new single family residential subdivisions, totaling 1,500 residential lots, were approved for development in the Fountain City area. Harrill Heights was one of these subdivisions (see Figure III-1).[59]

Even though Fountain City was unincorporated, there was a private utility district that provided both water and sewer service to the Fountain City area. Other necessary services, such as road maintenance and police protection were provided by Knox County. Fire protection and garbage collection were furnished by contract with private companies.[60]

Due to an accumulation of growth impacts in the Fountain City community, residents formed a committee, known as the Fountain City

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[59]Fountain City Study Group, Fountain City, Tennessee (Knoxville, Tennessee: Fountain City Study Group, 1955), p. 3.

[60]Ibid.

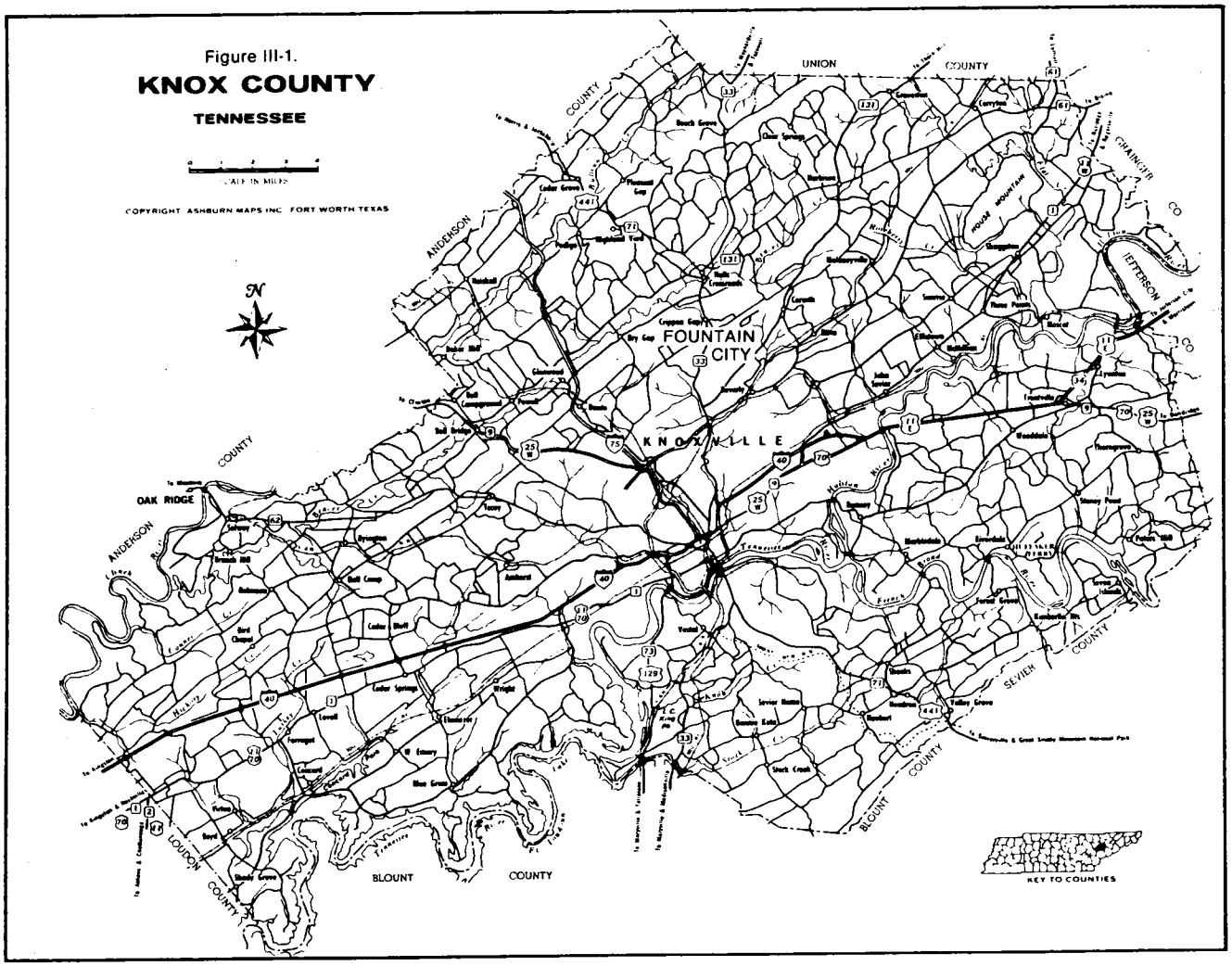


Figure III-1

Knox County, Tennessee

Study Group. The purpose of this committee was to analyze the issues involved in the incorporation of Fountain City into a separate municipality in Knox County, or to support annexation into the City of Knoxville. The study group considered such issues as: (1) the problems with the Fountain City Utility District, as its water and sewer treatment plants were reaching capacity and there were no plant capacity expansion plans; and (2) improvement and paving of the roadway system in their community. The County road plan was not a capital improvements plan of feasible transportation improvements, but a set of standards within the subidivision regulations that stated road construction specifications. The Fountain City Study Group published a report in 1955 addressing these issues. However, the committee failed to make a definite recommendation concerning the question of incorporation versus annexation, merely stating the facts on both sides of the question.[61]

The City of Knoxville completed an annexation study in the early 1960's. It identified areas of Knox County that were logical proposed extensions of the City's municipal boundaries. Fountain City was one of those areas.[62] The Knoxville City Council passed a motion annexing Fountain City in 1962.[63] Since that year, development or redevelopment

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[61] Ibid., p. 4.

[62] Metropolitan Planning Commission of Knoxville-Knox County, Tennessee, Program of the Metropolitan Planning Commission (Knoxville, Tennessee: Metropolitan Planning Commission, 1975), p. 2.

[63] Interview with Milton Roberts, former City Council Member, Fourth District, February 1979.

in the Harrill Heights subdivision was subject to all applicable regulations and codes of the City of Knoxville.

The planning efforts of the City of Knoxville are also of particular interest to the topic of this study. The City of Knoxville employed Harland Bartholomew and Associates to develop a general plan and a zoning ordinance for the city in the 1920's. However, lack of sufficient staff hindered the effective administration by the city of the plan and the zoning ordinance.[64]

Not until the 1940's was interest again shown by city officials in the planning of Knoxville. From that time on, the City Council began to take steps to begin organizing the growth of the city. The major street plan was revised from the original 1920's plan. From 1949-52, a new general plan was written and adopted by City Council. The planning director at the time terminated his employment with the city and planning efforts were minimal from then until 1956.[65]

The Metropolitan Planning Commission of Knoxville-Knox County was created by the State Planning Commission in 1956. By combining the two planning commissions of Knoxville and Knox County into one regional planning agency, the government officials of Knoxville-Knox County displayed a positive interest in the development of their city and

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[64]Metropolitan Planning Commission of Knoxville-Knox County, Tennessee, Program of the Metropolitan Planning Commission, p. 1.

[65]Metropolitan Planning Commission of Knoxville-Knox County, Tennessee, "Unnamed Report on the History of the Metropolitan Planning Commission," p. 1.

and county in an orderly and uniform manner. The separate planning commissions merged and the Metropolitan Planning Commission took over both commissions' responsibilities. Both Knoxville and Knox County appropriated funds for the purpose of hiring additional staff members to coordinate planning activities.[66]

Soon after consolidation, the Metropolitan Planning Commission (MPC) applied for financial assistance under the 701 program. The first 701 project involved the preparation of five studies:

1. Base Map Preparation
2. Land Use Survey
3. Zoning Standards for the Planning Region
4. Traffic and Circulation Study
5. Community Facilities and Services Study

These work tasks were completed in the early 1960's.[67]

The first 701 program generated the data to allow the MPC to assist the total community and its needs. The outcome of the first 701 program included an urban renewal project along First Creek, near the mouth of the Tennessee River, in downtown Knoxville. Also, other community facility and service improvements were a direct result of the identification of problem areas through the 701 studies.[68]

After the 701 second program was approved, a revised zoning ordinance was developed for the city and adopted by the Knoxville City

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[66] Ibid., p. 2.

[67] Metropolitan Planning Commission of Knoxville-Knox County, Tennessee, Program of the Metropolitan Planning Commission, p. 2.

[68] Ibid.

Council in 1963. The revised zoning ordinance included flood plain zoning districts. The city and county, in 1966, adopted revised subdivision regulations. These revised subdivision regulations included a regulation limiting development in sinkholes.[69] These flood plain management tools were discussed at length in Chapter II.

The effect of the MPC's actions were marginal with regard to the Harrill Heights subdivision, since the final plat was approved in 1955 prior to the consolidation of the two planning commissions. Housing construction continued until 1958, when the Harrill Heights subdivision was almost completely developed. The major benefits of the MPC's actions were several road improvements in the Fountain City area which alleviated some traffic congestion problems for Harrill Heights and other Fountain City residents.

An Analysis of Land Use Controls that Guided Growth in the Harrill Heights Subdivision

Zoning criteria. The Harrill Heights subdivision was developed in the mid-1950's. Unit Two was of primary interest to this study, since this was the section of the subdivision in which the sinkhole was located. There were ninety lots in Unit Two, on approximately 30 acres of land, or a density of three dwelling units per acre. The average lot size was 100 feet by 150 feet. Lots tended to be smaller in Unit One and neighboring subdivisions with densities closer to four dwelling

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[69] Ibid.

units per acre. Due to the configuration of the remaining tract comprising Unit Two, lots were designed larger. Unit Two is displayed in Figure III-2.[70]

The zoning of the Harrill Heights subdivision was Residence District "A." This zoning category allowed both single family dwellings and two family dwellings. Minimum lot size for the district was 5,000 square feet, and the minimum lot width was fifty feet. All lots in the Harrill Heights subdivision exceeded the minimum requirements of the zoning district.[71]

The Harrill Heights subdivision was adjacent to a much larger subdivision known as Harrill Hills. Harrill Hills was in the same zoning category, and was developed in the early 1950's, three to four years before the development of the Harrill Heights subdivision. The subdivision was located on the uplands in the watershed of the sinkhole, and, as such, was not subject to the flooding problems of Harrill Heights. Stormwater runoff from the Harrill Hills subdivision flowed by sheet flow and street swales toward the sinkhole.[72]

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[70]Office of the City Engineer of Knoxville, Tennessee, Final Plats of the Harrill Heights Subdivision, #35650, approved December 10, 1954.

[71]Knox County Planning Commission, A Zoning Plan for Knox County (Knoxville, Tennessee: Knox County Planning Commission, 1941), pp. 6-7.

[72]Donald L. Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," Final Report to the Mayor and City Council of Knoxville, Tennessee, 1974, p. 11.

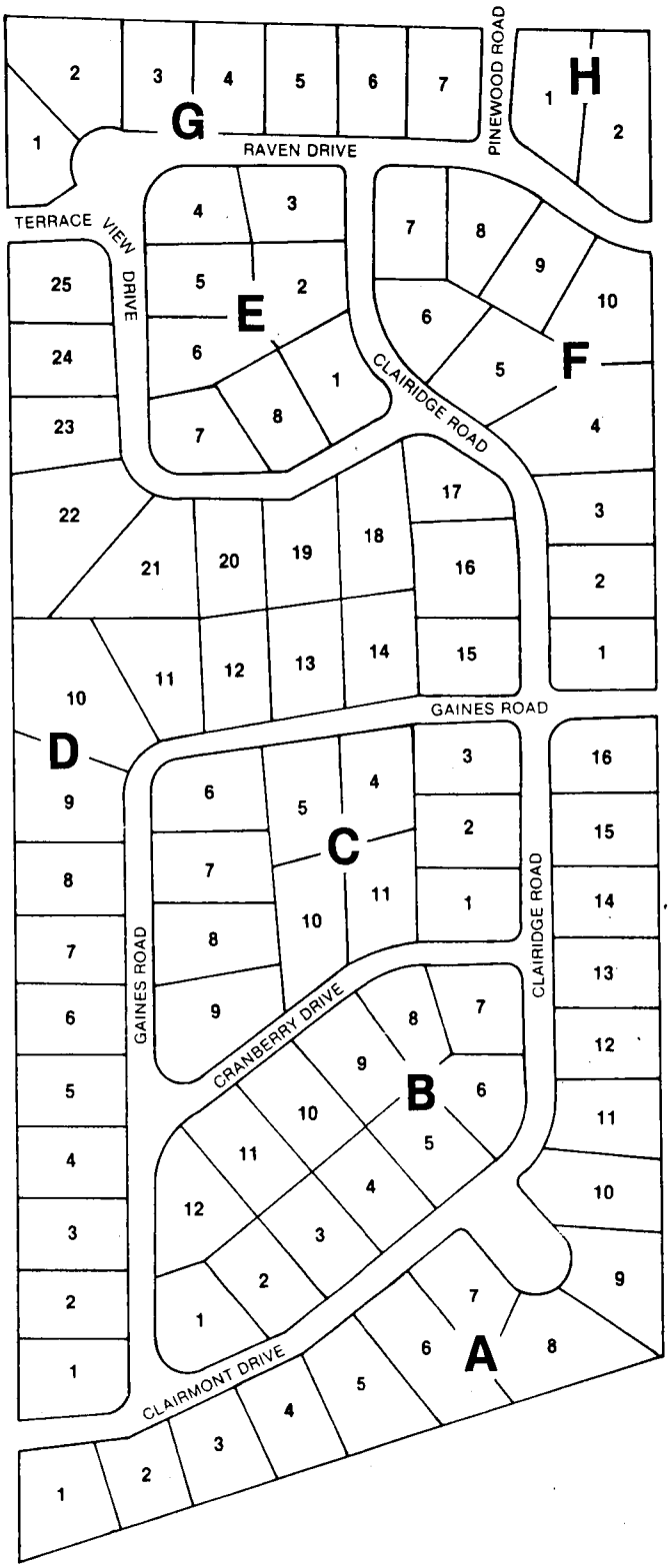


Figure III-2

Unit Two, Harrill Heights Subdivision

Master land use plan. The master plan for Knox County, at the time of development, included a general future land use map with generalized land use policies. Harrill Heights was located in a rapidly urbanizing area of residential growth. The Harrill Heights property was recommended for an agricultural use. This designation reflects the then current zoning on the property at the time of plan adoption as opposed to a recommended future land use.[73]

Subdivision regulations. The subdivision regulations guiding growth in 1955 were approved by the Knox County Board of County Commissioners in 1945. The subdivision regulations listed requirements for preliminary plat and the final plat. The importance of the subdivision regulations, including drainage and road improvements, merits detailed analysis.

A copy of the preliminary plat of the Harrill Heights subdivision was not obtainable. The preliminary plat was subject to the approval of the Knox County Planning Commission after county staff (Planning, Engineering, Highway Department, and Health Department) reviewed the project for compliance with the subdivision regulations.[74]

1. Preliminary plat requirements in subdivision regulations. The subdivision regulations required the following items on a preliminary plat:

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[73]Interview with Robin McNulty, Planning Director of the Metropolitan Planning Commission, Knoxville, Tennessee, October 1980.

[74]Knox County, Tennessee, Subdivision Standards, 1945, p. 9.

1. subdivision name, name of owners and consultants;
2. north point, graphic scale, location map;
3. the location of existing and platted property lines, roads, buildings, water courses, railroads, sewers, bridges, culverts, drainpipes, water mains, and any public utility easement on the adjoining land and the names of adjoining property owners of subdivisions;
4. name, locations, widths and other dimensions of proposed roads, alleys, easements, parks and other open spaces, reservations, lot lines, building lines and utilities;
5. preliminary sketch plans of proposed utility layouts, sewer, water and electric lines; feasible connections to existing and proposed utility systems should be displayed; (note: the regulations state that the Planning Commission shall review these sketches with the appropriate service agency);
6. profiles of all roads exhibiting natural and finished grades drawn to a scale of not more than one inch equals a hundred feet horizontal and one inch equals ten feet vertical;
7. contours at vertical intervals of not more than twenty feet and in steep terrains not more than five feet.[75]

Items four, five and six require additional analysis. Item four required all easements to be identified. Therefore, any proposed drainage easements in the Harrill Heights subdivision would have been displayed on the preliminary plat.

Item five only required "preliminary sketch plans of proposed utilities." It appears that the subdivision regulations did not require detailed engineering plans displaying how utility systems would be placed underground on the preliminary plat. Item five, however, did require review of preliminary plats by the engineering department.[76] The regulations did not specify who was to inspect to insure proper placement of utility lines once the systems were in place. Failure of subdivision regulations to require inspection of the utility systems was

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[75]Ibid., p. 10.

[76]Ibid., p. 9.

a major flaw in the subdivision regulations. As a direct result, the sewer lines in the Harrill Heights subdivision were improperly laid and manholes improperly placed. Some sewer lines were below the ground water table; other lines did not have a steep enough slope for proper gravity flow. During flooding sequences, surcharging occurred within the lines. Surcharging was the result of improperly laid pipes with insufficient slope coupled with the event of ponded runoff in and above manholes. The mixture of runoff and raw sewage filled the sewer lines and the manholes, thus clogging these systems. This mixture of ponded raw sewage and stormwater runoff caused severe health problems.[77]

Item six of the requirements for the preliminary plat required profiles of all roadways. Profiles were to include the adjacent drainage systems in the road right-of-way. The subdivision regulations placed the responsibility with the County Highway Department to inspect roads for compliance to the engineering specifications in the subdivision regulations. Inspection was to take place prior to the dedicated roads being accepted as public right-of-way by the Board of County Commissioners.[78] The importance of these engineering specifications will be discussed later in this chapter.

2. Final plat requirements of the subdivision regulations. A final plat of both Unit One and Unit Two of the Harrill Heights subdivision was obtainable. Unit Two will be reviewed in greater detail, since the

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[77]Interview with John Kincaid, Director of Waste Water, City of Knoxville, Tennessee, February 1979.

[78]Knox County, Tennessee, Subdivision Standards, p. 9.

sinkhole was located in this section. The final plat for Unit Two was approved by the Knox County Board of County Commissioners on October 4, 1955. Unit Two is displayed in Figure III-2 (page 45).

The final plat requirements in the subdivision were typical of most final plat requirements with a listing of:

1. identification of all road boundaries and names of roads;
2. lot lines, block lines and numbering, in addition to any other boundary lines;
3. title of subdivision, seals, north point;
4. names and location of adjoining subdivision and lot numbers;
5. identification of all utility and drainage easements;
6. seal of the Metropolitan Planning Commission and the Board of County Commissioners.[79]

Item five is important to this study. The subdivision regulations required a minimum of five feet of easement along all rear lot lines except where alleys were proposed.[80] The final plat for Harrill Heights identified drainage easements which varied in width. In the sinkhole area of Harrill Heights, each lot had a ten foot rear yard drainage easement, and a five foot side yard easement. Thus, adjoining lots resulted in easements ten feet wide along side yard lot lines, and twenty feet easements in the rear yards in the lowest portions of the sinkhole. Other rear yard easements were not as wide; there were five foot easements along the rear of two lots, totaling ten feet of easement.[81]

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[79] Ibid., pp. 10-11.

[80] Ibid.

[81] Engineering Department of the City of Knoxville, Tennessee, Final Plats of the Harrill Heights Subdivision.

It was apparent that the county staff, during the review process, considered it necessary to provide a means for stormwater runoff to flow into the lower portions of the sinkhole. Easements were graded with drainage swales. One must conclude that the county engineers considered that the drainage through these easements would be sufficient to handle the stormwater runoff to the openings in the sinkhole. The minutes of the public hearing before the Board of County Commissioners for the final plat approval quoted the City Engineer's opinion that "the drainage on the property was in good shape."[82] However, years later, as a direct result of destructive flooding, culverts and concrete ditches were installed in many of the drainage easements to guide stormwater runoff to the opening of the sinkhole.[83]

Portions of the sinkhole appeared to have been filled in order to facilitate development.[84] It is not known whether the house sites were built up higher than the rest of the lot. Also, the subdivision regulations did not address types of acceptable fill material except in the case of roadways. Former residents of the sinkhole commented that their backyards seemed to sink and that cement block foundations easily cracked. These occurrences indicate that the fill may not have had adequate bearing strength or the earth had shifted underground.

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[82]Board of County Commissioners of Knox County, Tennessee, Minutes of December 10, 1954.

[83]Interview with Robert Bowers, City Engineer, City of Knoxville, Tennessee, January 1979.

[84]Ibid.

The subdivision regulations for Knox County did not require submittal of detailed drainage plans on the preliminary plat. This omission was, perhaps, the major deficiency of those regulations, even though engineering specifications were stated elsewhere in the regulations. The preliminary plat merely required the display of existing culverts and water courses. The lack of drainage plans on the preliminary plat was finally recognized and steps taken to correct it.

The subdivision regulations limited attention to storm drainage provisions in its section for the engineering specifications for subdivision streets. It was acceptable practice at that time to permit postdevelopment quantities of surface runoff to flow into open or closed drainageways along streets without any pollution control devices or stormwater retention mechanisms. Runoff was allowed to enter the storm drainage provisions (ditches, culverts, etc.) of collector and arterial streets that drained to roadways off the property. Review, however, was required by the County Highway Department for the proper sizing of the culverts that flowed into off-site drainageways.[85]

In the subdivision regulations, Section II, A.6 Cross-Section of Roadway, widths of streets with open and closed drainage systems were specified. Also, a maximum slope and the design for swale ditches alongside internal subdivision streets was stated. A positive aspect of the subdivision regulations is that "the builder was required to improve

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[85]Knox County, Tennessee, Subdivision Standards, pp. 4-5.

the area from the lot line to the street pavement." Thus, the builder was required to finish the grading and seed grass within the remaining public right-of-way as a preventive erosion measure.[86]

The county engineer reviewed all road construction plans and the calculations for the sizing of culverts, ditches, etc., for the Harrill Heights subdivision and all new subdivisions.[87] The minutes of the public hearing, on October 4, 1955, before the Knox County Board of County Commissioners, for final plat approval, stated the bond issue on the subdivision streets was released. The county engineer at that time, Mr. Love, stated at the public hearing "that a masonry head wall was built along one road in order that the road would not wash out into the lots."[88] He did not indicate whether he anticipated any future drainage problems within the subdivision.

Internal drainage in the subdivision regulations was also addressed in the section for road specifications (Section II, A.7. entitled Drainage). The regulations were as follows:

> An adequate drainage system, including necessary open ditches, pipes, culverts, intersectional drains, drop inlets, bridges, etc., shall be provided for the proper drainage of all surface water. Cross drains shall be provided to accommodate all natural water flow and shall be of sufficient length to permit full width roadway and the required slopes . . . . The Highway Department shall be consulted before any drains are installed so that they will conform to the formula for the proper size culverts.[89]

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[86]Ibid., p. 6.

[87]Ibid., p. 9.

[88]Board of County Commissioners of Knox County, Tennessee, Minutes of December 10, 1954.

[89]Knox County, Tennessee, Subdivision Standards, p. 4.

Based on his statement of approval at the public hearing before the Board of County Commissioners, for acceptance of the final plat, the county engineer was satisfied with the internal drainage system for Harrill Heights, Unit Two. It is, therefore, assumed that in the Harrill Heights subdivision, the provision of rear or side yard swales in easements provided a sufficient means for internal subdivision drainage to ditches in the public right-of-way and/or to openings in the ground in the sinkhole.

History of Flooding

The Harrill Heights subdivision is located within the 22.1 square mile watershed of First Creek, a tributary of the Tennessee River. The Harrill Heights subdivision had suffered numerous damaging floods. The subdivision did not have an actual year-round flowing waterway running through it, merely a wet weather spring located at the extreme southern end of the sinkhole area. These flooding incidents were a result of stormwater runoff backing up within a sinkhole. The Harrill Heights sinkhole was a drainage receptacle for a subbasin within the First Creek watershed (see Figure III-3). The subbasin had a surface drainage area of 452 acres and the subbasin is predominately developed in single-family residential subdivisions.[90]

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[90]Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," p. 11.

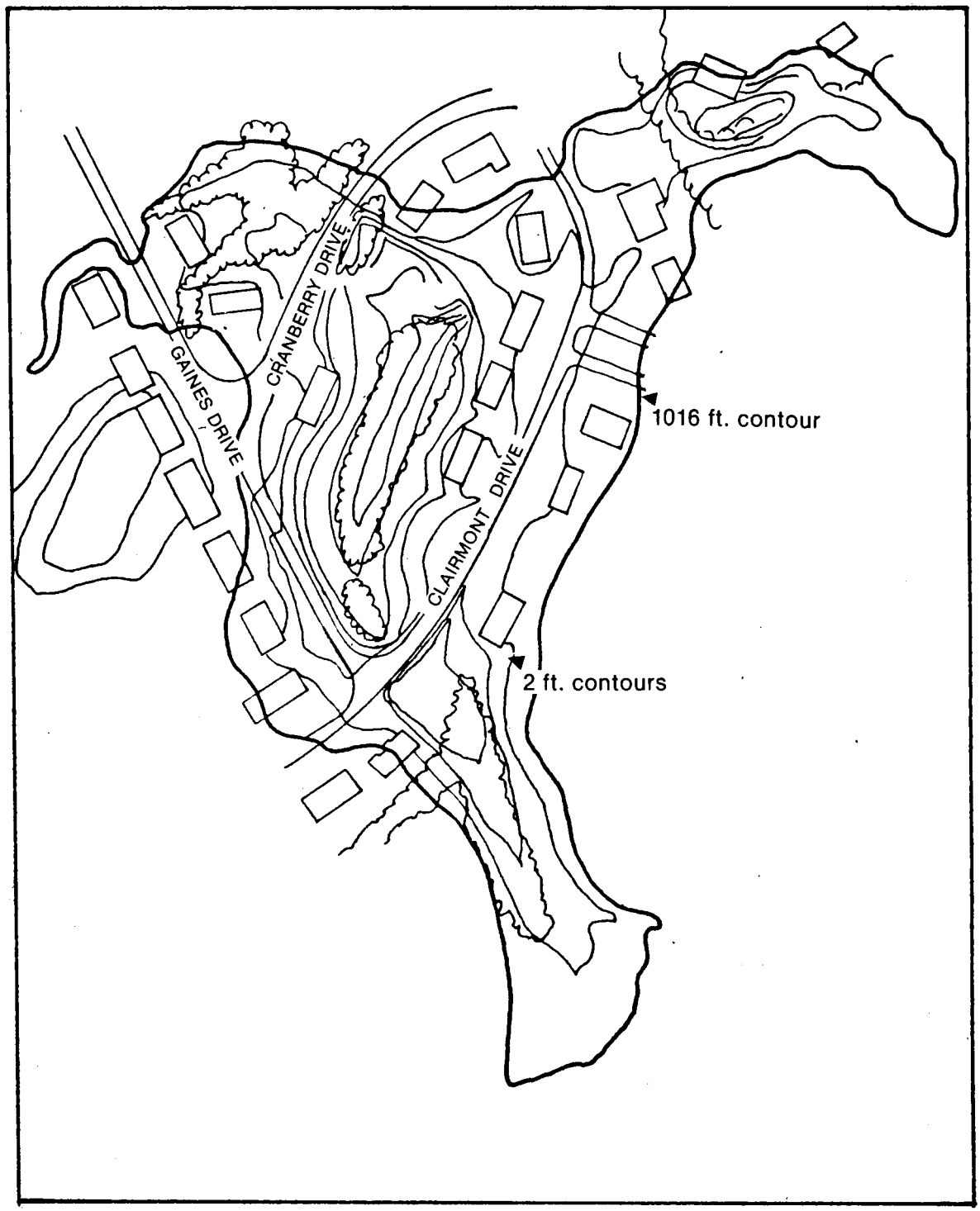


Figure III-3

Harrill Heights Sinkhole

The sinkhole was approximately 13.2 acres. The boundary of the sinkhole was the 1,016 foot contour line which coincides closely to the 100 year flood delineation of the Federal Flood Insurance Maps (see Figure III-4). Some long-term residents of Fountain City had indicated that the Harrill Heights sinkhole flooded prior to development. However, there were no records of the magnitude or the frequencies of these floodings.[91]

Records of flooding since development were kept by the City Engineering Office. Incipient flooding was determined to occur at a stage (high water) of approximately eight feet above the cave entrances at the lower elevations of the sinkhole. These cave entrances were the principal means for the drainage outflow in the sinkhole (see Figure III-5).[92] The dates of flooding are listed in Table III-1 with the associated maximum flood stages (high water).

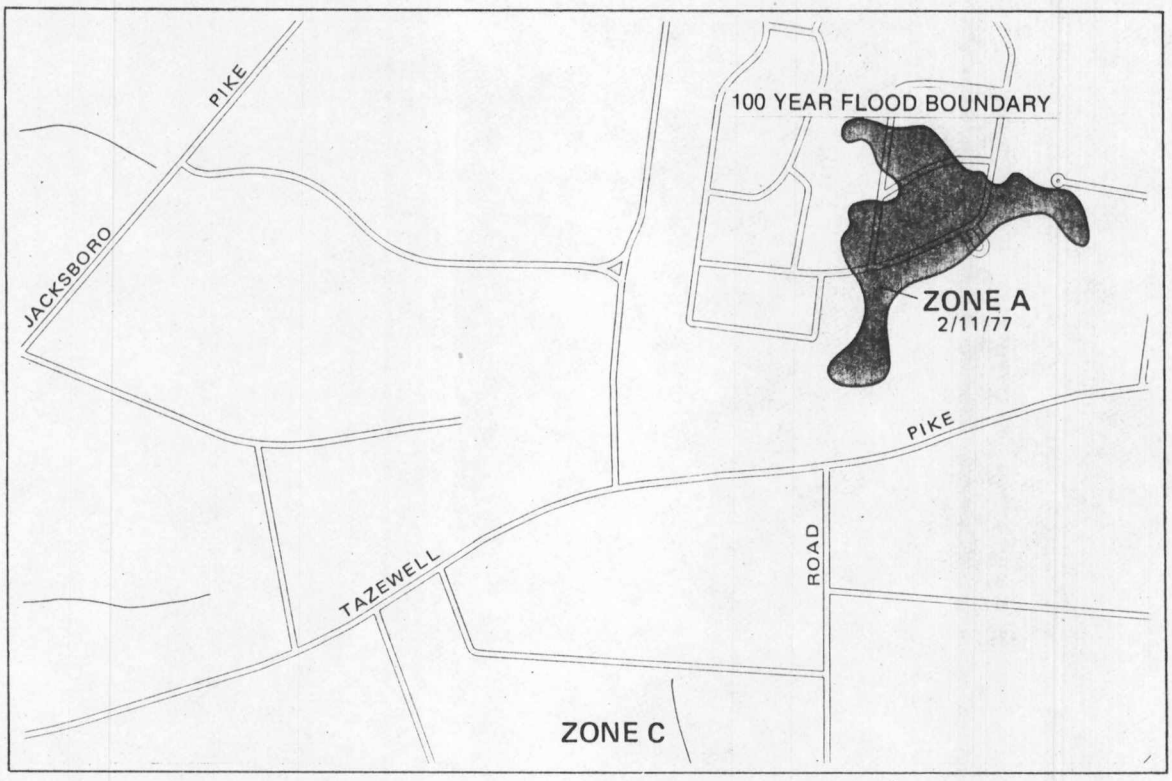
Seven of the 12 floods occurred in a 15-month period between December 1972 and March 1974. Although Knoxville experienced an unusual amount of rainfall during this period, heavy rainfall sequences can only partially explain an increase in flooding. Other contributing factors will be examined in this chapter.

One of the most severe and damaging floods occurred in March of 1973. A maximum flooding stage of 14 feet was reached. The flood was determined to be of the magnitude of a 100 year flood. Water flooded 27 homes; several of the homes were completely submerged. An estimated

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[91] Ibid., p. 13.

[92] Ibid.



SOURCE: Flood Hazard Boundary
Map H-09
Federal Insurance Administration

Figure III-4

100 Year Flood Delineation of the Harrill Heights Sinkhole



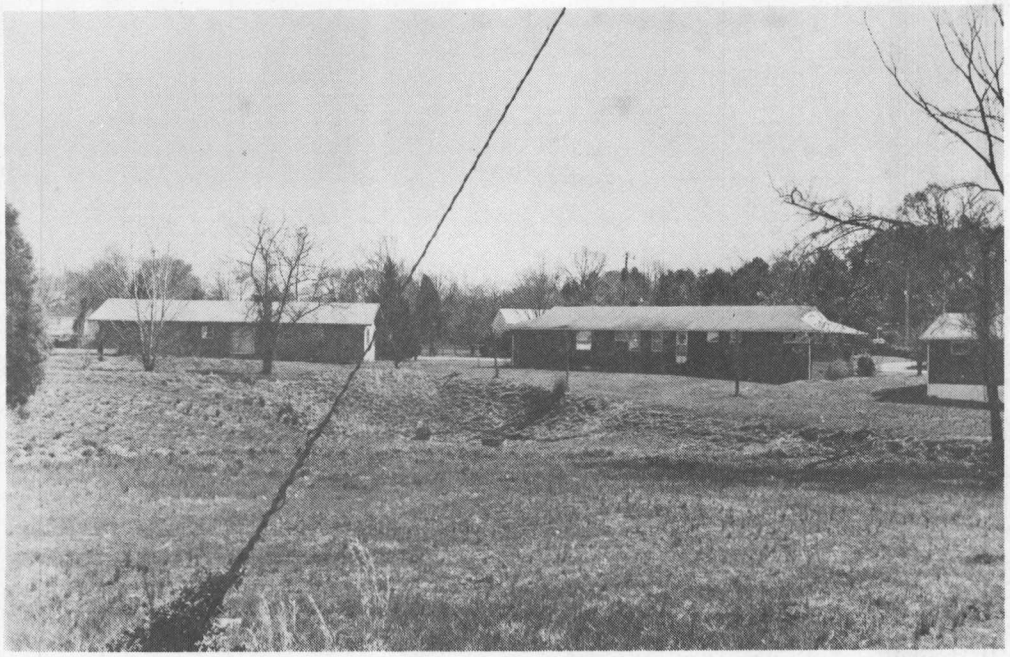


Figure III-5

Drainage Structures in Center of Sinkhole

Table III-1

Floods in Harrill Heights Subdivision

Date	Maximum Stage or High Water in Feet
November 1956	10
March 1963	12-13
December 1968	9.5
December 1972	14*
March 1973	9.5
November 1973	11
December 1973	10
January 1974	12
March 1974	9.5
Spring 1975	unknown
April 1977	14*

*Determined to be a 100 year flood.

Source: Donald L. Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue" and City Engineering Office, Knoxville, Tennessee.

four and 1/2 million cubic feet (33 million gallons) of water ponded in the sinkhole and a week elapsed before the flood water subsided below the eight foot threshold flood stage level.[93]

Factors in flooding. Flooding in Harrill Heights was attributed to many factors including intense, prolonged rainfall. Another major factor which caused flooding was the fact that the sinkhole was principally drained by only three cave openings and the total area of the three cave openings is approximately five square feet. The amount of drainage flow downward was dependent on the size of the outlet. A backing up of water was caused by the limited size of the drainage outlet.[94]

Flooding has also been attributed to the fact that there exists a finite capacity for stormwater flow into the underground water system. The underground water system was unable to accept any more runoff; the result was also a backing up of water in the sinkhole. Two questions then arise:

1. What was the capacity of the underground drainage system? and
2. Where did the subsurface water drain to?

With the use of models and statistical records of events which generated high water of less than six feet, the area of underground capacity was estimated. This underground room(s) must have had a holding capacity of approximately 2.5 catchment inches of runoff; this is equivalent to about

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[93]Ibid., p. 14.

[94]Ibid., p. 22.

100 acre feet of storm runoff, which is roughly equal to the amount of water ponded in the sinkhole after the 100 year flood of March 1973. Water must have seeped from the cave at the rate of about 0.3 catchment inches per day, or approximately 10 acre feet per day.[95]

Although no tracer or dye studies have been performed, TVA geologists have determined the approximate routing of the underground drainage from the sinkhole in Harrill Heights. Harrill Heights lies in the Beaver Valley thrusthead between the Saltville and Beaver Valley faults.[96] Underground drainage was estimated to run down slope in the thrustsheet by gravity flow in groundwater springs. Elevation of the bottom of the sinkhole was approximately 1,000 feet. Figure III-6 identifies two areas. One is the sinkhole area, the other is the pond that TVA geologists have determined is the receptor for the groundwater springs flowing from the sinkhole. This pond had an outflow to First Creek.[97]

The most significant factor aiding in flooding was the transformation of 452 acres of farm and woodland to residential development. According to computations from a Soil Conservation Service runoff curve number

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[95]Ibid., p. 22.

[96]Robert E. Hershey, The Geology of Knox County, Tennessee (Nashville, Tennessee: Tennessee State Department of Conservation, 1973), p. 263.

[97]Interview with geologists of the Tennessee Valley Authority, Knoxville, Tennessee, April 1978.

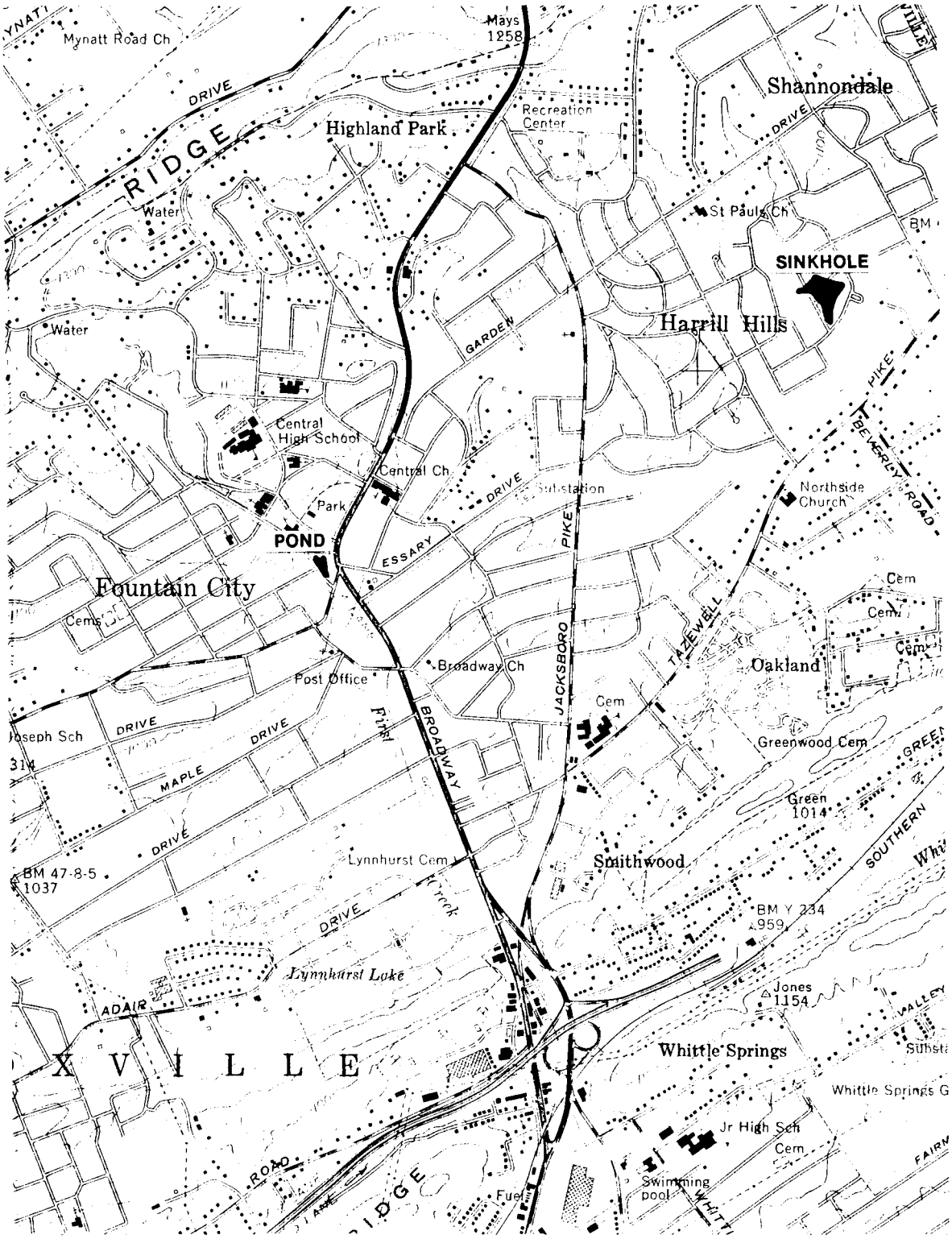


Figure III-6

Sinkhole and Receptor Pond

analysis, this change in land use almost tripled the storm runoff from the area and cut the time of runoff in half.[98]

Development may affect the likelihood of flooding in several ways. First, the ability of the ground to absorb water may change due to soil compaction and changes in the amount of impervious ground cover. This leads directly to changes in surface runoff. Second, the vegetative cover may be altered. For example, deeply rooted plants, such as trees or native grasses, are typically replaced by lawn grasses with shallower roots. The result is a change in the amount of water stored in the soil and transpired by plants, leading in most cases to increased amounts of surface runoff. Third, development is most often accompanied by topographical changes and often by a reduction in average slope. These often increase the rate of water percolation through soils and decrease the rate of surface runoff, although the removal of topsoil may negate or reverse the effect.[99]

The damaging floods in Harrill Heights were caused by a complex interaction of abnormally high rainfall, increased runoff aggravated by increased development of farmland, a finite capacity in the underground water system and the simple fact that the houses were located in the flood prone area.

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[98]Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," pp. 32-33.

[99]Dale L. Keyes, Land Development and the Natural Environment; Estimating Impacts (Washington, D.C.: The Urban Land Institute, 1976), pp. 55-56.

CHAPTER IV

RESOLUTION BY THE CITY OF KNOXVILLE

In Chapter IV a history is given of how a decision was made, and action taken to solve the flooding problems of the Harrill Heights subdivision. A review of earlier proposals under Mayor Testerman's administration is described to acquaint the reader with the progression of events leading to the actual resolution of the problem under Mayor Tyree's administration. The problem solving process is analyzed, and the input of the available interdisciplinary information resources is reviewed. Various public and private costs will also be discussed related to the Harrill Heights subdivision.

Early Attempts to Solve the Harrill Heights Flooding Problem

As early as February of 1973 TVA, a month before the 1973 100 year flood at Harrill Heights, completed an independent study outlining seven alternative actions which would solve the Harrill Heights flooding problem. Although most of the recommendations were engineering solutions such as storm sewers, the preferred alternative was condemnation of the sinkhole area, removal of homes, and the redevelopment of the area into a public park. The report also listed this alternative as the most practical and economical.[100] City government at that time did not take

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[100]Tennessee Valley Authority, Possible Flood Relief Measures—Harrill Heights Subdivision, Knoxville, Tennessee (Knoxville, Tennessee, 1973), pp. 1-2.

advantage of the expertise in flood plain management offered by TVA in this alternative analysis.

As a result of the damages from the March 1973 flood along First Creek and at Harrill Heights, the Knoxville City Council and Mayor Kyle Testerman, at the April 10, 1973, council meeting, recommended a committee be formed composed of council members to study the flooding problems and report back to the entire council and the Mayor. The Mayor did not appoint himself to the committee. Mr. Testerman indicated at that time that cleanup crews were still cleaning up the debris from the floods.[101]

Milton Roberts, councilman for the district which included Harrill Heights, represented the committee and presented its findings almost a year later at the March 26, 1974, City Council meeting. Mr. Roberts recommended, and the council agreed, that council should enter into a contract with Dr. Donald L. Overton, a water resources engineering consultant at The University of Tennessee, to prepare a feasibility study to investigate and propose solutions to the Harrill Heights flooding problem.[102]

Dr. Overton completed his report entitled, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," in August of 1974.

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[101]City Council of Knoxville, Tennessee, Minutes of the City Council Meeting, April 10, 1973.

[102]The Knoxville Journal, March 16, 1974.

Dr. Overton made the following recommendations in his study:

1. Develop three stormwater detention basins to produce a capacity level of 18 cubic feet;
2. Direct stormwater output from the three detention basins out of the sinkhole by a storm sewer;
3. Enlarge the total area of the sinkhole cave openings to 15 square feet from the existing 5 square feet to aid in the drainage in the sinkhole; and
4. Execute basin improvements in the area near the cave openings to facilitate drainage to the underground system. Such improvements included diking, channel improvements and clean up.[103]

Dr. Overton estimated the stormwater management program would cost $220,000 in 1974 dollars. Included in this cost estimate is an allocated $130,000 for the storm sewer.[104] Dr. Overton did not see the need for land acquisition in his study.[105]

The City then engaged Environmental Planning Engineers, Inc. (EPE), to review Dr. Overton's feasibility study and from the study determine final hydrologic and hydraulic design specifications for the stormwater detection ponds and the optimum location for the least cost routing of the storm sewer out of the sinkhole. EPE completed their report in December of 1974. EPE's least cost design exceeded Dr. Overton's estimates by $59,000. EPE also recommended that some land acquisition would be necessary.[106]

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[103]Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," pp. 6-10.

[104]Ibid., p. 47.

[105]Ibid., p. 2.

[106]Environmental Planning Engineers, Inc., Least Cost Design of Drainage Facilities in Harrill Heights Subdivision (Knoxville, Tennessee, 1974), p. 36.

Following these reports the city council decided to entertain bids for the project. The lowest bid was $571,355, over twice as much as EPE or Dr. Overton had estimated. The city council did not appropriate money for the project as bid.[107] Action of First Creek and Harrill Heights came to a halt in the Testerman admiinistration when Council did not appropriate money for the project.

In the fall of 1975 Mayor Testerman was defeated in the mayoral election by Mr. Randy Tyree. The two candidates had taken opposing positions on the First Creek/Harrill Heights issue. Mayor Testerman took a public stand against spending taxpayer money for solving problems which he felt were grandfathered in through annexation of county land. Mr. Tyree promised voters that he would make the First Creek/Harrill Heights problem a priority of his administration.[108] Whether or not the clearly opposing views on this issue caused Mayor Testerman's defeat is speculative and a matter of detailed political analysis. Nonetheless, the election of Mayor Tyree apparently had the effect of speeding up resolution of the First Creek/Harrill Heights flooding problems.

Actions Taken in the New Administration

Goals set by the new mayor. The First Creek flood plain was the most extensively developed flood plain the city of Knoxville. As a

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[107] The Knoxville News-Sentinel, September 7, 1975.

[108] Interview with Mitch Cramer, Deputy Law Director, City of Knoxville Law Department, Knoxville, Tennessee, May 1982.

result of the numerous floods in the First Creek flood plain, extensive flood damage over a period of several years had caused blighting to affect neighborhoods and business districts in flood plain areas. Property owners gradually stopped restoring homes and businesses affected by flood damage. A major priority of the Tyree administration was to not only stop flooding, but to improve the First Creek flood plain area by eliminating marginal businesses and flood damaged homes. Deterioration of homes within the sinkhole in Harrill Heights was also occurring; homes damaged by flooding were being abandoned by owners, adding to the blight.[109]

The three primary goals of the Tyree administration regarding First Creek and Harrill Heights were: (1) to end the spread of blight, (2) to correct existing blight and restore land values and neighborhood integrity, and (3) to reduce future flood damages by resolving flooding problems.[110]

Mayor's directive. To facilitate action on his primary goals, Mayor Tyree instructed the Service Director to have his staff in the City Engineering Office prepare alternatives for resolving the flood problems which would in turn reduce or eliminate the present blighting effect.[111]

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[109]Interview with Don Mauldin, former City Engineer, Office of the City Engineer, Knoxville, Tennessee, February 1979.

[110]Ibid. [111]Ibid.

By the summer of 1976 the Engineering staff had prepared and submitted three alternatives to the Mayor:

1. Alternative A: do nothing.
2. Alternative B: protect all susceptible property from damage resulting from the 100 year flood.
3. Alternative C: channel improvement and property acquisition to protect from the 100 year flood.[112]

TVA recommended the use of the 100 year flood as the level of protection because current flood plain regulations for the city were based on the 100 year flood and because of the quantity of data generated by TVA for the Federal Insurance Agency on the 100 year elevations demarcated in the city.[113]

At this point a further explanation of the three alternatives presented to the Mayor is in order. Alternative A (Do nothing) would allow the current situation of homes, buildings, and businesses to remain and/or continue to operate with the provision that no new construction would be allowed in flood prone areas and all existing structures would be removed as they became obsolete. Further development or redevelopment of the flood plain outside of the designated floodways would conform to existing zoning and drainage ordinances. Under this proposal, it would be required that a mandatory part of any title search be the determination as to whether or not a parcel of property is located

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[112]H. Don Mauldin and Don L. Porter, City Engineers, First Creek Channel Improvement Project (Knoxville, Tennessee: Office of the City Engineer, 1976), pp. 5-6.

[113]Ibid., p. 4; interview held with F. E. Kimball, Floodplain Management Services, Tennessee Valley Authority, Knoxville, Tennessee, October 1978.

in a flood prone area. With the buyer so informed, they would then be responsible for any flood damages which happened to their development.[114]

In this proposal the city would take the position that the owners must accept the risks of developing flood prone properties or purchasing flood prone properties and that the city has no responsibility of flood damage prevention other than through appropriate zoning and drainage ordinances. The City Engineering Office estimated the value of properties which would be expected to experience varying degrees of damage from the 100 year flood to be approximately $35,000,000.[115]

If Alternative B were to be adopted, the city would accept responsibility for protecting all property which could possibly be damaged by a 100 year flood. In this option deeper channelization of First Creek by the use of engineering structures, i.e., replacement of larger box culverts, would take place. Only those properties required for the actual channel improvement would be purchased.[116] For Harrill Heights this option would provide construction of a storm sewer to accommodate the runoff from the 100 year flood; however, there would be no homes acquired by the city.[117] A preliminary estimate of the project cost for Alternative B for First Creek and Harrill Heights was $18,000,000.[118]

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[114]Mauldin and Porter, First Creek Channel Improvement Project, p. 5.

[115]Ibid.

[116]Ibid., p. 6.

[117]Interview with Don Mauldin, former City Engineer, February 1979.

[118]Mauldin and Porter, First Creek Channel Improvement Project, p. 6.

In Alternative C the Engineering Department proposed widening, deepening and realigning First Creek, replacement of inadequate bridges and construction of one new bridge. Because the city owned very little land adjacent to First Creek, it would be necessary to purchase the land required for channel improvements and overflow areas which would include many of the deteriorated structures causing unsightliness.[119] In the Harrill Heights area, seven homes within the lowest elevations in the sinkhole would be acquired and a storm sewer would be constructed to pipe runoff from the sinkhole to a receptor in the First Creek watershed. The estimated cost of Alternative C was $11,241,000 in 1976 dollars.[120]

With this information at hand the Mayor next met with members of his staff to discuss options. These staff members included the Assistant to the Mayor, the Service Director, the City Engineer and the City Law Department Director.[121]

The City Law Department voiced a variety of concerns regarding the alternatives proposed by the Engineering Department. The Law Department was concerned about possible liability on the part of the city if a no action (Alternative A) posture was adopted. The Law Department also felt that, despite the information provided by the Mayor's administrative staff that Alternative A, although it would be the least cost option, would also be the most difficult to enforce,

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[119]Ibid., pp. 6-7.

[120]Ibid., p. 11.

[121]Interview with Don Mauldin, former City Engineer, May 1982.

especially for established residences and businesses. In addition, the stipulations regarding limitation of development and limitation of city liability would more than likely be subject to challenge in the courts and defense of these items could be very costly for the city, especially if compensation was rewarded in the courts.[122]

In addition, the City Law Department was extremely wary of setting a precedent in Alternative C for public acquisition of private property when the city had not initially had the power of approval or denial on development of the land in question. At the time of development Knox County had zoning and drainage jurisdiction over the subject area. The Law Department suggested that not only would this possibly constitute a legal precedent, but that a political precedent would also be established.[123] This opinion was buttressed by an editorial in The Knoxville News-Sentinel which stated in part, "Once the city commits its resources to First Creek, residents along the city's other creeks and tributaries will expect similar relief."[124]

Considering the fact that the mayor had rejected the no action route to solving the problems of First Creek in his campaign, Mr. Tyree could not support the use of Alternative A. The concerns of the Law Department were dismissed and the matter of precedent deferred to

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[122] Ibid.

[123] Ibid.; interview with Mitch Cramer, Deputy Law Director, May 1982.

[124] The Knoxville News-Sentinel, August 13, 1976.

a later date. Alternative B was the most costly and could perhaps create political problems for the Mayor in the area of fiscal responsibility. In addition, this alternative did not call for the removal of blighted residences and businesses, a factor which could cause image problems by not being cosmetic enough. Further, the goal of the Mayor to increase the property value of the blighted areas would not be satisfied by this alternative.[125]

After reviewing the alternatives, Mayor Tyree selected the third option. This option had the benefit of being in the middle of the two extreme alternatives and would result in removal of blighted residences and businesses. He then directed the Office of the City Engineer to prepare a document, along with estimated costs, proposing Alternative C for First Creek and Harrill Heights.[126]

On August 5, 1976, the third alternative was proposed in detail in the document "First Creek Channel Improvements," prepared by City Engineers. Harrill Heights is addressed in the proposal as Stage VI. In its final form the proposed alternative for Harrill Heights called for the employment of engineering methods and land acquisition. In particular, the proposal suggested a large storm sewer to drain the sinkhole and the purchase by the city of seven homes within the lowest elevation surrounding the sinkhole. The proposed costs for the storm sewer was $800,000 with an additional cost of $200,000 for

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[125]Interviews held with Don Mauldin, former City Engineer, and Mitch Cramer, Deputy Law Director, May 1982.

[126]Ibid.

acquisition of seven homes and $50,000 for engineering consultant costs. These costs totaled $1,050,000 in 1976 dollars.[127]

First Creek channel improvements. Mayor Tyree and the City Engineer presented the proposed First Creek Channel Improvements Project to the city council in mid-August. After a council work session the council approved a future bond sale for the $11.2 million First Creek Channel Improvement project which included a resolution of the Harrill Heights flooding problem.[128]

Both the MPC and the Director of Waste Water Control Department endorsed the project publicly, although the MPC endorsement included several qualifications. The Director of Waste Water Control supported correction of the Harrill Heights flooding problem in order to prevent future incidents in which flood waters clogged and flooded sanitary sewers and manholes. Many times in the past the Harrill Heights area had experienced this situation.[129]

MPC, while endorsing utilization of the 100 year flood elevation as being compatible with flood plain regulations and insurance practices, qualified their support. The MPC staff seemed less than enthusiastic in supporting the city's plan to stop deterioration of homes and businesses in the blighted areas. MPC staff supported the land

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[127]Mauldin and Porter, First Creek Channel Improvement Project, p. 11.

[128]City Council of Knoxville, Tennessee, Minutes of the City Council Meeting, September 24, 1976; The Knoxville Journal, August 11, 1976; The Knoxville News-Sentinel, August 20, 1976.

[129]Interview with John Kincaid, Director of Waste Water Control, February 1979.

acquisition alternatives, but counseled careful selection in order to not destroy neighborhood identity.[130] At best the MPC endorsement could be characterized as a tentative vote of confidence for the city's handling of the coming project.

The first action taken by the Office of City Engineer in resolving the flooding problem at Harrill Heights was to request design plans for the storm sewer from contracted consultants. Preliminary design plans for the storm sewer at Harrill Heights were prepared by the engineering firm of J. R. Wauford & Company.[131]

Criticism of the project. Soon after publication of the document First Creek Channel Improvements, Mayor Tyree was criticized by the media because of what they considered excessive cost of the proposed project. In an August 13, 1976, editorial, The Knoxville News-Sentinel refused to endorse the $11.2 million First Creek Channel Improvements project which was to be financed by bonds. The newspaper cited Dr. Overton's report as an example of a less expensive method for resolution of the First Creek/Harrill Heights flooding problems which did not require land acquisition.[132]

Again, in its September 21, 1976, editorial, The News-Sentinel criticized the proposed project saying, "that $11 million dollars was

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[130]Interview with Ken Pruitt, Metropolitan Planning Commission Staff, Knoxville-Knox County, Tennessee, February 1979.

[131]Interview with Robert Bowers, City Engineer, February 1979.

[132]The Knoxville News-Sentinel, August 13, 1976.

too high, and Knoxville taxpayers would be paying for flood control overkill and a workable, far less costly solution should be found." The editorial also stated that if a less expensive approach would work, it should be used instead and leave the city financially able to deal with other pressing needs. The News-Sentinel added the suggestion that Dr. Overton should be given the chance to update his proposal.[133]

Opposition to the proposed project, and Harrill Heights in particular, came from other residents in the First Creek watershed, especially residents in or near the First Creek flood prone areas. These residents claimed that the piping of water via storm sewers from the sinkhole to a tributary, whether natural or channelized, would result in merely displacing the flood waters, and would not solve the problems. They voiced fears that the storm sewers would increase the flood peak, and the velocity and volume of First Creek, thereby aggravating their problems.[134]

In early September 1976, Attorney Joe Levitt, Jr., a resident of the First Creek flood plain, mailed a letter to the Mayor which made recommendations for the resolution of Harrill Heights flooding problem that were derived from the 1973 TVA study on Harrill Heights.[135] As previously mentioned, the study presented seven alternatives for

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[133]The Knoxville News-Sentinel, September 21, 1976.

[134]Interview with Don Mauldin, former City Engineer, May 1982.

[135]The Knoxville Journal, September 8, 1976; interview with Joe Levitt, Jr., Attorney, Knoxville, Tennessee, June 1982.

resolution of the flooding problems, recommending as a preferred alternative the purchase of 27 homes and several lots in Harrill Heights.[136] Mayor Tyree indicated in a Knoxville News-Sentinel article on September 22, 1976, that the information in Levitt's letter, of which a summary was published, was different than information he had received from TVA.[137]

Pursuant to public criticism Mayor Tyree instructed the City Engineering Office to study the feasibility of additional land and home acquisition. In addition he ordered a review of the proposed storm sewer to determine whether or not it was necessary.[138]

The Office of the City Engineer reevaluated the Harrill Heights flooding problem with increased consideration of larger land acquisition. The engineers chose the 100 year flood elevation of 1,016 mean sea level (msl) as the boundary line for determining which homes to be acquired. The entire First Creek Channel Improvements project was based on protecting against damage from a 100 year flood. Also, use of the 100 year flood elevation was legally defensible because of the adoption of flood plain regulations recommended by TVA based on the 100 year flood. The 1,016 feet elevation coincided with the 100 year flood demarcation on the Federal Flood Insurance maps.[139]

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[136]Tennessee Valley Authority, Possible Flood Relief Measures—Harrill Heights Subdivision, Knoxville, Tennessee, pp. 1-2.

[137]The Knoxville News-Sentinel, September 22, 1976.

[138]Interview with Don Mauldin, former City Engineer, May 1982.

[139]Interviews with Robert Bowers, City Engineer, February 1979, and Don Mauldin, May 1982.

With this additional technical background, 21 homes and three vacant lots were identified for acquisition. Two homes of the 21 were outside the 100 year flood plain but were recommended for acquisition based on their orientation or proximity to the sinkhole.[140] (See Figure VI-1.)

The Office of the City Engineer and the Service Department estimated the cost of the land acquisition to be less than $700,000. This estimate was $350,000 less than the cost of the installation of a storm sewer and the acquisition of only seven homes as previously proposed. An added benefit of the new proposal for Harrill Heights was the funds which would be received by the city when the homes were auctioned.[141]

In early 1977 the Mayor endorsed this solution to the Harrill Heights flooding problem and instructed the Finance Department to appropriate the funds from the bond issues to finance this portion of the First Creek Channel Improvements project. In addition to the desire for political benefit of saving taxpayer dollars the Mayor had two other reasons for adopting this new least cost alternative. First, he had been searching for ways to save money because costs on another section of First Creek had been greater than expected. Second, this option on Harrill Heights offered the Mayor a good opportunity to

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[140] Interviews with Robert Bowers, City Engineer, February 1979, and Lewis Walton, former Assistant City Attorney, City of Knoxville Law Department, May 1978.

[141] Interviews with Robert Bowers, City Engineer, and John Murrian, Assistant to the Mayor, February 1979.

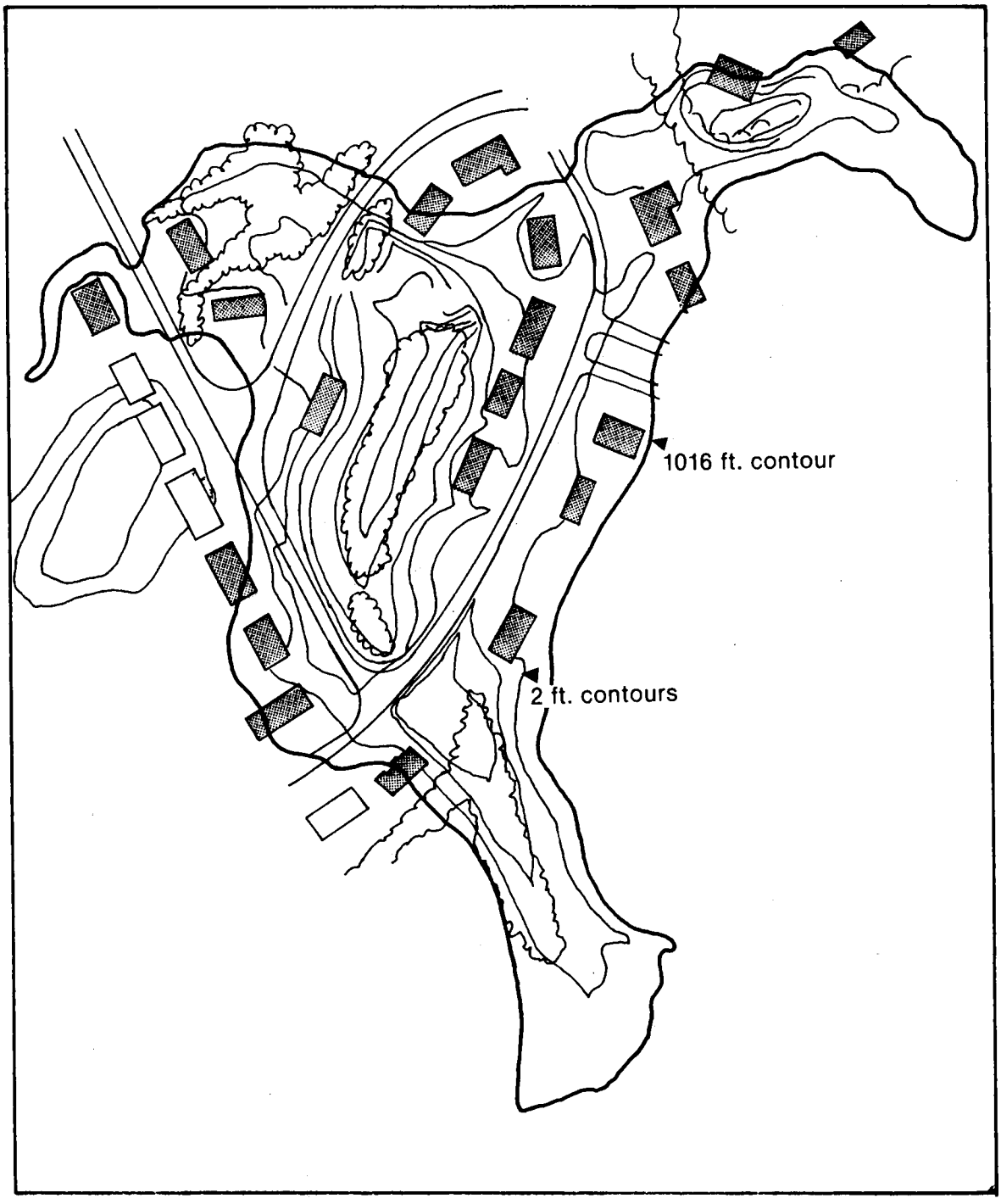


Figure IV-1

Harrill Heights Sinkhole, 21 Homes Acquired by City

rapidly restore the blighted area in Harrill Heights, thereby restoring the land values in the area as well as showing the voters movement on a public problem by an elected official.[142]

In April of 1977, First Creek and Harrill Heights experienced a flood of the magnitude of a 100 year flood. Flood waters reached the high water stage of 14 feet above the cave openings at Harrill Heights. Some homes were completely submerged and some had to be evacuated. The City of Knoxville provided rescue services, as well as police protection to prevent vandalism, and the pumping of water out of the sinkhole by the Fire Department. The police also helped with evacuation of residents and cleanup crews were provided to the area after the water had receded. The Mayor personally directed these emergency procedures and was aware of the vast consumption of man-hours involved in the rescue operation.[143]

The occurrence of a flood of the magnitude of a 100 year flood resulted in more negative publicity for the Mayor regarding his efforts on First Creek and Harrill Heights projects. By coincidence, the Mayor had scheduled a meeting on the night of the flood with the Fountain City Town Hall, a civic group in north Knoxville. Mayor Tyree kept his appointment with the group and reassured the members that his plan would bring the flooding problems to an end.[144]

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[142]Interview with Don Mauldin, former City Engineer, May 1982.

[143]Interviews with Robert Bowers, City Engineer, February 1979, and Don Mauldin, former City Engineer, May 1982.

[144]Interview with Don Mauldin, former City Engineer, May 1982.

Acquisition. In the spring of 1977 the Mayor instructed John Murrian, his assistant, to meet with each of the homeowners or landowners to determine if they would cooperate with the city by selling their homes and/or land. The city did not want to use the eminent domain process, preferring homeowners and landowners to voluntarily sell their property. Mr. Murrian received a favorable response from all 21 homeowners and three landowners affected in the Harrill Heights sinkhole area.[145] (See Figure IV-1, page 78.)

The next step in the process was the actual acquisition of the properties. The Law Department, under the direction of the City Attorney, began to take the necessary steps to acquire the property in the summer of 1977. Title searches began and the city hired two independent appraisers to make estimates on the homes and the land. The city offered residents the higher of the two appraisals. The offers made by the city on the homes ranged from $25,000 to $44,000.[146]

The Finance Department appropriated the funds from the bond issues to purchase the homes and land. In addition, each resident, whether owner-occupied or tenant-occupied, received a relocation allowance of $500. All of the homes were acquired by the city by the fall of 1977.[147]

On January 7, 1978, the city conducted an auction to sell the 21 homes. The sale of the houses brought $114,075. The new owner was

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[145]Interview with John Murrian, Assistant to the Mayor, February 1979.

[146]Interview with Lewis Walton, Assistant City Attorney, May 1978.

[147]Ibid.

required to move the purchased home with 120 days. The prices of the auctioned homes ranged from $1,600 to $8,100, depending on the amount of previous flood damages to the particular house.[148]

After the homes were removed, the city had various work tasks to complete before finalizing the Harrill Heights flooding problem. Once the homes were removed, the Waste Water Control Director had sewer and water lines removed from the lots. Such action alleviated any future flooding into sanitary sewers.[149]

The Service Director instructed the City Engineers to prepare plans for deepening the sinkhole to handle the volume of water for a 100 year flood. Their plans were drawn up; however, excavations to that depth have yet to be completed. In addition, the Service Director had city maintenance crews remove driveways and place sod in the sinkhole area.[150]

Model of the decision making process. A model is presented in Figure IV-2 representing the sequence of events and actions taken by the City of Knoxville to solve the Harrill Heights flooding problem. The model is in the form of a flow diagram. The purpose of diagraming the decision making process is to give an overview of the political decisions made by the Mayor of Knoxville and to display the participation

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[148]The Knoxville News-Sentinel, January 8, 1978.

[149]Interview with John Kincaid, Waste Water Control Director, February 1979.

[150]Interview with Robert Bowers, City Engineer, June 1979.

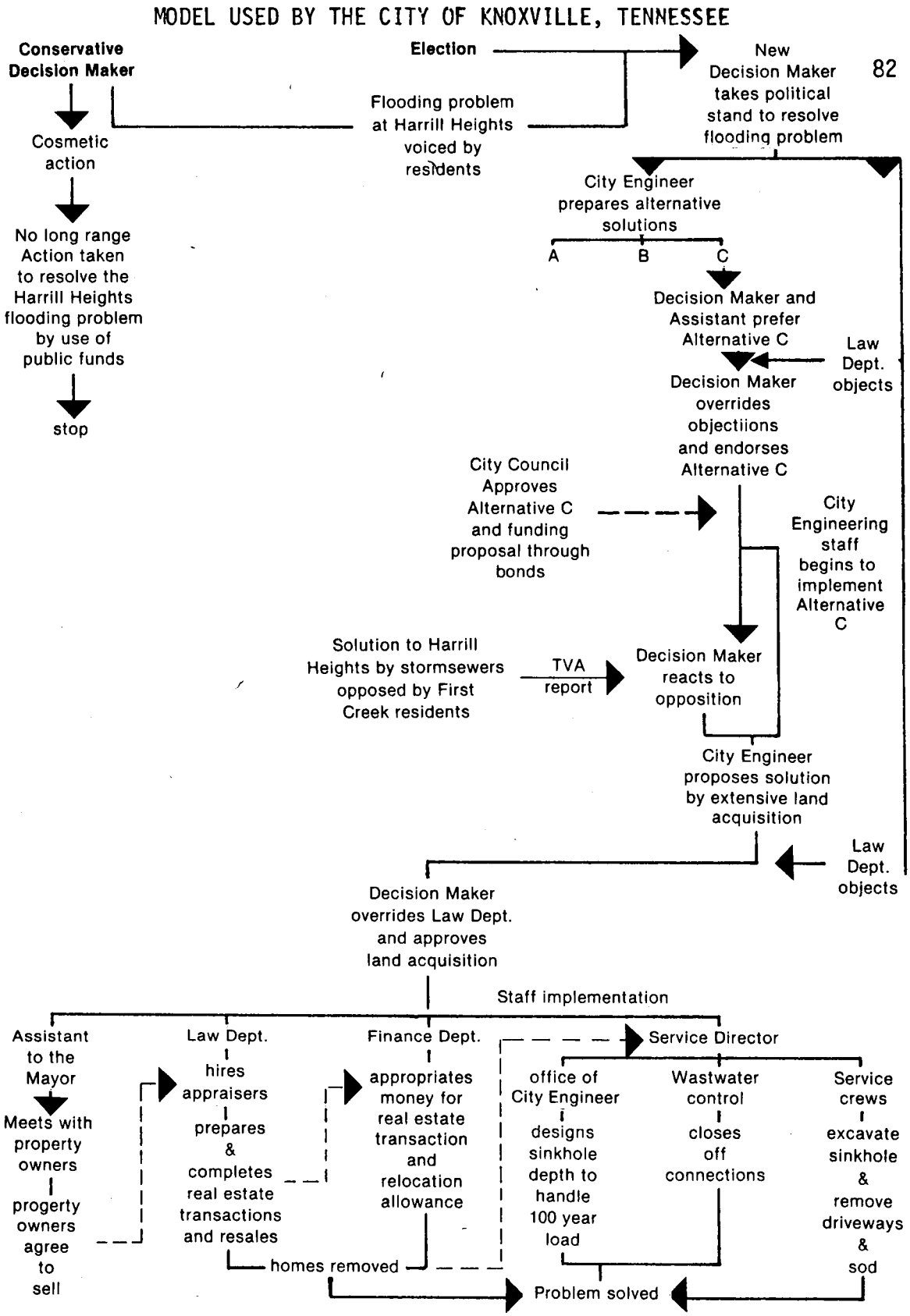


Figure IV-2

Model Used by the City of Knoxville, Tennessee

of the different city departments which implemented the resolution of the flooding problem.

Strengths and Weaknesses of the Resolution Process

The decision making process in the case of First Creek and Harrill Heights flooding problems is heavily dependent on the attitude of the chief decision maker, the Mayor. In this case predispositions toward this type of problem solving were manifested by both Mayors Testerman and Tyree. One chose an essentially "no public action" route, the other did not.[151]

Reliance on a political office holder has both strengths and weaknesses in this resolution process. One weakness is that the First Creek/Harrill Heights issue could have been entangled in other issues which were more important to the voters at election time. Another weakness is the possibility that the voters could have adopted a parochial attitude in relation to First Creek and Harrill Heights, assuming that this issue was of primary importance in the Mayoral campaign. For instance, a majority of voters do not live in the affected areas and, if they voted according to their narrow self-interest, they probably would have chosen the "no public action" alternative advocated by Mayor Testerman.

Another weakness of the problem solving approach by the City of Knoxville in this case is the failure to utilize expertise from areas

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[151]Interview with Mitch Cramer, Deputy Law Director, May 1982.

other than engineering, expertise which was readily available and without additional cost to the city.

Mayor Tyree indicated in a public statement in The News-Sentinel that he considered the information in Mr. Levitt's letter (which was based on the 1973 TVA report) to be different than information he had received from his staff and from the Office of the City Engineer.[152] This lack of awareness shown by the Mayor supports the conclusions that Mayor Tyree did not effectively utilize the expertise available to him and results in a narrowness of scope regarding solution of the flooding problems.

In addition to the failure of the Mayor to utilize TVA's recommendations, he also did not make use of the MPC staff. MPC staff was only consulted when the decision was finalized, and then were only asked for their endorsement.

Nonuse of TVA and MPC staff further showed a weakness in the problem solving process in Knoxville. With TVA and MPC staff being used only in an advisory capacity, the Mayor, in this strong-mayor form of government, is not compelled to seek their advice.

Public Costs

Public costs are expenses entailed by governmental activities. For this inquiry, direct public costs are defined as expenditures made by the City of Knoxville relating to the Harrill Heights subdivision.

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[152] The Knoxville News-Sentinel, September 22, 1976.

Indirect costs are public costs to the City of Knoxville and Knox County for the loss of revenue by removing 21 homes and three vacant lots from the tax rolls.

Direct public costs. These direct public costs which were absorbed by the City of Knoxville fell into two categories: expenditures by the city for rescue operations and other efforts to mitigate losses during a flood at the Harrill Heights sinkhole and the expenditures made to prevent a recurrence of flooding in the sinkhole.

Rescue operations required emergency services of the City Fire and Police Departments. The two departments aided in the evacuation of homes when necessary. Additional police protection was needed to patrol the subdivision to insure vandalism did not occur.[153]

Other services by the city, during a flood and immediately thereafter, included inspections by the Health Department and the Waste Water Department to ensure that no health problems existed as a result of the mixture of raw sewage in flood waters from flooded or clogged sewer lines and manholes. The Waste Water Department also had to repair or unclog any sewer lines should such work become necessary.[154] The Service Director sent city maintenance crews to assist in cleanup after the floods and haul away debris.[155]

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[153]Interview with John Murrian, Assistant to the Mayor, February 1979.

[154]Interview with John Kincaid, Waste Water Control Director, February 1977.

[155]Interview with John Murrian, Assistant to the Mayor, February 1979.

An estimation of man-hours used for the various work tasks for rescue operations and other city service during and after floods was not obtainable from the city. The consensus of government officials interviewed regarding the cost to the city was that no accurate cost in man-hours and dollars could be assessed; all indicated that the policy at the time of the floods was one of immediately providing safety and minimizing hazards to the residents regardless of costs.

Other costs to the city involved expenditures for the means of resolving the flooding problem and preventing any further flood damage. Costs of the land acquisition, the relocation of residents and the costs of consultant services were obtainable from the City Finance Department.

The City, in earlier attempts to solve the Harrill Heights flooding problem, contracted a number of engineering and survey firms to study the sinkhole and propose resolutions to the flooding. These consultant fees are listed in Table IV-1.

Table IV-1

Consultant Costs

Firm	Year	Amount
Environmental Planning Engineers, Inc.	1974	$13,633.30
Donald Overton, Ph.D.	1974	13,442.96
J. R. Wauford & Co.	1976	23,290.38
	Total	$50,366.64

Source: City Finance Records

Based on the summation of the fees shown in Table VI-1, the City of Knoxville paid engineering and survey consultants in excess of $50,000 for information on the sinkhole and postulated resolutions to the Harrill Heights flooding problem. The consultants generally recommended resolutions by means of engineering structures, i.e., culverts, retention ponds and storm sewers, with minimal land acquisition.

The Mayor's office allocated $700,000 of bond money from two of the bond issues for the First Creek Channel Improvements Project for the acquisition of 21 homes and three vacant lots in order to resolve the Harrill Heights flooding problems. The city received $114,075 for the resale of the homes at a public auction. In total the city paid $559,000 for the land acquisition. Additional allowance of $500 to each of the 21 households and the cost to hire the auctioneer.[156]

The city originally allocated $ 1,050,000 in the First Creek Channel Improvement document for a storm sewer, consultant costs and land acquisition of seven homes.[157] The city saved $446,000 by using land acquisition to solve the Harrill Heights flooding problem. In addition, long-range costs for the maintenance of the storm sewer were eliminated.

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[156]Interview with Robert Bowers, City Engineer, February 1977.

[157]Mauldin and Porter, First Creek Improvement Project, p. 11.

Indirect public costs. An indirect cost to the City of Knoxville and to Knox County was the loss of 21 homes and three vacant lots on the tax rolls. Homes in the 13-acre sinkhole were determined by the City Tax Office to have a market value of $10,000 to $14,000. Assessments for property taxes were calculated by multiplying the above figure by 25 percent. City taxes were charged on a rate of $4.05 per $100 of assessed value; county taxes for property within the city was computed at a rate of $3.73 per $100 of assessed value. (Note: These figures are based on 1976 property tax rates since that year was the last full year these properties were on the tax rolls.) The amount of tax revenue lost by the city was approximately $2,400; the amount lost by the county was in excess of $2,200.[158]

Private Costs

There were also direct and indirect costs to the former occupants of the 21 homes in the Harrill Heights sinkhole.

Direct private costs. Direct costs for the former residents covered a variety of expenditures which included the expense of finding temporary lodging and paying for meals after one had evacuated one's home during a flood, the loss of work, the repair or replacement of damages not covered by insurance and the expenses, time and effort to clean up one's home after a flood. These immediate costs differed for each household and/or owner during each individual flooding sequence.

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[158]Interview with Linda Hamilton, Property Tax Office of Knoxville, Tennessee, June 1982.

A summation of the costs from each property owner or tenant was unobtainable. Another cost which was an unquantifiable factor was the psychological effect on homeowners created by the hopelessness of seeing one's home and belongings damaged by floodwaters in addition to the lingering threat of recurrent flooding.

Dr. Overton, a consultant for the city, in his report "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," estimated probable flood damage for the return period of the flood: the 100 year, the 50 year, and progressively smaller floods to the 5 year flood. The 5 year flood was considered the first flood level at which damage would be caused at the eight feet flood elevation. His estimates were made using 1973 dollars. The 1973 flood had previously been determined to be a 100 year flood. The table from Dr. Overton's report was supplemented in Table IV-2 in order to give an indication of probable flood damage costs to homeowners and insurance companies in 1977 dollars when the next 100 year flood took place prior to land acquisition. Dr. Overton indicated damages "represented the cost of returning damaged property to its initial status and not devaluation of property and other direct costs such as temporary lodging, meals and loss of work." The computer program Dr. Overton used to estimate damages was a function of the return period of the flood in years and the flood stage (height of flood waters).[159] See Appendix B.

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[159]Donald L. Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," p. 37.

Table IV-2

Estimated Flood Damages for Harrill Heights

Return Period (Yrs.)	Stage (Ft.)	Damages (1973 dollars)	Damages (1977 dollars)	Risk of Being Equalled or Exceeded (Any Given Year)
100	14.1	202,200	277,620	1
50	13.4	164,000	225,172	2
25	12.6	122,000	167,506	4
10	11.4	28,300	38,856	10
5	8.0	0	0	20

Sources: D. L. Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of the Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," 1974, p. 8; 1977 dollars obtained from a multiplier derived from the U.S. Consumer Price Index.

From Table VI-2 one can observe that between 0.7 of a foot, the distance separating the stage height of the 100 year flood and the 50 year flood, approximately $50,000 (in 1977 dollars) more would be needed to restore homes to a preflood condition. The difference between the 10 year flood and the 25 year flood is a matter of 1.2 feet of additional flood waters. This additional 1.2 feet according to the table would require almost $130,000 more to restore homes to preflood conditions. Had resolution of the Harrill Heights flooding problem not taken place by the end of 1977, the cost to restore homes at a later date would have been greater considering the inflation rates of the late 1970's.

Indirect private costs. Many of the former occupants of the Harrill Heights subdivision had flood insurance coverage that is subsidized by the federal government.[160] Flood Insurance was available under two programs: the Emergency Program and the Regular Program. The City of Knoxville participated in the Emergency Program of the National Flood Insurance Program in 1970 and entered the Regular Program in 1971.

When a city or county enters the Emergency Program, residents of that city or county may apply for flood insurance coverage up to a ceiling of $35,000. This limit of coverage is known as the first layer of coverage. Once the city or county enters the Regular Program, a second layer of coverage is available in addition to the first layer of coverage. The two layer rate structure is only available for coverage on buildings that were constructed prior to the city or county entering the Regular Program. Premiums for construction after acceptance into the Regular Program have a uniform rate for the entire coverage.[161]

All of the houses acquired by the City of Knoxville were built prior to 1971 when the city entered the Regular Program. Therefore, these 21 homeowners in the sinkhole qualified for the federally subsidized rates of the first layer of coverage.

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[160] Interview with John Murrian, Assistant to the Mayor, February 1977.

[161] The Federal Insurance Administration, National Flood Insurance Program, Questions and Answers (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 6-8.

Rates under the first layer of coverage were $0.25 per $100 of coverage up to a $35,000 ceiling for residential structures. The rate for coverage of contents of residences was $0.35 per $100 worth of coverage up to a $10,000 ceiling for the first layer. The nationwide minimum annual premium prior to 1978 was $25 which provided $10,000 worth of coverage for residential structures.[162] A homeowner who qualified for first layer rates, as the Harrill Heights homeowners did, could purchase a $35,000 policy for $87.50 per year and $10,000 worth of coverage for contents at a premium of $35.

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[162]Ibid., p. 7.

CHAPTER V

INTERDISCIPLINARY PROBLEM SOLVING MODEL

In this chapter an interdisciplinary problem solving model will be offered. This model was developed in response to the weaknesses inherent in the problem solving process employed by the City of Knoxville in solving the First Creek/Harrill Heights flooding problems. In this suggested model, discussion of the political decision making process is focused on the strong mayor form of government, the form used by the City of Knoxville. As each form of local government possesses strengths and weaknesses related to the political environment which exists in the particular community, it is impossible to develop a political decision making model which will apply to all communities.

However, it is the intent of this study to suggest a general interdisciplinary problem solving model regarding flooding problems which could be employed by communities, regardless of their particular political decision making process.

Presentation of the Model

The proposed interdisciplinary problem solving model in Figure V-1 offers a considerably different response to a flooding problem than the response which actually occurred in the case of First Creek/Harrill Heights.

In the proposed model (Figure V-1), the Planning Department has been selected as the lead agency for resolving urban flooding problems. The

RECOMMENDED MODEL

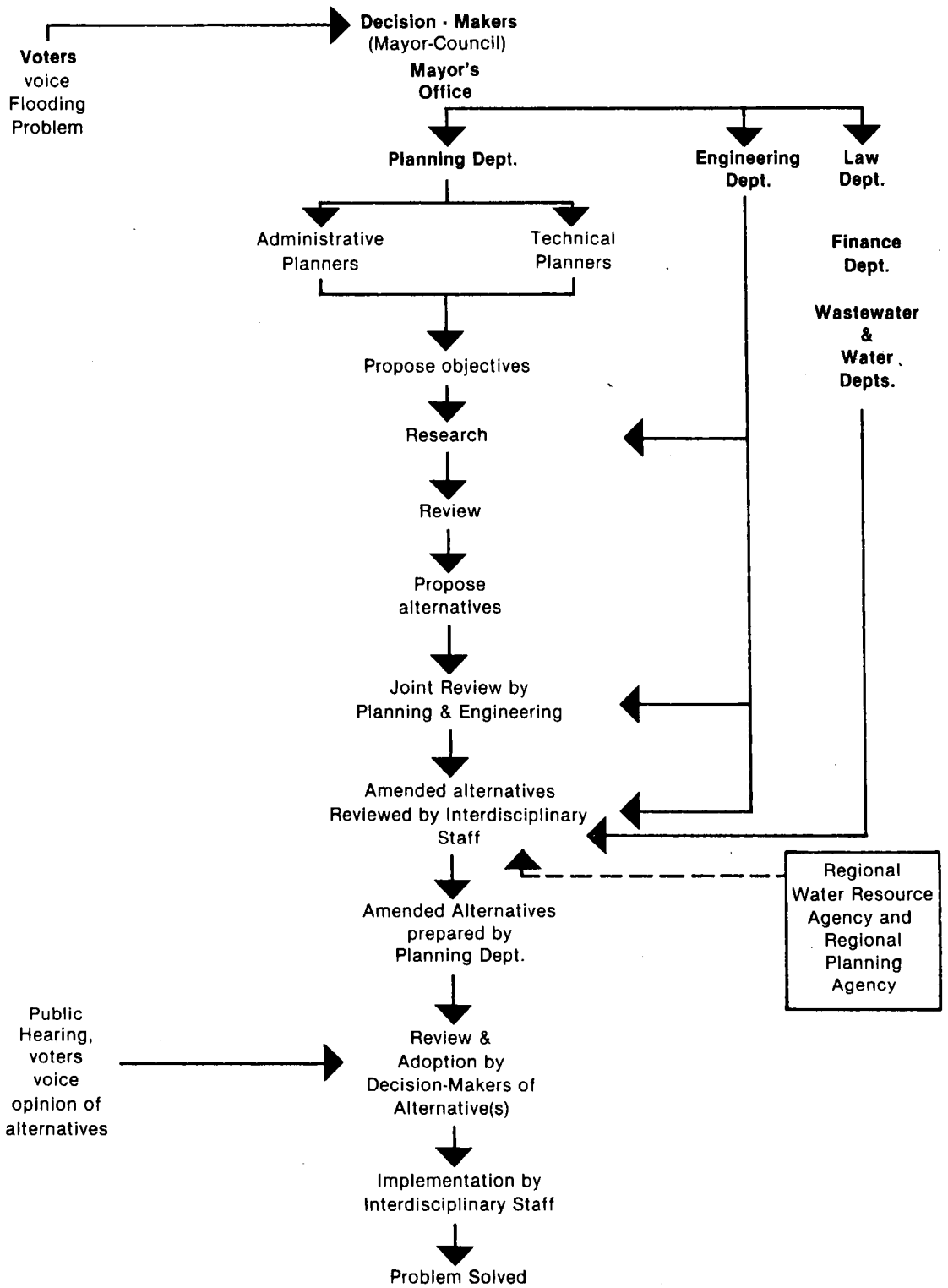


Figure V-1

Recommended Model

selection of a Planning Department is based on a number of factors. First, Federal directives since 1966 have been aimed at an integrated system of land use regulations and engineering practices for flood plain management.[163] Planners generally administer land use regulations to ensure that development or redevelopment meets standards to ensure the general health, safety and welfare to all residents within their jurisdiction. Second, a typical metropolitan urban planning department will have an "interdisciplinary" staff in order to carry out its duties. The type of expertise an urban planning department can contribute in resolving urban flooding problems includes environmental water resource and flood plain management. These specialized forms of planning include the expertise to interpret flood data and engineering in flooding problems. Also, urban planning departments typically have planners skilled in interpretation of statistical data. In addition planners forecast trends of development and redevelopment in local jurisdictions which helps understand development pressures in flood plains. Community development planners have expertise in urban redevelopment and relocation strategies. Their expertise can be utilized in instances where land acquisition requires relocation of people or businesses. Other expertise generally found in planning offices are policy analysis, cost analysis, or grant writing; these skills are essential in urban problem solving in general and are also useful in solving flooding problems.

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[163]Wright, Some Future Challenges in Flood Plain Management, p. 1.

Step by step analysis of the model. The first step in the model to be conducted by the Planning Department is a statement of objectives and research. Preliminary alternatives may be postulated by staff at this stage. The feasibility of alternatives will occur during the various levels of review.

The next step in the process of forming alternatives should be from the Engineering Department. Communication between Planning and Engineering should be continuous. Information needed from the Engineering Department includes not only flood related data, but also design specifications of engineering approaches to resolve the problem and estimated costs of the approaches. However, the Planning Department should not rely on the Engineering Department as their sole source of information. The Engineering Department's information should be used as a check on alternatives proposed by the Planning Department.

Following the interchange of information and analysis by Planning and Engineering Departments, the process then calls for additional interdepartmental input. At this time the more specific expertise available in the local government would be employed to review the alternatives proposed. This interdepartmental expertise would include review by the Legal Department, Finance Department, Office of the Mayor, the Water Department, and the Waste Water Department. This review would be in the form of reports addressing the feasibility of the alternatives proposed and the effect on the respective department in the event the proposal was approved.

In addition to input from various departments, appropriate regional offices would be requested to review the proposal and offer input. In

the case of First Creek and Harrill Heights, TVA and MPC staffs should have been asked earlier in the process to contribute what data and/or advice they had to solving the flooding problems of First Creek/Harrill Heights.

Following the synthesis of input from various departments and regional authorities, the information would be evaluated by the Planning Department and revised alternatives would be prepared and presented to the decision makers. In the case of the Knoxville City government, the revised proposals would be offered to the mayor and his staff for decision.

Comparison of Models

Utilization of the model in the First Creek/Harrill Heights flooding problems should have resulted in a more timely resolution of those problems. Though the argument could be made that Mayor Testerman, considering his administration's emphasis on saving tax dollars might have ignored the solutions offered by such a process, it is certain that the Tyree administration would have had an opportunity to expedite resolution of the problem in the first year in office had this process been in place.

Mayor Tyree began his term in 1975 and one of his first actions was to order a review of the flooding problems in the First Creek watershed. A major problem with the information gathering process used in the First Creek/Harrill Heights case was a lack of use of available expertise in city government. Had the proposed model been in place,

proposals and reports would have been immediately available to the mayor and resolution of the problem would have been expedited. In addition to the time saved studying the problem (which should have already been studied), Mayor Tyree would have been aware of the 1973 TVA report on the subject. The Planning Department, in this model, would have had the TVA review alternatives.

The fact that other departments, especially planning, legal and the regional authorities, were not consulted until three alternatives were in place, points out the need for a more systematic procedure for solving such problems. In the Harrill Heights flooding problem, information bias resulted in an essentially "last minute" adjustment when the mayor took advantage of the recommendations in TVA's 1973 report. Had the proposed model been in place, departments would not have been merely responding to three alternatives after they had been decided upon, but would have had input much earlier in the problem solving process.

In addition to alleviation of information bias, the proposed interdisciplinary problem solving model offers an advantage to the taxpayers. In this case a considerable amount of tax dollars could be saved by not having to employ consultants to tell the city what it already knew. In the Harrill Heights case, three consultants were hired at considerable expense to the city. This process not only initially wasted tax dollars, but also wasted additional tax dollars by the fact that the flooding problems took longer to solve. In addition, the almost year-long study by the city council committee to merely recommend a further study delayed the solution of the problem.

The proposed interdisciplinary problem solving model offers an economical and efficient process by which the resources of a local government can be organized to solve such problems.

CHAPTER VI

CONCLUSION

This chapter addresses two of the basic research questions which were developed in Chapter I.

1. Could the flooding problem of Harrill Heights have been avoided had current land use controls been in effect at the time of development?; and
2. Can current land use controls prevent similar flooding problems from occurring in the future and what are some examples in which land use tools were effective or noneffective in preventing flooding problems?

Effectiveness of Regulations

The basis for answering the research questions will come from two sources. First, the opinions of past and present public officials, relative to the effectiveness of the regulations for guiding development, will be discussed. Second, examples of development in the Knoxville area will be presented in order to demonstrate the effectiveness of appropriate land use regulations.

Opinions of past and present public officials. Officials responding to the research questions included the former City Engineer, his Assistant, the current City Engineer, the Assistant to the Mayor and

the former Councilman for the Fourth District (which includes Fountain City and Harrill Heights).[164]

All the engineers replied to both research questions in the affirmative. The Assistant to the Mayor supported the opinion of the engineers. He also voiced confidence that the regulations his staff implemented would avoid future flooding problems. The only public official giving a negative response to the questions was the former councilman of the Fourth district. He expressed satisfaction with the regulations but added that it was his opinion that no set of land use regulations could be produced to guarantee that political factors would not override the regulations.[165]

The engineers responding to the research questions all had some part in the strengthening regulations for drainage and flood control. Prior to the mid-1970's the City of Knoxville had adopted revised subdivision regulations that were more stringent regarding lot drainage. These regulstions included a clause limiting development in sinkhole areas. An additional requirement called for design of storm drainage systems. The regulations also included the design specifications and display of the proposed drainage system on the subdivision plan. The entrance of the City of Knoxville into the National Flood Insurance

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[164]Interviews with Robert Bowers, City Engineer; Don Mauldin, former City Engineer; Don Porter, former Assistant City Engineer; John Murrian, Assistant to the Mayor; and Milton Roberts, former Councilman of the Fourth District; Knoxville, Tennessee; February 1979.

[165]Ibid.

Program required compliance with federal mandates to strengthen flood plain zoning districts. These zoning districts were amended by the city council to conform to federal requirements and are administered currently through the Metropolitan Planning Commission staff.

Flood control in Knoxville was further strengthened in 1976 when the city council adopted an ordinance which required detention ponds for storm water control in new developments. The importance of detention ponds is that runoff is temporarily detained in a pond and slowly released downstream. The function of the ponds is to reduce stormwater peak flows on the downstream system. An added benefit is infiltration of detained water into the groundwater system.

The current City Engineer prepared a flood hazard prevention ordinance. The ordinance was passed by the city council in 1978 requiring that all new construction and substantial improvements were to be built with materials and utility equipment resistant to flood damage. In particular all new or replacement water and/or sewer systems were required to be constructed in such a way as to prevent infiltration of the system of runoff or groundwater.[166]

The engineers interviewed were unanimous in their opinion that regulations currently in effect would prevent a problem such as Harrill Heights from occurring in the future. All agreed that, had Harrill Heights been in the City of Knoxville, and had the current

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[166]For a detailed discussion of drainage control and flood plain management regulations in Knoxville, Tennessee, see Chapter II, pp. 32-35.

land use regulations been in effect in the 1950's, the flooding of Harrill Heights would have been avoided.

Examples of development. Although the enactment of ordinances is a sign of progress regarding flood plain management, the true test of the effectiveness of such ordinances is in the enforcement. The four examples used in this chapter indicate which combination of regulations actually works to prevent future flooding problems.

The Farmington West subdivision in west Knoxville, off Middlebrook Pike, provides an example of the necessity for the detention pond requirement. This single family residential subdivision was approved immediately prior to enactment of the detention pond ordinance. As a result of this timing, Farmington West developers were not required to provide detention ponds. The stormwater management systems required for this subdivision consisted of routing stormwater from side and rear yard lots through swales to roadside swales and on to larger ditches and culverts. The inferiority of this stormwater management system is evident in the numerous reports of flooded streets and accumulation of sediment on streets which has occurred as a result of an overflow of stormwater in the roadside swales. Had detention ponds been in place the flooding problems could have been alleviated.[167]

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[167]Office of the City Engineer of Knoxville, Tennessee, Final Plat of the Farmington West Subdivision, Approved February 4, 1977.

The following three examples involve subdivisions which were approved following adoption of the ordinances requiring detention ponds and construction with materials which are flood resistant.

The Hickorybrook subdivision is a single family residential subdivision in west Knoxville, off Northshore Drive. The subdivision contains approximately 175 residential lots. The stormwater management system was designed to hold one acre-foot of storage in the detention pond. The ditches along Northshore Drive are near capacity for storm flow peaks. Any substantial increase in peak stormwater flows in the ditches would threaten three homes near the ditches with flooding. By temporarily storing runoff in the detention ponds these homes have been protected from flooding by stormwater.[168]

Williamsburg Apartments in north Knoxville, on Inskip Drive, provides another example of a situation in which subdivision regulations in combination with the use of detention ponds has prevented a flooding problem. A detention pond on the site has a capacity of 1/4 acre-foot of water storage. Prior to development the runoff from the undeveloped site flowed into a creek that passed under Inskip Drive. The culvert under Inskip Drive was near capacity at the time of development. Had the detention pond not been provided for, a situation could have occurred in which stormwater flow peaks increased greatly causing backwatering at the culvert, which would have resulted in flooding of two homes in the development.[169]

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[168]Bill Elmore, List of Developments prepared for Alice Ogg, Office of the City Engineer, Knoxville, Tennessee, June 1979.

[169]Ibid.

The final example is the Westwood Apartments in West Knoxville, located off Lake Brook Boulevard. This example shows how an apparent negative can be turned into a positive. The sinkhole on this site called for stringent controls. However, in this case the sinkhole was used as a detention pond. To develop the site at the proposed intensity, four acre-feet of storage capacity was required. With the use of a supplemental detention pond, which drains into the sinkhole, the requirement was met and development approved. The requirement for the large amount of detention capacity was mandated by the fact that all storm sewers in the vicinity were at capacity and no allowance for discharge from the sinkhole was allowed.[170]

These four examples demonstrate the effectiveness of applying regulations to development with the result of flooding problems being avoided. Prior to adoption of the detention pond ordinance, control of flooding was at best questionable, at the worst wishful thinking. The Farmington West subdivision illustrates this point and the final three examples emphasize the effectiveness of more stringent regulations and combinations of regulations.

Concluding Remarks

Planners in this study were recommended to act as a lead agency in local governments for the resolution of urban flooding problems. This recommendation was based on the assumption that planning departments would have an interdisciplinary staff made up of administrative and technical

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[170] Ibid.

planners. Such expertise could study the many aspects contributing to an urban flooding problem.

The same interdisciplinary staff should be performing another essential planning function simultaneously while resolving current flooding problems. This coinciding function is to regulate new development/redevelopment to prevent future flooding. Planners may exercise flood prevention through the enforcement of land use controls: subdivision regulations, building, floodproofing requirements, drainage regulations, and zoning powers, i.e., flood plain districts. These land use controls need to be stringent standards designed to prevent future flooding problems.

Important changes have occurred in flood plain management in the more than 20 years since Harrill Heights was developed. If no development existed today in the Harrill Heights area, it is probable, considering the advancement of knowledge in flood plain management, that the area would have been developed using the sinkhole as a detention pond instead of building 21 homes which had to be purchased by the city because of flood damage. Flood plain management techniques are at the point at which, when judiciously applied, they can prevent flooding problems. As in other areas of knowledge, mistakes are made, and learning through trial and error has occurred.

Advances in flood plain management are always possible. The model proposed in this study could be used to achieve more economical and efficient planning. Using a planning department in conjunction with this suggested process could alleviate what can be an excessively political decision making process and save tax dollars.

With the above in mind, it should be pointed out that, as the councilman from the Fourth District said, any plans, no matter how perfect, can be overridden by the political factors. Certainly it is not the purpose of this study to recommend a bureaucratic short circuiting of the democratic process, no matter how imperfect it may be. It is, however, the intention of this study to recommend better use of existing expertise in solving problems.

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5. Final Plats of Harrill Heights Subdivision. Set of 2, No. 35650. Approved 12/10/54.
6. Geological Maps of Knox—TVA.
7. Final Plat of Farmington West Subdivision. Approved 2/4/77.

APPENDICES

APPENDIX A

DEFINITIONS

The following is a listing of terms and definitions used in this study.

Base Flood—is that flood which has a 1 percent chance of occurrence in any given year (also known as a 100 year flood). This term is used in the National Flood Insurance Program to indicate the minimum level of flooding to be used by a community in its floodplain management regulations.

Base Floodplain—the 100 year floodplain.

Building Code—A collection of regulations adopted by a local governing body setting forth standards for the construction of buildings and other structures for the purpose of protecting the health, safety, and general welfare of the public.

Channel—A natural or artificial watercourse of perceptible extent, with definite bed and banks to confine and conduct continuously or periodically flowing water. The top of the banks form the dividing lines between the channel and the flood plain.

Design Flood—The selected flood against which protection is provided, or eventually will be provided, by means of flood protection or control works. It is the basis for design and operation of a particular project after full consideration of flood characteristics, frequencies and potentials, and economic and other practical considerations.

Designated Floodway— The channel of a stream and that portion of the adjoining flood plain designated by a regulatory agency to reasonably provide for passage of flood flows.

Fault—Faults are subsurface ruptures where opposite walls of rock move past each other.

Flood—An overflow of lands not normally covered by water and that are used or usable by man. Floods have two essential characteristics: the inundation of land is temporary; and the land is adjacent to and inundated by overflow from a river or stream or an ocean, lake, or other body of standing water. Normally a "flood" is considered as any temporary rise in stream flow or stage, but not the ponding of surface water, that results in significant adverse effects in the vicinity. Adverse effects may include damages from overflow of land areas, temporary backwater effects in sewers and local drainage channels, creation of unsanitary conditions or other unfavorable situations by deposition of materials in stream channels during flood recessions, rise of ground water coincident with increased stream flow, and other problems.

Flood Control—The elimination or reduction of flood losses by the construction of flood storage reservoirs, channel improvements, dikes and levees, bypass channels, or other engineering works.

Flood Damage Stage—The stage or elevation in a stream or body at which damage becomes significant in the reach or area in which the elevation is measured. It is generally comparable to "flood stage" and has been commonly referred to as "flood stage" by the USWB and others.

Flood Duration—The total length of time the stream is above flood stage.

Flood Frequency—The average interval of time, based on the period of record, between floods equal to or greater than a specified discharge or stage. It is generally expressed in years.

Flood Fringe—The portion of flood plain between the limits of the designated floodway and the limits of the flood selected for controlling elevations.

Flood Peak—The maximum instantaneous discharge of a flood at a given location. It usually occurs at or near the time of the flood crest.

Flood Plain—The relatively flat area or low lands adjoining the channel of a river, stream or watercourse, or ocean, lake, or other body of standing water, which has been or may be covered by flood water.

Flood Plain Regulations—A general term applied to the full range of codes, ordinances, and other regulations relating to the use of land and construction within the channel and flood plain areas. The term encompasses zoning ordinances, subdivision regulations building and housing codes, encroachment line statutes, open-area regulations, and other similar methods of control affecting the use and development of the areas.

Flood Probability—The percentage chance of a flood equal to or greater than a specified discharge or height occurring during any one year.

Flood Proofing—A combination of structural changes and adjustments to properties subject to flooding primarily for the reduction of flood damages.

Flood Recession— The phase of a flood during which the stage or discharge is decreasing.

Flood Stage—The stage or elevation at which overflow of the natural banks of a stream or body of water begins in the reach or area in which the elevation is measured.

Floodway—The channel of a stream and that portion of the adjoining flood plains designated to provide reasonably for passage of flood flows without significant heading up.

Floodway District—An area designated in a zoning ordinance as a separate district to provide for the passage of flood flows without causing significant heading up. Uses permitted within the district are compatible with the degree of flood risk involved.

Natural Floodway—The channel of the stream or body of water and that portion of the flood plain that is inundated by a flood and therefore used to carry the flow of the flood.

Sinkhole—A sinkhole is surface opening on land caused by carbonic acid dissolving underground limestone strata. The result is a movement of the underground limestone which can cause the opening up of a large hole on the surface terrain. Sinkholes are also formed when cave roofs collapse.

Subdivision Regulations—Regulations and standards established by a local authority, generally the local planning agency, with authority from a state enabling law, for the subdivision of land in order to secure coordinated land development, including adequate building sites and land for vital community services and facilities such as streets, utilities, schools, and parks.

Thrustfault—It is a fault where a layer of rock has moved up to overhang on top of another layer of rock. The overhanging wall of rock folds over the lower wall of rock.

Thrusthead—It is a zone between two thrustfaults; a subterranean valley.

Thrustsheet—In a thrustfault, the older rock usually rests on a younger rock. The younger rock is the thrustsheet. A sheet is a thin layer of rock.

Zoning Ordinance—An ordinance adopted by a local governing body, with authority from a state zoning enabling law, which, under the police power, divides an entire local governmental area into districts and, within each district, regulates the use of land, the height, bulk, and use of buildings or other structures, and the density of population.

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APPENDIX B

COMPUTATION OF PROBABLE FLOOD DAMAGES

Benefits were considered to be the flood damage reduction which would result by implementing the recommended storm water management scheme. Probable flood damages for each year over the next 25 years were computed. The computations were carried out by performing the following operations:

1. Calculating the chance of each flood of rank i occurring exactly in each of the next 25 years, j, R(i,j).
2. Then summing the probable damages for each year and accumulating over the 25 years.

Probable flood damages, FD(j), in year j associated with a flood rank i are

$$FD(j) = \sum_{i=1}^{20} R(i,j) \times D(i)$$

Total Damages TD(25) over the 25 years are:

$$TD(25) = \sum_{j=1}^{25} \sum_{i=1}^{20} R(i,j) \times D(i)$$

These operations were computerized.

Source: Donald L. Overton, "Optimum Stormwater Management Plan for Minimizing the Flood Hazard of Harrill Heights Subdivision Near Gaines Road and Clairmont Avenue," Final Report to the Mayor and City Council of Knoxville, Tennessee, 1974, p. 67.

VITA

Alice Elaine Ogg was born in Knoxville, Tennessee, on July 20, 1951. She is the daughter of Mr. and Mrs. Wendall W. Ogg of Knoxville. Ms. Ogg has traveled widely due to overseas employment of her father. She graduated from high school in June of 1969 from the American International School of Vienna, Austria.

Ms. Ogg attended The University of Tennessee, Knoxville, and received an undergraduate degree in December of 1975, a Bachelor of Science in Agriculture. Her specialization in the Agricultural School was Ornamental Horticulture and Landscape Design.

She attended the Graduate School of Planning at The University of Tennessee, Knoxville. During her graduate studies she participated in a joint program sponsored by the Architectural School of The University of Tennessee and the Vice Ministry of Planning of Nicaragua in Managua, Nicaragua.

Upon completion of her Master's Degree, Ms. Ogg's career objectives are to be a professional environmental planner.