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A PROGRAM FOR REDUCING THE NATIONAL FLOOD DAMAGE POTENTIAL

MEMORANDUM

OF THE

CHAIRMAN TO MEMBERS

OF THE

COMMITTEE ON PUBLIC WORKS

UNITED STATES SENATE

EIGHTY-SIXTH CONGRESS

FIRST SESSION

AUGUST 31, 1959

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LETTER OF SUBMITTAL

AUGUST 31, 1959.

To the Members of the Committee on Public Works:

The Board of Directors of the Tennessee Valley Authority have transmitted to Congress a study and report entitled "A Program for Reducing the National Flood Damage Potential." This study is made under the authority of section 22 of the Tennessee Valley Authority Act, and contains much information of value to residents of the Tennessee River Basin and adjoining territory, and to the Congress.

The report discusses the enroachment of human activities on the flood plains of our streams, and the means of controlling such development to reduce probable flood damages. It is realized that with the increasing urbanization of our Nation, development and use of areas subject to flood hazards is also increasing. In many of these areas, flood protection is neither physically nor economically feasible.

Section 3 of the Flood Control Act of 1938 authorizes the evacuation of an area subject to flooding, when the cost of such evacuation does not exceed the cost of providing flood protection. States and communities can play an important role in encouraging sound land use through the enactment and enforcement of appropriate zoning and other regulations, standards, and codes.

The report contains the comments of various Federal agencies. Because of the public interest involved, and the belief that it might prove helpful to members of the Committee on Public Works, and other Senators. I am forwarding several copies for your use.

DENNIS CHAVEZ,
Chairman, Committee on Public Works.

LETTER OF TRANSMITTAL

TENNESSEE VALLEY AUTHORITY,
Knoxville, Tenn., March 9, 1959.

HON. RICHARD M. NIXON,
The President of the Senate,
U.S. Senate, Washington, D.C.

DEAR MR. NIXON: The Board of Directors of the Tennessee Valley Authority is pleased to submit for the information of the Congress a report entitled, "A Program for Reducing the National Flood Damage Potential," which has been prepared pursuant to section 22 of the Tennessee Valley Authority Act and Executive Order No. 6161 (June 8, 1933), providing for—

* * * surveys of and general plans for said Tennessee Basin and adjoining territory as may be useful to the Congress and to the Several States. * * *

Communities throughout the Nation are engaged in a new contest with their rivers and they are losing. They will continue to lose unless steps are taken to provide a new perspective—and a new channel of action—with respect to floods.

The problem arises from the basic fact that there are some floods which cannot be prevented and many cities that cannot be fully protected economically with artificial works such as dams and levees. Coupled with this fact is the rapid growth of urban communities, creating new pressures to utilize inviting but hazardous flood plains for subdivisions, shopping centers, commercial establishments, and other improvements. This mushrooming trend is creating new flood-damage potential faster than construction works can add to existing protection. New demands for Federal flood-control expenditures thus are created.

TVA believes that local communities have the responsibility to guide their growth so that their future development will be kept out of the path of floodwaters. With the States and communities of the Tennessee Valley, TVA has developed a means of putting this proposition into action. This experimental program has operated successfully for 6 years. It incorporates the concept of flood-damage avoidance as a partner of flood control just as forest-fire prevention is an indispensable arm of forest-fire control. It is saving lives and property in the area while diminishing the future demands on the Nation for flood-relief and flood-control expenditures. We believe the same results can be accomplished by adapting this experience to other areas throughout the United States. The pace of river-control development in relation to the even greater rate of urban encroachment makes it urgent that this broader concept be made a part of our national flood-control policy.

The key to the success of the TVA plan lies in the cooperation of State and local agencies. They are the bodies which must make the basic decisions to guide the growth of their communities so as to avoid

the low-lying areas vulnerable to floods. They must, of course, be able to obtain and use adequate technical data on storm probabilities and the behavior of floodwaters. The sciences of meteorology and hydrology long have been capable of supplying such information, and much of this kind of data is already available from the activities of several Federal agencies, in addition to TVA. To put the information to work, therefore, it is essential that a working relationship be established between Federal agencies which can furnish and interpret the data, and State and local bodies which can use it in preparing their development plans.

TVA believes the findings of this report and the program which it recommends will be useful to the legislative and executive branches of the Federal Government, as well as the States, in seeking to reduce the national flood damage potential.

The report has been submitted to the Office of the President. The Director of the Bureau of the Budget has replied that—

> while the administration is not prepared at this time to recommend additional legislation to put into effect all the aspects of the program suggested in the TVA report, we believe that the report is a valuable contribution and should be submitted to the Congress for its consideration.

We are forwarding the Director's letter, together with the comments of other interested Federal agencies.

We submit the report for appropriate reference and hope it can be published, together with appendixes, as a public document for wide distribution.

Respectfully yours,

HERBERT D. VOGEL,
Chairman of the Board.
ARNOLD R. JONES, *Director.*

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A PROGRAM FOR REDUCING THE NATIONAL FLOOD DAMAGE POTENTIAL

I. Introduction

No major section of the Nation is immune to flood hazards. The floods in recent years in New England, New York, Pennsylvania, Indiana, Illinois, Tennessee, Virginia, Kentucky, Texas, Oklahoma, Kansas, and California illustrate the fact that the flood plains of American rivers—both along the main streams and extending up the smallest tributaries—are potential danger areas. And along many of the low-lying coastal areas abnormal tides and waves pushed on shore by hurricanes batter and flood those structures built close to the sea. The disasters which occurred in Rhode Island in 1954, in North Carolina in 1955, and Louisiana in 1957 are example.

There are two basic approaches to the problem of flood-damage prevention. One is to control the extent of flooding by the construction of dams, reservoirs, levees, and other protective works. The other is to reduce the damages by adjusting the use of land to the flood hazards. Up to now, attempts to solve the problem have been directed almost exclusively to the use of flood-control structures. This was a natural development. In our early history it was convenient and often necessary to build homes and factories in the flood plains along rivers and streams. Our ancestors depended on the streams for drinking water, food, and transportation, and also for power for their mills and factories. As a result, the earliest towns and communities sprang up along the riverbanks and large portions of them were build on land which was subject to periodic overflow.

While the communities were small, the damages from flooding were correspondingly small and little effort was made to guard against them. As communities grew and the flood problem became greater, the people turned to the State and Federal Governments for help and billions of dollars have been spent in providing dams, levees, and other protective works. These works protect the existing investment in many industrial centers which are vital to the Nation's economy, and they produce large flood control benefits. However, they provide only a partial answer to the flood problem. There are many urban communities where flood problems still exist and the flood damage potential continues to grow. In many of these cases protective works are economically infeasible.

Modern advances in the technology of power, transportation, communication, and water supply have eliminated the need for most types of buildings to be located in flood hazard areas. In spite of these, technological advances an increasing number of new residential subdivisions and commercial and industrial establishments are being built in areas unprotected or inadequately protected from flood hazards. New flood problems are thus being created at the same time that vast

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expenditures are being made to alleviate existing problems. Because these new developments are so extensive, major sections of the Nation are actually losing ground in their efforts to reduce the potential flood damage.

The Tennessee River, with its system of dams and reservoirs, is one of the best controlled rivers in the world, but we are finding in the Tennessee Valley that flood control works alone are not enough. Such works are essential to protect the existing investments and to provide for full use of valuable lands in flood hazard areas. However, they need to be supplemented by other measures which will result in the adjustment of land uses and future developments to flood conditions in the hazard areas. TVA has found that through cooperation by Federal, State, and local governments a plan of adjusting to floods can be put into effect which holds promise for reducing the flood damage potential and thus lowering the cost of flood control to the American taxpayer by reducing the need for additional protective works.

This report briefly traces the history of Government participation in flood control works, outlines the comprehensive program begun 5 years ago in the Tennessee Valley, and suggests lines of action by while the program could be implemented on a national scale.

II. Flood Control as a National Program

Early State and local efforts to protect against floods

The first protective works of any consequence in the United States were the levees along the banks of the Mississippi River at New Orleans, started in 1717 by the plantation owners. By 1812, about 340 miles of river were leveed on both banks. Levee construction by non-Federal interests continued until 1917, with the peak of construction occurring in the 1850's.

The Miami and the initial development of the Muskingum Conservancy Districts in Ohio, the Hudson River Regulating District in New York, and projects undertaken by the State of Pennsylvania are other examples of early efforts by local groups to prevent flood damage. Other State and local agencies have undertaken flood protection works, but in the past 20 years the Federal Government has borne most of the expense.

Federal flood-control activities

In 1879 Congress created the Mississippi River Commission. The Commission operated under the Secretary of War and was charged with preparation of plans to improve the Mississippi River channel, protect the banks, improve navigation, prevent destructive floods, and promote and facilitate commerce and the postal service. This was the first direct Federal participation in flood protection.

In 1917 Congress appropriated $45 million for flood control, the first Federal appropriation specifically for that purpose. The policy of local cooperation was affirmed by requiring substantial local contributions to construction costs. This legislation also recognized the multiple-purpose concept by specifying that flood control surveys should include power and other functions. These activities were placed under the Corps of Engineers.

In 1924, Congress authorized flood surveys on many streams. These surveys were extended by the River and Harbor Act of 1927,

which adopted the provisions of the historic House Document 308, and authorized surveys of navigable streams in the United States except the Colorado for the purposes of navigation, waterpower, flood control, and irrigation. The 1927 act was of far-reaching significance in that it laid the groundwork for the later adoption of the 1936 Flood Control Act.

Following a disastrous flood on the lower Mississippi River in 1927, Congress adopted a comprehensive flood protection plan for the Mississippi in May 1928. This plan included new and strengthened levees, channel improvements, bank protection, cutoffs to shorten the river channel, emergency spillways to discharge excess floodwater into floodways and reservoirs. The entire cost of $325 million was to be borne by the Federal Government

In 1933 Congress created the Tennessee Valley Authority and directed that the control of floods in the Tennessee and Mississippi River drainage basins be one of its primary objectives. Under this act TVA has built a system of multiple-purpose reservoirs at a cost of about $744 million, of which approximately $184 million has been allocated to flood control.

Three years later Congress passed the Flood Control Act of 1936. That act provides for Federal participation in the cost of flood control projects—

> * * * if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected.

The work was to be done in cooperation with the States and their political subdivisions.

The Corps of Engineers was given general responsibility for planning and constructing the control works—dams, reservoirs, channels, and levees. A total of about 1,000 flood-control projects, estimated to cost approximately $11 billion, has been authorized by the Congress under this and subsequent acts and amendments.

The Congress authorized a Federal flood insurance program through passage of the Federal Flood Insurance Act of 1956. The program was to be underwritten in part by the Federal Government and ultimately in part by the States. In 1957 Congress failed to appropriate funds for operation of the program and it was therefore abandoned. Under the proposed program insurance rates were not related to flood risk. The cost of insurance to the owner of property located on high ground and subject to only occasional flooding would have been the same as to the owner of property located on lower ground and subject to frequent flooding. This would have tended to encourage development of the more vulnerable areas, thus increasing the flood damage potential and the cost to the Federal Government when floods occurred.

In summary, the Federal Government in recent years has assumed the major role in planning and financing the flood-control program. The historic approach to the flood problem has been to construct flood-control structures and protective works with little or no attention to the approach of land use adjustment.

III. Need for Additional Measures To Meet the Total Flood Problem

The Tennessee River system of mainstream and tributary dams and reservoirs provides flood relief to a composite area of 264,000 acres within the Tennessee Valley and some 4 million acres of unprotected land in the lower Mississippi River Valley. In some areas, complete protection has been afforded, while in other areas the depth and frequency of flooding have been materially reduced. Yet, there is evidence that the flood damage potential of the Tennessee Valley is increasing. This is largely due to expansion of cities and communities brought about by industrial development of the valley and decline of farm employment.

Since 1930 farm population in the valley has declined by nearly 400,000, while the number of nonfarm people—most of them living in or adjacent to cities—has increased by 900,000. Today, this urban group is 65 percent of the population. Nearly every city has experienced major expansion in its residential, business, and industrial plant. Many of these expansions have been within flood hazard areas, creating additional flood problems.

What is now happening at Chattanooga, Tenn., illustrates this point. In the 20-year period following 1937 there has been a net increase of more than 900 residential, and over 300 commercial, industrial, public, and other types of structures in areas subject to floods. The TVA reservoir system can reduce a flood of the same magnitude as the maximum of record (1867) by about 18 feet, and can reduce other great floods by substantial amounts. However, larger floods which even when regulated will produce stages as high as the record flood are still possible and levees are needed to supplement the reservoir system in order to give complete protection. Nevertheless, construction of homes and commercial buildings has been allowed to proceed in the potential flood damage areas and damages during great floods would amount to many millions of dollars in spite of protection afforded by the reservoir system. The city is beginning to meet the problem by restricting new development in the lower sections of the flood plain.

The increase in the flood damage potential of the valley is not confined to areas along the Tennessee River and its major tributaries. Cities throughout the valley are growing. Many of these are upstream from the reservoirs themselves, and much of the new growth is occurring in flood hazard areas. Examples are Kingsport, Gatlinburg, Bristol, and Dayton, Tenn. As growth continues the flood damage potential becomes greater.

These trends will continue as the Tennessee Valley becomes more and more urbanized. It is estimated that by 1975 some 80 percent of the population will be nonfarm. On the record of past experience, this can only result in greater development of flood plain areas unless steps are taken to hold the development in such areas to a minimum.

The movement of new development into flood plain areas in the Tennessee Valley is not unique. The spread of development into flood hazard areas along the coasts and rivers of the United States is increasing to such an extent that the flood damage potential of the entire Nation is growing despite large Federal expenditures for flood control. Review of the 50-year record of flood damages since 1902

shows that average annual reported losses have increased and that losses during the last half of the period were twice as great as those in the first half, after allowing for changes in the value of the dollar. Part of the increase is accounted for by the somewhat greater amount of flooding which occurred in the last half of the period, but this is offset to some extent by the expenditure since 1936 of several billions of dollars for flood control works.

According to Gen. S. D. Sturgis, then Chief of Engineers, U.S. Army ("The Annals of the Academy of Political and Social Science," January 1957), some 1,000 flood-control projects have been authorized under the 1936 Flood Control Act and subsequent acts and amendments. The estimated cost of these projects was $11 billion, including the $6 billion spent on 400 projects completed or under construction as of 1956. Some 300 additional projects are active and ready for construction at an estimated cost of $3 billion, and 300 more costing $2 billion are inactive or subject to review.

The Sturgis report estimated that the average annual flood damage potential in the project areas alone as of July 1954, without Federal protective works, amounted to $911 million. Works in full or partial operation would prevent damage of $491 million; works under construction but not in operation would prevent damage of $83 million; and works authorized but not started would prevent damage of $137 million, leaving a remaining damage potential of some $200 million for which no protection has been considered. The present Federal program of protective works may therefore prevent about three-fourths of the damage potential for existing development of the flood plains in these project areas. Of course, the project areas do not encompass all flood hazard locations within the Nation and consequently the damage potential is much greater.

At present rates of construction the existing program might be completed in from 25 to 30 years. But in the meantime new flood hazard areas will be developed. It is estimated that by 1975 the national population will have increased by 55 million, with most of the increase in urban areas. This continued national growth and resultant development of flood plain lands will require additional protective works which were not included in the foregoing estimated costs.

Recent studies by the University of Chicago point out that between 1937 and 1957 development in the flood hazard areas of the Nation has increased substantially. Further, present information indicates that development taking place in the flood plains of major sections of the Nation is outstripping the current flood control program and the Nation's ability to pay for the protection of these newly developed flood hazard areas. These data also indicate that flood protection structures alone cannot do the whole job. If the growing flood problem now facing the country is to be solved, the program must be reinforced by other methods and techniques which will prevent the flood damage potential from increasing.

IV. The TVA Approach to Local Flood Problems

In 1953 TVA began a cooperative program in which flood damage prevention is considered a problem of adjusting the use of the land to the conditions existing in areas subject to flood. Viewed in this manner, the prevention of local flood damage becomes an essential

part of community planning and development. It means giving adequate consideration not only to dams and other protective structures, but also to the use of zoning and subdivision regulations. to land acquisition for parks and open spaces, to planning of streets and utilities, and to construction standards for buildings which must be located in flood hazard areas. It requires cooperative effort on the part of Federal, State, and local government groups, but places in local hands the responsibility for solving the problem.

The various cities and communities have been advised that TVA will assist them, at their request, in making a study of their particular flood problems. When a community requests information on its flood situation, TVA draws on the large amount of flood data which it has already assembled in planning and operating its system of reservoirs. It supplements these data wherever necessary and prepares a report outlining the flood hazard for the particular locality. (See appendix A.) The completed report is furnished to the State planning agency and its technicians then assist the local planning commission in using the data. The report provides information on historical floods and estimates the size of floods that may be reasonably expected in the future. The report does not attempt to recommend plans for solving the flood problem but provides a basis for further study and planning on the part of the community itself.

In the past, local governments have asked Federal agencies for reports directed toward the single purpose of justifying protective works. Such reports usually do not give a community sufficiently detailed data to appraise its overall flood problem. On the other hand, the flood data in the TVA reports are presented in a form useful to Government agencies, industries, financial institutions, local officials, and private individuals interested in adjusting their activities to the flood conditions. Flood profiles showing the slope of the stream and the height of the flood crest, as well as maps and cross sections showing areas flooded, are included in the reports.

More than 50 communities in 5 States have requested such assistance of TVA through their respective State planning organizations. Flood reports have been prepared for about 35 communities. Approximately 10 reports are completed each year.

Planning studies by State and local planning agencies (see appendix B) resulting from TVA s flood reports have been completed for 10 communities. These planning studies usually lead to a proposal for establishment of a floodway for the stream in which structures that would block or unduly interfere with floodflows would be prohibited. Permissible uses of the floodway might include parking lots, outdoor theaters, and similar facilities not subject to severe flood damage. Buildings along the fringes of the floodway would have floor levels at an elevation which would be above the flood stage for which the zoning was adopted.

Six cities have officially adopted flood plain zoning. In each case the new zoning ordinances were approved by the local planning commission and the city council. Other communities are now making planning studies to determine how improvements in flood hazard areas should be controlled.

A variety of uses have already been made of TVA's flood reports. At Lewisburg, Tenn., the city, Federal Housing Administration, and Veterans' Administration used TVA's flood data as a basis to prevent

the opening of two subdivisions already laid out in areas subject to frequent flooding. Without the data, the subdivisions would have been approved and financing would have been arranged. Twenty or more houses would have been completed in time to be flooded 4 or 5 feet deep during the flood of March 1955.

City officials in Cleveland, Tenn., expanded their purchase of a school site to include flood-free land suitable for buildings. The land which is subject to flooding is being used for playgrounds. Also, officials of Chattanooga, Dayton, and Spring City, Tenn., have used flood data in planning new school buildings.

Maggie, N.C., a community with a high potential as a mountain tourist center, is using TVA's flood data in planning its development without the force of official zoning or other regulations.

Shelbyville and Knoxville, Tenn., have used flood information in planning urban renewal projects which include relief from flood damages.

The Veterans' Admlnistration, Federal Housing Administration, Public Housing Administration, and Urban Renewal Administration have all used the flood reports in processing home loans and planning public projects. Highway, industrial development, and other departments of the States make use of the flood information in carrying out their programs.

Significant reduction in flood damages through these means is necessarily a slow process. However, once local communities understand the problem they can accomplish a great deal through a program of land use controls for developments in low-lying areas. The acceptance that local governments have accorded the concept of land use regulation in the Tennessee Valley indicates it would have successful application in other regions.

An important aspect of this approach is the placing of responsibility for solving local problems in local hands. Federal initiative in this field has led to Federal responsibility for the total problem, including project justification, design, construction, and financing, as is so well illustrated by events since passage of the Flood Control Act of 1936.

V. Summary and Recommendations

The historical approach to the reduction of flood damage has been to construct protective works—dams, reservoirs, dikes, and levees—with little or no attention to preventive measures. In the past 20 years the Federal Government has been responsible for constructing and financing most of these projects. Although they protect existing developments, the total flood damage potential of the Nation continues to grow each year. It would be uneconomical to protect all newly developed areas, and at present rates of construction, it could never be accomplished. A new approach is needed.

TVA has found that a comprehensive plan involving Federal, State, and local government cooperation can be put into effect which will control the growth of the flood damage potential. This plan is one of adjusting the use of floodable lands to the local conditions and requires that new emphasis be placed on three major points:

(*a*) An expanded program for collection, analysis, and wider use of flood data.

(*b*) A broad approach to flood damage abatement which includes preventive as well as corrective measures.

(*c*) More active participation by State and local governments in solving the flood problem.

A. An expanded program for collection, analysis, and wider use of flood data

Fundamental to a flood damage abatement program is an understanding of the nature and extent of the flood problem. This means that adequate information about storms and floods must be available. TVA's reports suggest one approach to the type of flood study needed. Desirable information would include the magnitude, height, areas of inundation, duration, and other characteristics of both historical floods, and floods that may be expected in the future. Once collected, the data must be presented in a form which can be easily understood.

The present programs for collecting and analyzing flood data need to be expanded areawise and placed on a continuing and more systematic basis. These programs are of wide regional significance and therefore should be sponsored by the Federal Government either directly or in cooperation with the States.

B. A broad approach to flood-damage abatement which includes preventive as well as corrective measures

Except for a few instances, current flood control activity is centered on corrective measures—dams, reservoirs, and local protective works built by the Federal Government. These are oriented almost exclusively to the correction of existing problems resulting from intensive use of flood hazard areas. They have successfully reduce the heights and frequency of floods; but economic considerations place limitations on the extent of protection which they can give. Usually a residual flood problem remains.

Understanding this limitation is important. Present emphasis on corrective structures alone seems to be predicated on the assumption that areas which need protection will not expand. With the dynamic and spectacular changes taking place in the shift from an agrarian to an urban-industrial economy, the number of new homes, stores, and factories built in flood hazard areas is increasing greatly. These developments extend the problem to new areas and bring demands for additional protective structures.

To meet this situation present activities need to be supplemented by measures which will prevent the flood damage potential from increasing. This means preventing the creation of new flood problems by the use of zoning, subdivision standards, land acquisition, urban renewal, and occupancy standards for flood hazard areas. Ways must be developed through which all of these possible remedial actions may be considered in a comprehensive program for drainage basins of the country.

C. More active particpation by State and local governments in solving the flood problem

Under the policies established by the Flood Control Act of 1936 and its subsequent amendments, the Federal Government assumed major responsibility for planning and financing protective structures. The role of the States and local communities became that of approving and supporting Federal projects.

Yet the powers to adopt land use regulations belong to State and local governmental units. These powers must be used if new developments are to be prevented from spreading into flood hazard areas and thereby increasing the Nation's flood damage potential. Use of these powers depends upon States and localities assuming a greater share of the responsibility for meeting the flood problem.

In general, State and local responsibilities would fall in two classes. The first involves the exercise of police powers to prevent the use of flood hazard areas in a manner which will increase the flood damage potential. The second involves the assumption by State and local governments of responsibility for planning and developing local protective works. This would mean increased financial participation on the part of the States and localities in single-purpose flood protection projects whose benefits are primarily local. It would also require local initiative and responsibility for studying the total community flood problem. The community would assume responsibility for preliminary surveys as well as for the more detailed design as a preparation for construction of specific projects approved as part of the total local flood damage abatement program.

Because of the national interest and concern with water resources, Federal planning and development of projects which are parts of major stream regulation systems are essential. These systems, as under present programs, should continue to be financed largely by Federal funds.

RECOMMENDATIONS

To implement this program the following recommendations are submitted for consideration by the executive branch, the Congress, and the States:

(1) A national flood damage prevention policy should be developed. The objectives of the policy should be (*a*) to prevent the unnecessary spread of buildings and other improvements to new flood hazard areas, combined with continued efforts to alleviate damages in those flood hazard areas which have already been developed, and (*b*) to encourage appropriate State and local bodies to assume the responsibility for initiating and developing plans and programs for local flood damage abatement through construction of protective works and establishment of land use controls as necessary. The policy should also provide a basis for technical and financial assistance by Federal agencies.

(2) If protective works are economically justified as a part of the local program for flood damage abatement, the Federal financial contribution to such projects should be contingent upon the requirement that the city or State initiate and prepare engineering plans of the proposed works and that the plans be submitted to an appropriate Federal agency for review and approval.

(3) As a prerequisite for the contribution of Federal funds to local flood protective works, State and local governments should be required to adopt and administer flood plain zoning and other such controls as are needed to prevent the unnecessary spread of buildings and other improvements in areas subject to flood damage.

(4) Provision should be made to insure that all Federal agencies having responsibility related to site selection or financing of physical structures observe local flood plain zoning and other standards in carrying out their responsibilities, and in cities without land use

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controls but subject to flood damage require establishment of such controls before Federal programs are approved and put into execution.

(5) An expanded and systematic program of collecting and analyzing basic flood information by existing Federal agencies should be authorized which will meet the needs of States, local communities, industries, and others in adjusting to flood conditions.

(6) For the purpose of providing cities and communities with basic flood information on which to prepare plans for growth and development and for the prevention of local flood damages, appropriate Federal agencies should be authorized, where such authorization is necessary, to prepare upon request local flood studies which would describe and analyze the local flood situation.

APPENDIXES

Appendix A

FLOOD HISTORY OF BIG ROCK CREEK IN VICINITY OF LEWISBURG, TENN., TO MAY 1, 1957

This report describes investigations of flood conditions made on a 6-mile reach of Big Rock Creek in the vicinity of Lewisburg, Marshall County, Tenn.

No extended record of stages and discharges of Big Rock Creek has been maintained. A gaging station was operated at Lewisburg in 1933, and the U.S. Geological Survey established a gaging station at the Tennessee Highway 50 bridge in December 1953. To obtain information on floods on Big Rock Creek, field investigations were made and local residents were interviewed to locate high water marks for past floods. Careful search was made of newspaper files at Lewisburg and Nashville. From these investigations, knowledge of important floods at Lewisburg has been developed for the past 100 years or more.

Summary

1. The two greatest floods in the past 100 years at Lewisburg occurred on June 18, 1939, and on March 21, 1955. Through Lewisburg the 1955 flood was slightly greater in height and peak discharge than the 1939 flood. These floods covered the flood plain for widths up to 1,500 feet and depths up to 9 feet.

2. The third highest known flood at Lewisburg was on March 28, 1902. This flood was approximately one foot lower than the 1939 and 1955 floods. The 1902 flood was reported at the time it occurred to be the greatest in the "history or tradition" of Lewisburg and Marshall County, exceeding a previous record flood on May 6, 1856.

3. A flood about two feet under the 1939 and 1955 crests occurred on February 22, 1945. Floods of about the same height as in 1945 probably occurred on May 6, 1856, April 29, 1912, and June 21, 1926.

4. Available data show that in at least 28 of the past 100 years, the highest annual flood has exceeded bankfull stage at Lewisburg. Recording stream gage records available since 1954 indicate that minor overbank flooding may be expected several times a year. Known floods have occurred in every month except September, October, and November with the greatest number in January, February, March, April, and June.

5. The creek banks at Lewisburg are overtopped at stages of 5 to 9 feet above the stream bed. Flooding of streets and residences in Lewisburg begins on First Avenue, North, in the vicinity of the College Street intersection. Water was over 4 feet deep at this intersection in June 1939, and the overflow in that flood extended

for 1,700 feet, or more than 3 blocks, along First Avenue, North. Flooding of business places begins at a stage approximately 4.5 feet under the 1939 crest.

6. The 1939 flood entered 31 homes and 7 business or industrial buildings in Lewisburg, causing damage estimated at $20,000 at 1939 prices. The loss from a flood of this magnitude with present day prices and development of the area would be substantially greater.

7. Ten highway bridges and one railroad bridge cross the creek in the 6-mile reach investigated. Three highway bridges and the railroad bridge are within the Lewisburg city limits. All four of these bridges in the city would be overtopped by the recurrence of a 1902 or a 1939 flood.

BIG ROCK CREEK BASIN

Settlement

The Big Rock Creek watershed shown on plate 1 lies almost entirely in Marshall County, Tenn. A small part of the East Rock Creek watershed extends into Bedford County.

Marshall County was formed on February 26, 1836, from parts of Lincoln, Bedford, and Maury Counties. Early settlement of the county dates back to 1800. Lewisburg, the county seat, was incorporated on December 16, 1837, and was named after Meriwether Lewis. The city had a 1950 population of 5,164 and ranks 15th in size in the middle Tennessee area.

Lewisburg serves a prosperous agricultural area and is the location for a number of industries. The Louisville & Nashville Railroad passes through the west edge of the city while a branch line of the Nashville, Chattanooga & St. Louis Railway ends at Lewisburg. U.S. Highway 31A running north and south and Tennessee Highway 50 running east and west cross in the center of the city.

The creek and its valley

Big Rock Creek has a total drainage area at the mouth in Duck River of 121 square miles. Of this area, 52.8 square miles is drained by East Rock Creek which enters the main creek 2 miles above its mouth. The drainage area of Big Rock Creek at the Tennessee Highway 50 bridge in Lewisburg is 24.9 square miles. Collins Creek, the principal tributary above this point, has a drainage area of 5.34 square miles.

Big Rock Creek heads on the north slopes of Elk Ridge, the divide between the Duck and Elk Rivers. This ridge is an arm of the Highland Rim which projects out into the Nashville Basin. Top elevations are between 1,000 and 1,200 feet above mean sea level. The elevation of the creek banks along the Lewisburg waterfront ranges between 710 and 720. The watershed is approximately 25 percent forested with the forest cover principally in small scattered tracts.

The average fall of the creek in the 6-mile reach covered by the investigation is 11 feet per mile. The tops of the banks in the Lewisburg vicinity range from 5 to 9 feet above the streambed and average 8 feet. A stage of 8 feet at the U.S. Geological Survey gaging station has been taken as bankfull stage. The flood plain, based on the width attained by the 1939 flood, varies from 400 to 1,500 feet wide in the Lewisburg vicinity.

PLATE I



DRAINAGE AREAS SHOWN ON THIS MAP:

Big Rock Creek above mouth---121 sq mi
Big Rock Creek above Lewisburg---24.9 sq mi
East Rock Creek above mouth---52.8 sq mi

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BIG ROCK CREEK WATERSHED

Scale 0 1 2 3 4 5 Miles

JUNE 1954

As shown on plate 3, the development of the city has been almost entirely along the west or left bank of the creek. Soon after the town was settled, homes and small business places were built along First Avenue, North, which parallels the creek north of the town square. East Church and East Commerce Streets, leading from the square to the creek, were developed with a number of small stores in the early days of the city. In the past 15 years, four business places have been established along Commerce Street (Highway 50) east of the creek. These buildings are erected on an expansion of the highway fill and their floor levels are 1 to 2 feet higher than the 1939 flood crest level. Except for these four business places there has been no construction in the flood plain on the east side of the creek and this area is used for pasture and other farming purposes.

Ten road bridges and the Nashville, Chattanooga & St. Louis Railway bridge cross Big Rock Creek between miles 15 and 21 which is the reach covered by this report. The locations of these are shown on plate 3. Table 1 gives pertinent data for each bridge. Floors at five of the highway bridges are now above the level of the 1939 flood. The U.S. Highway 31A bridge at mile 18.37 was inundated by a few inches in 1939, but the bridge has since been rebuilt so that the approach fills and bridge floor are now about 5 feet higher than the 1939 crest. The U.S. Highway 31A bridge at mile 15.90 and its approach fills are also higher than the 1939 flood level. The remaining five highway bridges would be flooded by the recurrence of a 1939 flood to depths ranging from 1 foot to nearly 5 feet. The lowest bridges with respect to flood levels on the creek are Belfast Road Bridge, mile 17.99, and Old Farmington Road Bridge, mile 16.12. Both of these bridges are overtopped at stages of about 13 feet on the new Lewisburg gage. The approach roads on one or both sides of all bridges except the two on U.S. Highway 31A are at the level of the flood plain, and floods block traffic even where the bridge floors are above the high water.

TABLE 1.—*Bridge data for crossings of Big Rock Creek, vicinity of Lewisburg, Tenn.*

Mile above mouth	Identification and type	Width of clear opening	Elevations at bridge			
			Floor	Clearance	Stream bed	1939 flood crest
20.36	County bridge, steel girder	69	752.0	751.2	737.4	749.6
19.69	County bridge, concrete	51	740.3	739.3	728.4	741.3
19.30	----do	50	738.7	737.6	726.3	737.5
18.83	----do	64	732.8	730.5	719.7	732.8
18.37	U.S. Highway 31A, concrete	156	733.6	731.5	716.5	727.7
18.08	Nashville, Chattanooga & St. Louis Ry., steel girder	65	[1] 724.9	721.9	710.7	726.0
17.99	Belfast Rd., steel truss	80	720.6	719.8	707.6	725.0
17.82	Tennessee Highway 50, concrete	156	721.5	719.9	705.0	722.6
17.74	East Church St., steel truss	75	719.0	718.0	704.4	721.0
16.12	Old Farmington Rd., steel truss	60	701.7	700.8	688.7	706.3
15.90	U.S. Highway 31A, concrete	238	705.5	702.4	686.8	704.5

[1] Top of rail.

The Nashville, Chattanooga & St. Louis Railway crosses the creek at mile 18.08 with fills 8 to 10 feet above the flood plain and a single span steel girder bridge 65 feet long. In 1902 the flood in March overtopped the bridge and the then existing approach fills by several feet. A timber truss span near the left side of the flood plain and a

few hundred feet of fill were washed out. The 1939 flood again overtopped the track by about 1.5 feet.

The Lewisburg sewage disposal plant is situated on the right bank of the creek about 0.9 mile downstream from the Highway 50 Bridge The lowest structures at the plant are the final clarifying tanks where the top of the retaining wall is at elevation 711.1. The 1939 flood reached elevation 713.5 at the old pumphouse located between the new clarifying tanks. The plant building is at about elevation 730. The city water supply is obtained from two reservoirs high on the ridge slopes southwest of Lewisburg and from a pumping station built in 1944 on Duck River near the mouth of Rock Creek. The latter station was put out of operation by the high flood on Duck River in February 1948.

Collins Creek watershed

Collins Creek enters on the right side of Big Rock Creek just upstream from the Nashville, Chattanooga & St. Louis Railway bridge. This stream also heads on Elk Ridge southeast of Lewisburg and has a drainage area of 5.34 square miles. The stream bed in steep with a fall in the lower 1½ miles of 41 feet or an average of 27 feet per mile.

Backwater from the June 1939 flood on Big Rock Creek extended 0.6 mile up Collins Creek and caused wide flooding near the mouth of the smaller stream. Above the confluence of the Big Rock Creek backwater, Collins Creek overflows are limited to widths of about 200 to 400 feet and cause little damage.

FLOOD DATA

Flood records

The U.S. Geological Survey established a recording stream gage on Big Rock Creek on the downstream side of the Highway 50 bridge in Lewisburg on December 17, 1953. A staff gage was installed at the Belfast bridge, 900 feet upstream, on June 8, 1932, but observations were made only between April 17, 1933, and August 30, 1933. Except for these two brief periods, there is no continuous record of the stages and discharges of the creek.

Information on flood heights and dates of occurrence was obtained by a careful search of the Lewisburg and Nashville newspaper files and by interviews with local residents in Lewisburg and along the creek above and below the city. Two newspapers have been published in Lewisburg. Files of the Lewisburg Tribune are available from 1899 to date while files of the Marshall Gazette cover the period from 1905 to date. Papers were published in Lewisburg prior to these dates but earlier files have not been located.

The great floods of June 18, 1939, and March 21, 1955, were investigated at Lewisburg by field engineers of the Hydraulic Data Branch at the time of their occurrence. A report on the investigation of the 1939 flood has been published in the TVA bulletin "Precipitation in Tennessee River Basin" for June 1939. The investigations of the 1955 flood are described in the accompanying "Supplement No. 1." Immediate field investigations were also made after the floods of February 22, 1945, and February 13, 1948. The 1945 floods are covered in a report in "Precipitation in Tennessee River Basin" for February 1945 and the 1948 flood by the report "Flood of February 1948 in Tennessee River Basin."

Flood stages and discharges

Table 2 lists the dates of all known floods that exceeded bankful stage at Lewisburg. For the most part these dates are based on newspaper stories describing the floods. Elevations and gage heights at Highway 50 bridge are given for the 1902, 1939, and 1945 floods from profile data. Approximate stages for other floods prior to 1954 are given where the newspaper description was detailed enough to permit making an estimate of the stage. The list is necessarily incomplete since numerous minor floods no doubt occurred that were not recorded in the newspapers.

TABLE 2.—*Big Rock Creek at Lewisburg, Tenn., flood crest stages and discharges*

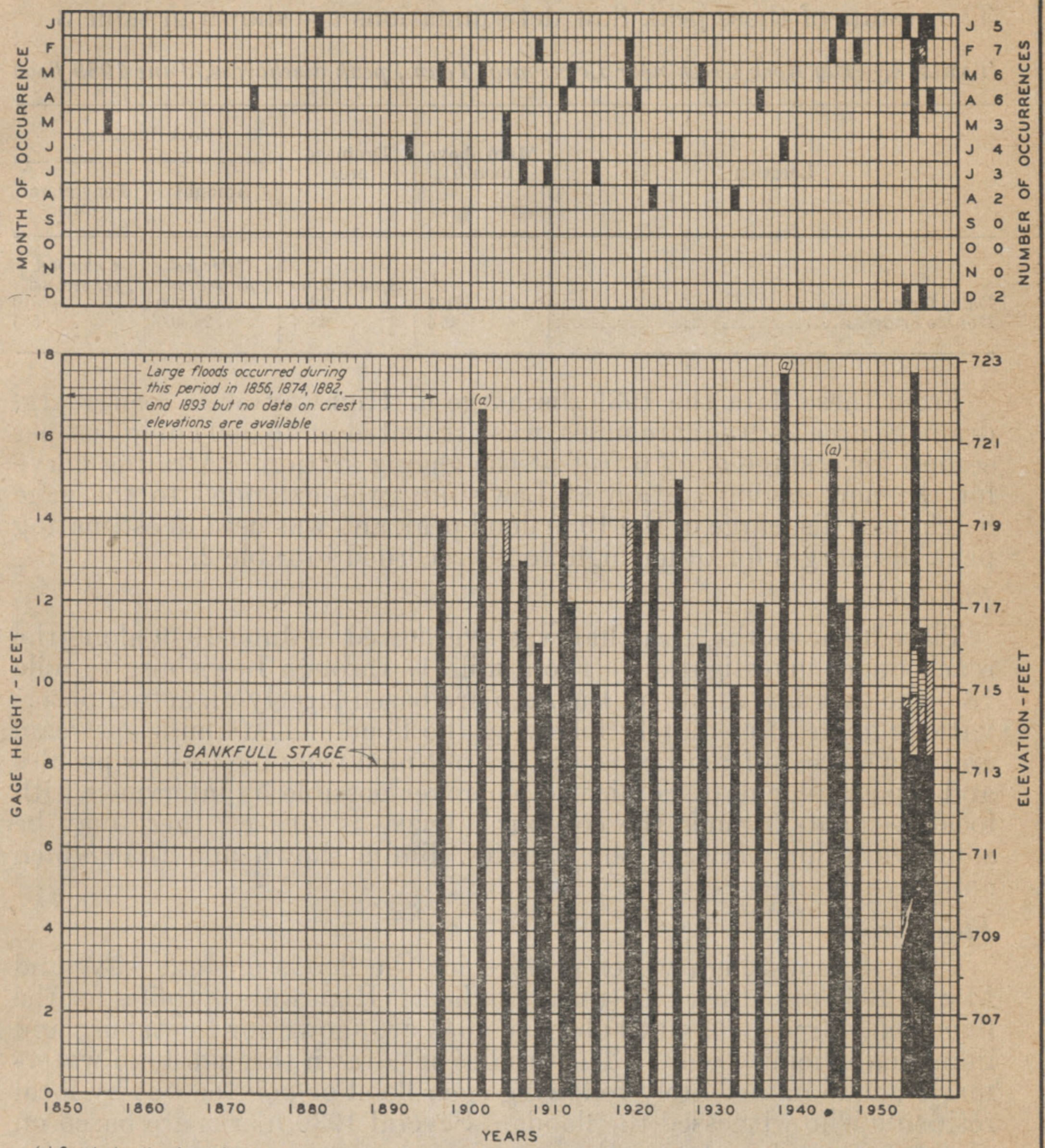
[Stages and elevations are referred to the U.S. Geological Survey gage established on Dec. 17, 1953, on the downstream side of Tennessee Highway 50 (Commerce St.) bridge. Drainage area 24.9 square miles, zero elevation 705.1, 1929 adjustment. Prior to 1954 stages are estimated from best data available]

Date of crest	Stage		Estimated peak discharge	
	Gage height	Elevation	Amount	Per square mile
	Feet	*Feet*	*Cubic feet per second*	*Cubic feet per second*
May 6, 1856	(1)			
Apr. 15, 1874	(1)			
Jan. 21, 1882	(1)			
June 1, 1893	(1)			
Mar. 19, 1897	14			
Mar. 28, 1902	16.7	721.8	13,900	558
May 23, 1905	14			
June 28, 1905	13			
July 1907	13			
Feb. 24, 1909	11			
July 17, 1910	10			
Apr. 29, 1912	15			
Mar. 13, 1913	12			
July 9, 1916	10			
Feb. 22, 1920	12			
Mar. 12, 1920	14			
Apr. 15, 1921	14			
Aug. 9, 1923	14			
June 21, 1926	15			
Mar. 24, 1929	11			
Aug. 30, 1933	10			
Apr. 6, 1936	12			
June 18, 1939	17.6	722.7	16,300	655
Feb. 22, 1945	15.5	720.6	11,000	442
Jan. 8, 1946	12			
Feb. 13, 1948	14			
Jan. 20, 1954	9.5	714.6	2,040	82
Dec. 29, 1954	9.68	714.78	2,410	97
Feb. 2, 1955	9.78	714.88	2,480	100
Mar. 21, 1955	17.62	722.7	16,700	670
Apr. 6, 1955	10.87	715.97	3,500	141
May 29, 1955	8.30	713.40	1,620	65
Jan. 29, 1956	10.30	715.40	2,910	117
Feb. 4, 1956	9.50	714.60	2,280	92
Feb. 17, 1956	9.05	714.15	2,010	81
Dec. 12, 1956	11.40	716.50	4,220	169
Jan. 28, 1957	10.59	715.69	3,190	128
Apr. 4, 1957	8.32	713.42	1,680	67

[1] Available information indicates that large floods occurred on these dates, but data are insufficient to estimate crest stages.

Plate 2 shows the stage and month of occurrence of known floods on the creek. Floods have occurred in all months except September, October, and November, with February the peak month. The larger floods have occurred in the spring and early summer. Of the two greatest floods of record, one was in March and one in June.

PLATE 2



(a) Crest elevation from high water profiles

Dates of occurrence of floods were determined from newspaper accounts. Crest elevations were estimated for all floods except 1902, 1939, 1945, and those since 1954 from the newspaper descriptions. Crests were referred to the gaging station established at Tenn Hwy 50 bridge on December 17, 1953, drainage area 24.9 square miles, zero elevation 705.1 (USC & GS 1929 ADJ)

Hatching has no significance but is used only to separate flood heights.

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FLOODS ABOVE BANKFULL STAGE

BIG ROCK CREEK
AT LEWISBURG, TENNESSEE
MAY 1957

45448—59——4

During the investigation in June 1939 of the flood of June 18, estimates were made of the discharge of Big Rock Creek near the U.S. experimental dairy farm, mile 21.1, and near Double Bridges, mile 9.4, from field measurements of high water slope and cross section area. The results of these peak flow determinations are shown in table 3.

TABLE 3.—*Big Rock Creek near Lewisburg, Tenn., peak discharges, June 1939 flood*

Location	Miles above mouth	Drainage area	Peak discharge	
			Amount	Per square mile
		Square miles	*Cubic feet per second*	*Cubic feet per second*
Dairy farm	21.1	12.0	9,700	810
Double bridges	9.4	48.4	26,400	550

From these data the 1939 discharge at Highway 50 in Lewisburg, drainage area 24.9 square miles, was estimated at 16,300 cubic feet per second for a stage of 17.6 feet at the gaging station. A rating curve for the new gaging station at Lewisburg was extended to the gage height and discharge of the 1939 flood peak and was used in estimating peak discharges for other high floods recorded in table 2.

Flooded area

Plate 3 shows the area that was overflowed in June 1939 along the reach under investigation. From mile 17 through Lewisburg to mile 18.5 the overflow limits on the map are based largely on actual observations made immediately following the flood. The limits upstream and downstream from Lewisburg are outlined from high water profiles and topographic data, confirmed wherever possible by interviews with local residents. Since the contour interval is 20 feet, there may be some variation between the overflow limits shown and that which actually occurred.

Flood profiles

Plate 4 shows high water profiles for the floods of June 1939 and March 1955 over the entire reach studied. High water profiles for the floods of March 1902 and February 1945 are shown for Lewisburg and immediate vicinity only. The profiles are drawn through high watermarks made immediately following each flood or pointed out by local residents who witnessed the floods. Several 1939 marks are based on photographs taken during the flood.

Also shown on plate 4 are profiles of the stream bed, low water, and top of banks.

Flood descriptions

The following descriptions cover the floods listed in table 2.

May 1856.—The storm of May 5 and 6, 1856, produced high floods on the small streams of Middle Tennessee and established records that stood for the next 46 years. Marshall, Maury, Giles, and Lincoln Counties were especially hard hit by this intense storm. In Maury County, Big and Little Bigby Creeks were higher "than ever before known," according to a dispatch from Columbia in the Nashville Daily Union and American. Fountain Creek, which heads about 10 miles west of Lewisburg, carried off "every bridge and every mill

* * * from head to mouth." Richland Creek and its tributaries, heading just across Elk Ridge from Big Rock Creek, "rose several feet higher than was ever before known."

At Lewisburg, Big Rock Creek reached a height in the great "May freshet" of 1856 that was not exceeded until the flood of March 28, 1902. No data are available to fix the height of the 1856 flood at Lewisburg.

April 1874.—High floods occurred in Big Bigby, Fountain, and Richland Creeks on April 15, 1874, as a result of heavy rainfall over the middle Tennessee area. Undoubtedly, a substantial flood occurred also on Big Rock Creek.

January 1882.—The Nashville newspapers again record flooding on the Duck River and its tributaries following some 20 days of rainy weather. A high flood occurred on Richland Creek and presumably Big Rock Creek exceeded bankfull stage.

June 1893.—Intense rainstorms and high floods occurred on creeks in west and middle Tennessee on May 31 and June 1, 1893. Fountain Creek west of Lewisburg was reported by the Nashville Daily American for June 3 to have been "1 foot higher than it has been in 30 years." Floods on Fountain Creek were of interest to Nashville and Columbia people because they delayed trains from the South to those two cities. Big Rock Creek nearby was doubtless affected by the storm.

March 1897.—The Nashville American for Sunday, March 21, 1897, carried the following story from Lewisburg, dated March 20:

> The heavy rains of Thursday night caused Rock Creek to reach its highest point at this place. Fences, culverts, and watergates were swept away all along the creek. In many instances people living near the banks were forced to remain indoors until the water went down. The water ran over many bridges but no serious damage to any has yet been reported. Reports from Wilhoite state that Duck River is 8 feet higher today than it has yet been during the recent rains.

The term "highest point" in the paragraph above probably means that the crest on March 19 was the highest of several during the period of heavy rains. The crest stage for the flood of March 19 has been estimated at 14 feet.

March 1902.—This was the third largest flood of which there is any knowledge on Big Rock Creek. At the time of its occurrence, the March 28, 1902, flood was the greatest known on Big Rock Creek. According to the Lewisburg Tribune for April 3, 1902:

> Never before in history or tradition has such devastation been wrought by water in Lewisburg and Marshall County. The nearest approach to last week's torrents was the great "May freshet" of 1856 which occurred on the 6th day of the month.

Big Rock Creek reached bankfull stage shortly after noon on March 28, according to the Tribune but—

> still the darkness of other and heavier torrents was on. This was more formidable on account of frequent lightning and thunder. Every stream began to swell with accelerative fury; and Rock Creek was especially violent in its rush over unwelcoming territory. The inhabitants along the creek, calling for help, began to betake themselves and property to safer grounds. But it was all practically in vain so far as saving property was concerned, for the stream rose several feet within 10 minutes. Many people were caught in their residences by the angry waters and before they could be rescued were in water waist deep. * * * The principal work of rescuing was done on the street leading from the post office toward Farmington.

The street mentioned is First Avenue North.

Damage to the railroad at Lewisburg is described in the following paragraphs:

> Mrs. Mary Gill's family, who lived at the W. R. Yowell residence in the bottom above the railroad, escaped by the railroad. They had passed over the trestle only a few minutes when it was swept from its support. The water only reached the sills of the Yowell house, however, and no damage was consequent.
>
> The damage to the railroad near Lewisburg was very heavy. Besides the loss of the trestle, about 500 yards of road was torn, leaving the roadbed clean.

Mrs. Gill's daughter, Mrs. C. C. Wallace, who is still living in Lewisburg, verified the newspaper account and showed the height the 1902 flood reached at the old home which was built before 1836 and is still occupied. The trestle mentioned is not the main creek bridge but a trestle near the left edge of the flood plain.

Two bridges, one a covered bridge on Church Street and the other on the Belfast road one-quarter mile upstream, were washed out. A story describing the Lewisburg flood in the Nashville American for March 31, 1902, says:

> The first damage done of consequence was the carrying away of a large covered bridge between the town and Needmore. The waters had risen to the floor of it when the structure was struck by the wreck of the Belfast Turnpike Bridge and they both went down the stream close together.

A woman and two children were drowned at Lewisburg and damage was done to a number of homes and business places.

High-water marks were shown by old residents for the 1902 flood and were used to define the profile on plate 4. The crest stage at the present gaging station based on this profile was 16.7 feet.

May 1905.—On May 23, 1905, a high flood occurred on Big Rock Creek which the Lewisburg Tribune said "lacked 3 feet being as high as the March flood" of 1902. The Sanders Bros. & Co. planing mill was flooded to depths of about 18 inches, as compared to submergence of most of the machinery in 1902. W. A. Braly's tanyard was flooded, and according to the Tribune this was "the third time Mr. Braly has sustained injuries within the past 20 years." The other two occasions were probably in 1897 and 1902.

The gage height of the May 1905 crest has been estimated at 14 feet.

June 1905.—On June 28, 1905, Big Rock Creek was again—

> visited by another flood * * * which undid much that had been done in the way of repairs to fences, watergates, etc., rendered necessary by the big rise of a few weeks ago, according to the Marshall Gazette of June 30, 1905. Much damage was done and farmers * * * are greatly disheartened on account of their frequent misfortunes.

The Tribune reported that "Mr. W. A. Braly again suffered heavy damages to his tanyard, the water covering every vat."

The newspapers mentioned no other flooding in Lewisburg and it was evident that the flood was lower than in May. A crest stage of 13 feet has been estimated.

July 1907.—In its issue of July 16, 1907, the Lewisburg Tribune reported that—

> The vats in the tanyard of Mr. W. A. Braly were filled with water and mud last week as a result of the high water, much damage being done to the hides in the vats. * * * This is the fourth time within the last few years that Mr. Braly has suffered this loss.

This flood was probably about the same as the June flood of 1905, or a crest stage of 13 feet.

February 1909.—A minor flood occurred on Big Rock Creek on February 24, 1909, as a result of heavy rain that followed a destructive tornado. The tornado path ranged across Marshall County from Roberson Fork to a point near Farmington, missing Lewisburg about one-quarter mile on the southeast. About 5 inches of rain fell after the tornado, according to the Tribune of February 26, 1909, "raising all the streams. The footbridge at the fairground is gone. Another bridge was washed away from Farmington."

The crest of the rise has been estimated at 11 feet.

July 1910.—An intense summer storm caused a minor rise in Big Rock Creek on July 17, 1910. According to the Tribune for July 19:

> Rock Creek was soon out of its banks and shocks of wheat could be seen floating downstream. Much of the corn crop was blown down flat on the ground.

The newspaper reported several houses in Lewisburg flooded and much damage done in the streets but this was obviously caused by surface water after the intense rain.

A stage oi 10 feet was estimated for the flood.

April 1912.—A "near approach" to the March 1902 flood was the Marshall Gazette's description of the important rise of April 29, 1912, on Big Rock Creek. The paper for Tuesday, April 30, reported:

> The rain began falling early in the night and increased in intensity until near daylight yesterday morning when the flood reached high tide. Farmlands were badly washed and stripped of fencing, bridges and culverts washed away, and the roads rendered almost impassable from drifts, washouts, etc. In Lewisburg the water stood on the floors of a number of residences, warning inmates to seek safer quarters and greatly damaging carpets and furniture.

The Lewisburg Tribune for May 3, 1912, reported the following which helps fix the height of the flood:

> The tollgate house on the Shelbyville Pike narrowly escaped being washed away by the high water. The water was a foot deep on the floors, and three pillars were washed from under it. Mr. Duncan and daughter were in the house and say they thought it was going away several times. The bridge floor was torn up so that it was impassable.

In the story on the March 1902 flood, the Tribune of April 3, 1902, said that water in the tollgate house at that time was so deep that the tollgate keeper piled wood on a chair and stood on it to get out of the flood. Apparently the water in 1902 was 2 to 3 feet deep in the house.

From the above data a crest stage of 15 feet, 1.7 feet less than for 1902, has been estimated for the 1912 flood. The Marshall Gazette called the flood "the greatest since 1902."

March 1913.—Tornadoes again swept across Tennessee on March 13, 1913, and the Marshall Gazette of March 18 reported that they were—

> accompanied by a terrific rainfall, with a heavy loss of property and damage to roads, bridges, fences, and telegraph and telephone wires.
>
> Lewisburg was visited by a severe wind and rain storm. Rock Creek was soon out of its banks and a number of residences were soon surrounded by water.

The Tribune described the tornadoes but made no mention of flooding in Lewisburg, indicating that the rise was not particularly important. A crest stage of 12 feet has been estimated.

July 1916.—Rain fell almost without intermission in Marshall County for 97 hours from the evening of July 6 to the evening of July 10, 1916. Duck River and small streams in the county were out of banks on July 9 but there was no mention in the news items of a damaging flood on Big Rock Creek. A crest stage of 10 feet has been assumed.

February 1920.—Overbank flooding occurred on February 22, 1920, from a hard rain that the Tribune reported totaled 3.53 inches in about 18 hours.

> Small streams and the river were booming with water Sunday morning * * * and much damage was done to land and fences.

Elsewhere the paper reported that—

> the heavy rains for the past several days have temporarily stopped all farming operations in Marshall County. Much of the bottom lands along the creek and river were overflowed last Saturday night and it will be a long time before they can be worked again.

There was no mention of the creek at Lewisburg exceeding damaging stage and a crest of 12 feet was assumed for the flood.

March 1920.—A "near cloudburst" fell at Lewisburg on the night of March 11, 1920, according to the Tribune for March 19. The paper described the rain and resulting flood as follows:

> Starting like a gentle spring rain shortly after dark the intensity increased until it appeared that the skies had been opened, and old Jupiter Pluvius was pouring it from buckets. The rain was accompanied by some lightning and thunder, and was the cause of much uneasiness among many of Lewisburg and Marshall County inhabitants.
>
> The damage to farmlands over the county was very great and many fences on bottom lands were washed away, the bridge at the Farmington and Shelbyville Pike was washed away, and the bridge at Farmington was washed from its base 3 or 4 inches. In several places it was almost equal to the March flood (of 1902). It came across the pike in front of the residence of Mr. Tom Arthur and nearly up to the first floor in the residence of Tom Wilson.

The description indicates a stage of about 14 feet at the present gaging station.

April 1921.—According to the Marshall Gazette for April 22, 1921, a damaging wind and rainstorm swept across Marshall County on the night of April 15—

> blowing down many houses and barns and doing much damage to timber and farmlands, and injuring a number of people.
>
> Rock Creek reached a point about as high as at any time since the memorable March flood (of 1902) and much damage was done along the stream.
>
> In all sections of the county the loss by washing lands, roads, and damage to crops is very heavy.

The crest stage was estimated to be 14 feet for this flood.

August 1923.—The Marshall Gazette for Friday, August 10, 1923, mentions briefly a flood occurring on the previous day:

> Though no serious damage has been reported there was much small damage sustained by the farmers by washing land and fencing, drowning chickens, etc. Rock Creek was out of bank and reached the highest point known since 1912.

The April 1912 flood crest was estimated at 15 feet. The August 9, 1923, crest stage was probably about 14 feet.

June 1926.—Both Lewisburg newspapers were agreed that the flood of June 21, 1926, was higher than any since 1902. The Tribune for June 24 described the flood as follows:

> While there was much damage in every section of the county, it was particularly bad around Lewisburg. The West Fork of Rock Creek which passes through

Lewisburg was higher than it has been since 1902. Several residences in the lower section were marooned for a time and the fields and lots along the bank of the stream were submerged.

The article describes heavy losses of shocked wheat, corn, and livestock along the creek and then continues:

> The creek at the crossing of the Belfast Pike ran over the floor of the bridge and it flooded over the Cornersville Pike, surrounding the residence of Mr. R. C. Armstrong, occupied by Mr. Virgil Cathey and family, covering the porch floor.

The description indicates a flood crest about 2 feet under the 1902 rise or a stage of 15 feet.

March 1929.—A high flood occurred on Duck River on March 24, 1929, and articles in the Lewisburg papers were devoted entirely to the river flood. Creeks were reported to be out of banks, but there was no specific mention of a flood at Lewisburg. It was assumed that the creek was out of its banks but below damaging stage and a crest of 11 feet was estimated.

August 1933.—The only flood during the brief early period of streamflow record occurred on August 30, 1933. The highest stage reported on the staff gage at Belfast Bridge was 9.50 feet at the regular afternoon observation, and the crest was probably higher. A stage of 10 feet at the new gage site 900 feet downstream has been estimated for this crest.

April 1936.—Torrential rain and hail accompanying a damaging windstorm caused a flood on Big Rock Creek on April 6, 1936, according to the Tribune for April 10. The paper reported that:

> Land was badly washed all over Marshall County, and the creek at Lewisburg was on a rampage, being higher than it has been in several years.
>
> Concrete forms for the new bridge just east of town on the Petersburg-Lewisburg highway were washed away by the high water.
>
> The Love family living in a house belonging to Mr. John Rogers on the Old Farmington Road near the Kelly Davidson farm, had to be rescued by boat during the night.

The crest stage on April 6, 1936, has been estimated at 12 feet.

June 1939.—Investigation of the storm by James W. Beverage, then area engineer of the Hydraulic Data Branch, soon after it occurred, showed that 6 to 9 inches of rain fell over a long, narrow area of 100 square miles with its long axis extending from the west edge of Marshall County eastward through Lewisburg to Shelbyville. Rainfall in Lewisburg was over 8 inches. The total at the experimental farm rain gage 3 miles south of the city was 6.8 inches and at Cornersville, near the headwaters of Big Rock Creek, 3.3 inches. This is one of the two greatest floods known on Big Rock Creek and resulted from an intense storm on June 18. On Friday, June 23, 1939, the Lewisburg Tribune's headlines reported "Rock Creek Goes on Rampage. Water Highest in History of Lewisburg. No Lives are Lost." The story continued:

> A flood, declared by many to be worse than the great March flood of 1902, caused around 25 families to evacuate their homes, killed considerable livestock and caused thousands of dollars of crop damage Sunday morning.

The Marshall Gazette reported that the crest on Big Rock Creek was "from 2 to 3 feet higher than in the memorable flood of March 1902" and that the creek "was higher than at any time in the history of the past 100 years."

Lewisburg suffered heavy damages as Big Rock Creek overflowed its banks and flooded 31 dwellings and 7 business places and industries. At Lewisburg the low flow of the creek is normally only about 10 feet wide and 1 or 2 feet deep. At the crest of the flood it was over 800 feet wide and from 5 to 15 feet deep. The principal streets flooded were Cornersville Road, Belfast Road, East Commerce Street, First Avenue, North, East Church Street, and Second Avenue, South. The creek rose with such rapidity that the dwelling occupants and owners of industries were unable to move their belongings to higher ground. In fact, the rise was so rapid that a number of persons were trapped in their homes. The loss was increased as a result of the heavy silt load carried by the creek. Machinery, upholstery, rugs, and walls suffered extensively from the silt. The heaviest industrial damage was experienced by the C.S. Sanders Lumber Co. and the Linton Pencil Co. Besides the loss of raw materials it was necessary to tear down machinery to remove the silt deposit. The principal business places flooded were the Sharp Motor Co., Green-Moss Chevrolet Co., Simmons Produce Co., Columbia Produce Co., and the Borden Milk Co. Total damages in Lewisburg were estimated at $20,500. With present day prices and development in Lewisburg the loss from a similar flood would be much greater.

High water marks obtained following the flood of 1939 define the crest profile shown on plate 4. The profile elevation at the location of the present gaging station was 722.7 which is equivalent to a stage of 17.6 feet on the gage. This is 0.9 foot higher than the 1902 crest at the same location.

February 1945.—High water marks obtained in Lewisburg for the February 22, 1945, flood show that it was 2.1 feet lower than the 1939 crest at the gaging station location and 1.2 feet under the 1902 crest.

The Tribune for Friday, February 23, 1945, reported on the flood as follows:

> Rock Creek came down with a vengeance Wednesday night, following the heavy rains of the day. For a time it looked like the business district might be flooded but only those places near the bed of the creek were damaged.
>
> Many families on the old Shelbyville Highway vacated their premises but were able to move back in Thursday, as the waters receded.
>
> The State guard was called out and took over the task of moving marooned families, five trucks for the purpose being provided by the city. Reports indicate that Brewers Shoe Shop, Sanders Lumber Co., and the Linton Pencil Co. suffered the heaviest damage.

Investigation by Hydraulic Data Branch engineers showed that damage at the pencil company resulted when floodwater reached boxes in storage before they could be moved. The plant was out of production for 2 days. Damage also occurred at the Simmons Produce Co. to feed, seed, and fertilizer, and to the furnace at the bus terminal.

January 1946.—On January 8, 1946, another flood threatened residents of Lewisburg. The Tribune for January 11 reported that—

> along the course of the creek here in Lewisburg it was thought for a while that residents along its route would have to move out. Company K, local unit of the State guard, was alert and ready to assist in the evacuation of families if it became necessary, but fortunately the creek fell before that time arrived.

February 1948.—High floods that occurred over much of the Tennessee Valley in February 1948 were the subject of a TVA report "Flood of February 1948 in Tennessee River Basin." The following description of the situation at Lewisburg is quoted from the report:

> The heavy rains of February 11 to 13, 1948, put Big Rock Creek out of banks along its full length early Friday morning, February 13. However, the flood crest at Lewisburg was 4 or 5 feet below the flood of June 1939, and was little if any bigger than several high stages in Lewisburg since 1939.
>
> Water broke over the left bank along First Avenue, North, beginning 2 blocks from the courthouse square and continuing for 2 blocks to the turn of the creek away from First Avenue. Ten basements were flooded, lawns were damaged at eight homes, and sewers, streets, and street drains were affected. A small quantity of lumber was washed away when water overflowing the right bank flooded building materials stored at a construction site. The Red Cross alerted its disaster committee, who moved furniture from a number of homes, evacuated one family, and made preparations to make further evacuations. The flood subsided before doing any appreciable damage.

The actual damage in Lewisburg was estimated in the report to be $1,300.

March 1955.—This is one of the two greatest floods that are known to have occurred at Lewisburg and is described in the accompanying "Supplement No. 1" to this report.

Minor floods, 1954–57.—Stream gage records show that, in addition to the March 1955 flood, there have been 11 floods at Lewisburg with crest stages ranging from 8.32 feet to 11.40 feet in the period from December 1953 to May 1957. This record indicates that minor flooding probably occurred at Lewisburg prior to 1954 with greater frequency than the newspaper descriptions showed.

ACKNOWLEDGMENTS

This report has been prepared by personnel of the Hydraulic Data Branch, Division of Water Control Planning, under the general direction of James S. Bowman, formerly Chief Water Control Planning Engineer, and Reed A. Elliot, Chief Water Control Planning Engineer, and the immediate supervision of Albert S. Fry, Chief, Hydraulic Data Branch.

Field investigations were made under the direction of James W. Beverage, Head of the Field Investigations Section, who also investigated the June 1939 flood at the time of its occurrence. Level ties to high water marks, bank and low water elevations, and determinations of flooded area were by Claude W. Wilkins, Claude H. Smith, and Carl E. Martin.

John H. Scott of the Hydraulic Investigations Section searched the Lewisburg and Nashville newspapers for data on floods on Big Rock Creek, and much of the data on the occurrence and magnitude of past floods is based on his research.

The flood information was analyzed and this report was prepared by James Smallshaw, Head of the Hydraulic Investigations Section.

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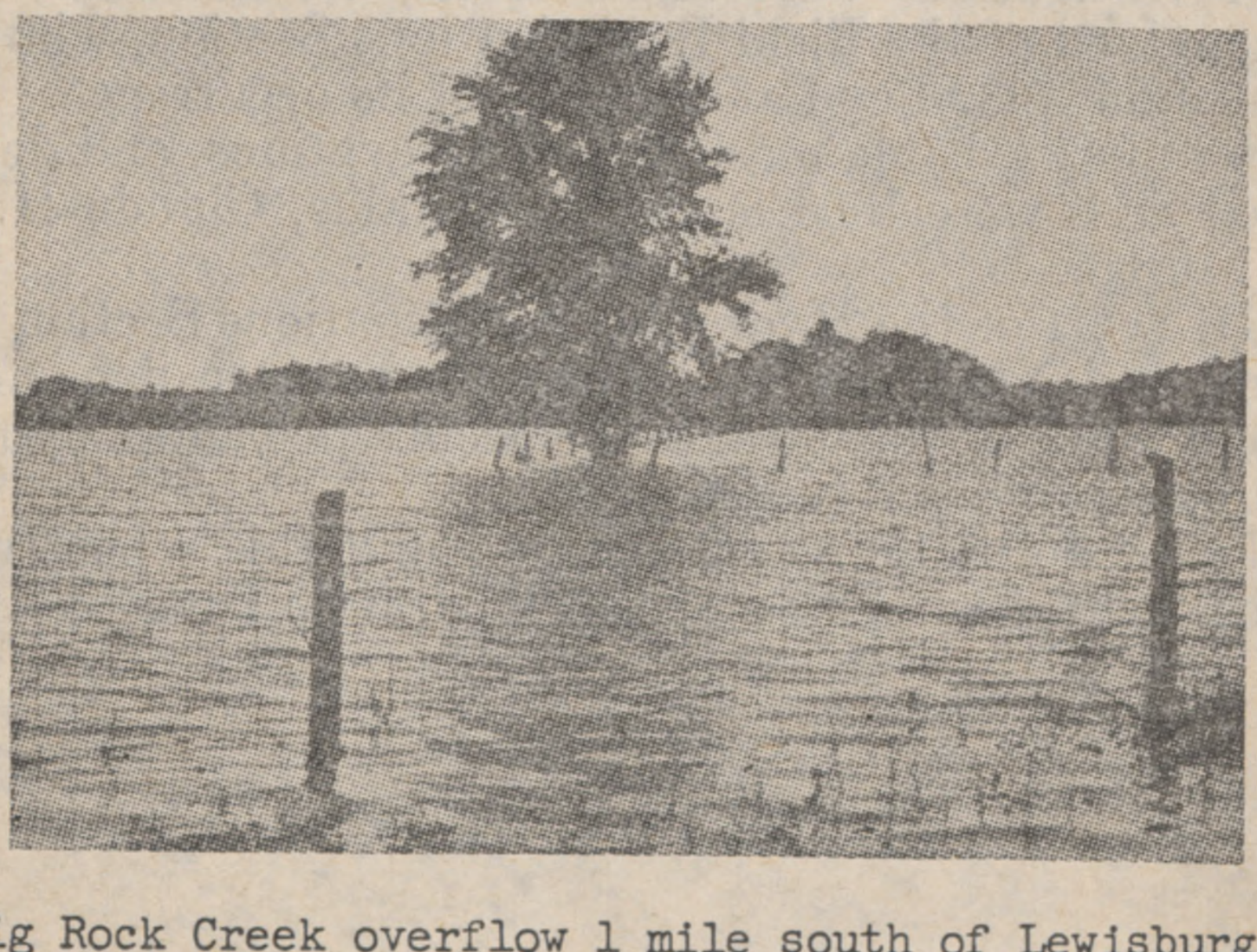
FIGURE 1.—FLOOD OF JUNE 1939 AT LEWISBURG



(a) East along East Church Street from First Avenue North. Big Rock Creek channel is in background. Crest of flood was 18 inches higher than water shown in picture.



(b) Flood conditions near intersection of Commerce Street and First Avenue North. Crest was about 18 inches higher than the water shown in picture.

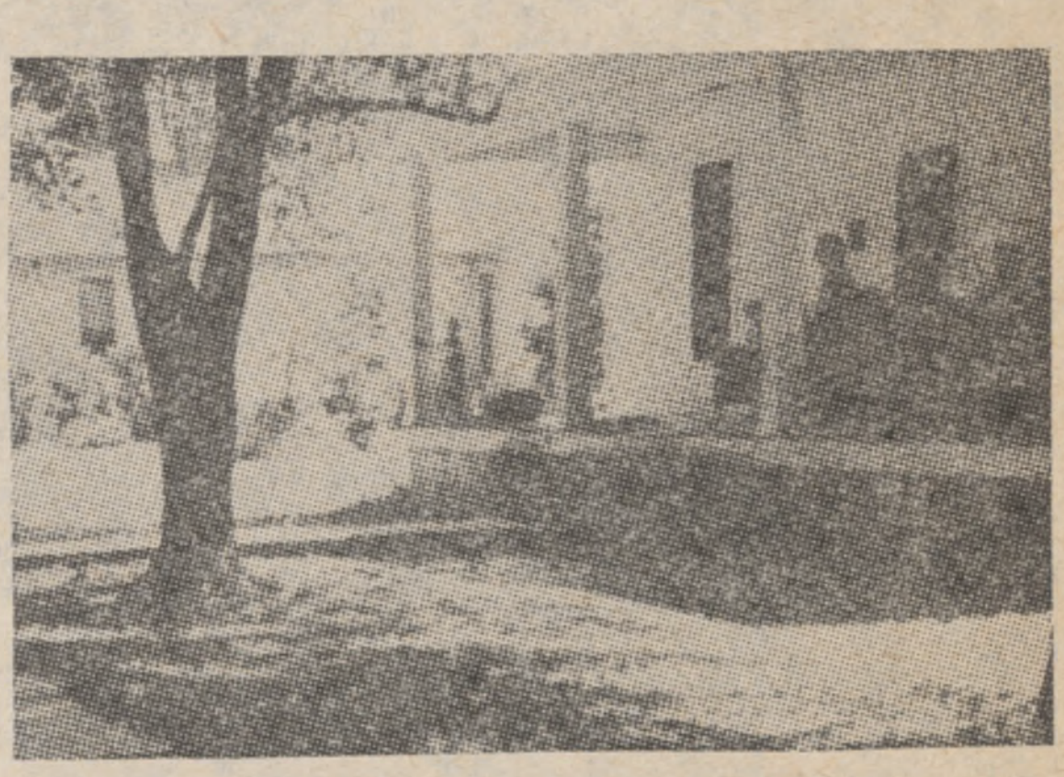


(c) Big Rock Creek overflow 1 mile south of Lewisburg.

FIGURE 2.—AFTER THE JUNE 1939 FLOOD IN LEWISBURG



(a) Downstream from the left end of East Church Street bridge immediately after the flood. The old Linton Pencil Company plant is in the background.



(b) At this house on First Avenue North, the boy at the corner of the porch is pointing to the crest elevation of the flood.



(c) South along First Avenue North. At the crest of the flood, water was five feet deep in the street.

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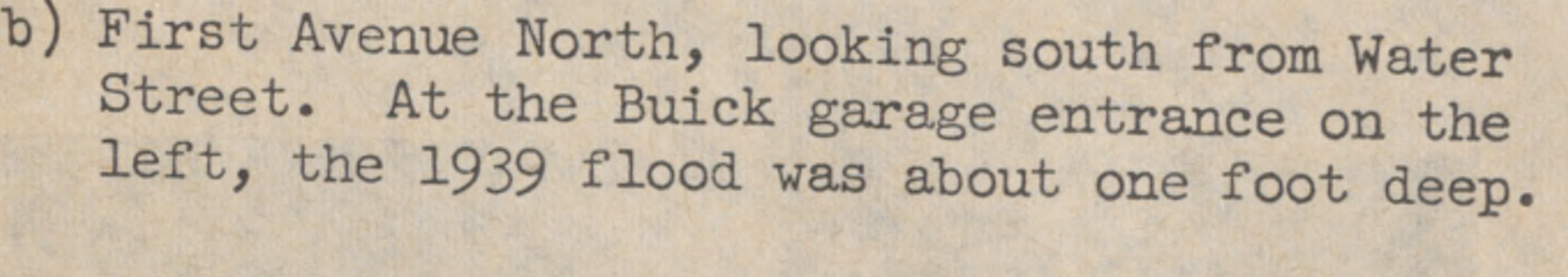
FIGURE 3.—1939 FLOOD ON LEWISBURG STREETS



(a) East Commerce Street, looking east from courthouse square. The limit of the 1939 overflow was near where the two men are walking on the sidewalk at the left.

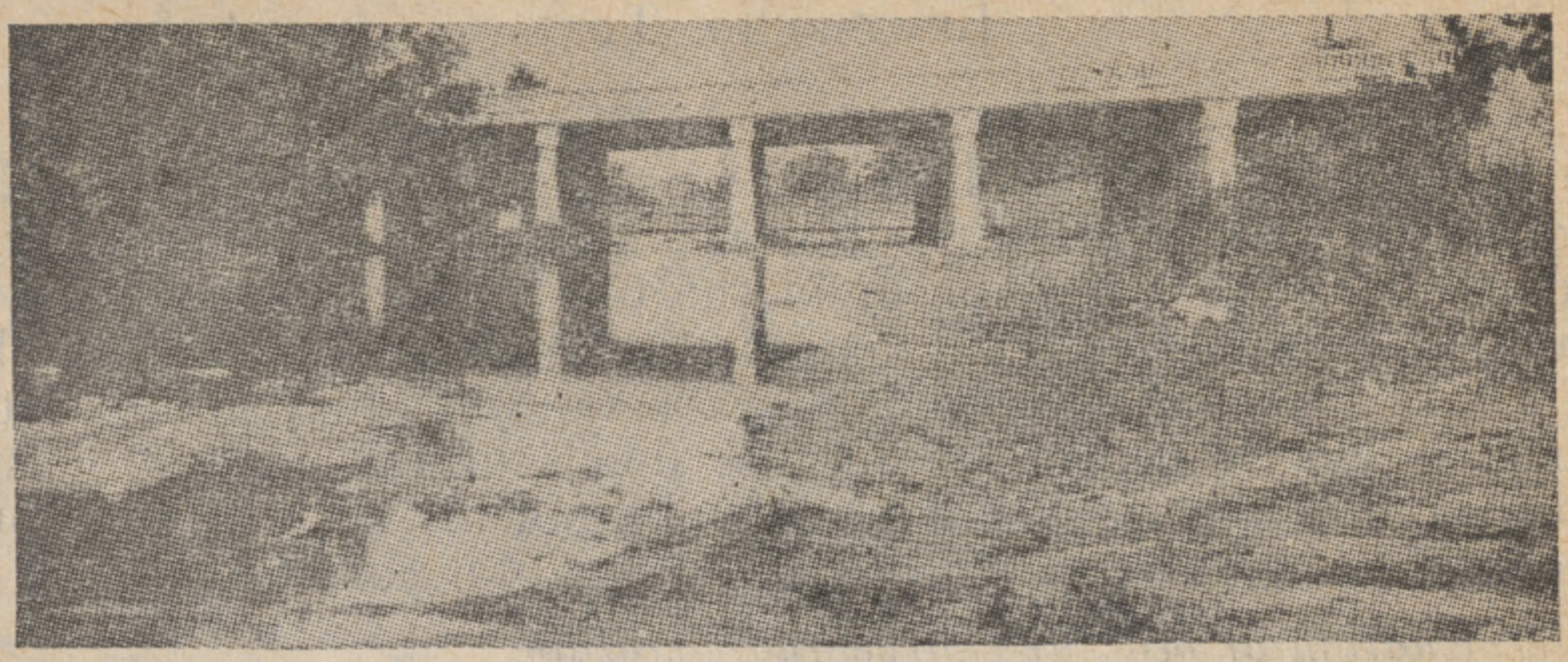


(b) First Avenue North, looking south from Water Street. At the Buick garage entrance on the left, the 1939 flood was about one foot deep.

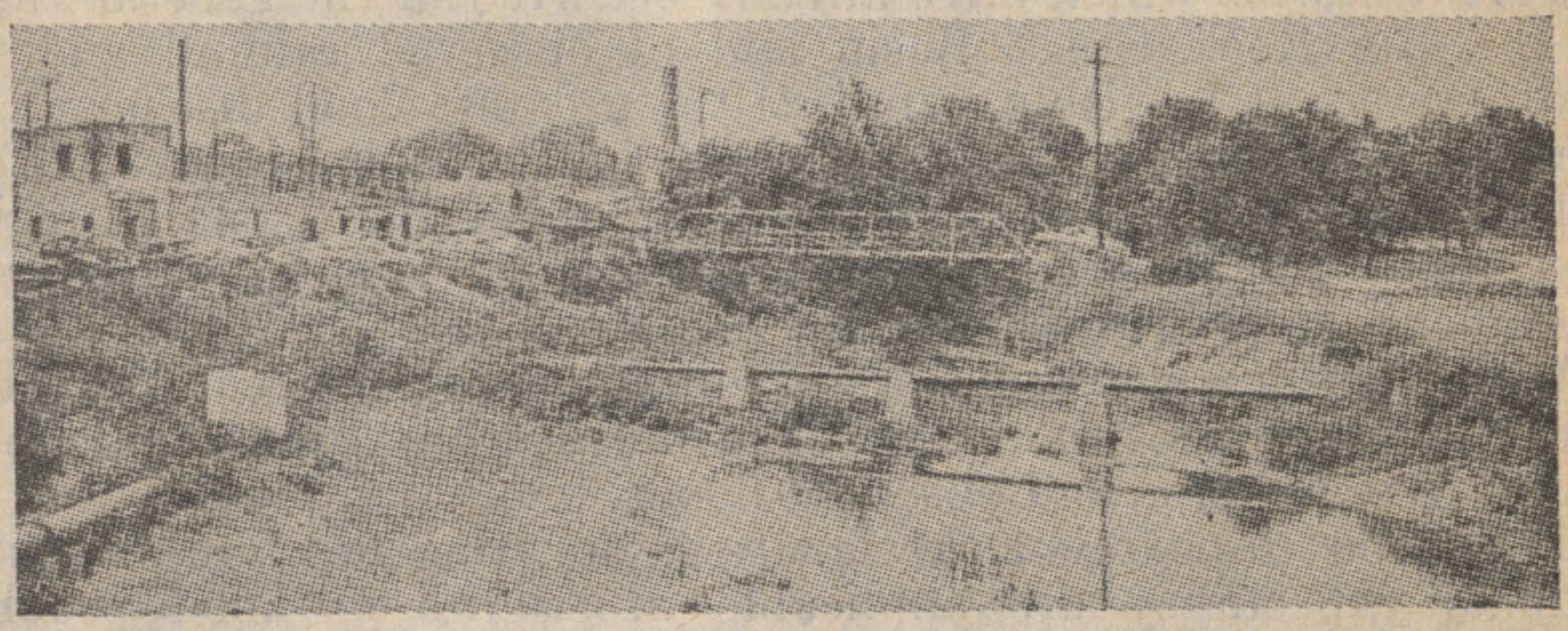


(c) North along First Avenue North from Water Street. The 1939 flood was about three feet deep at the Kroger parking sign on the right.

FIGURE 4.—BRIDGE CROSSINGS IN LEWISBURG



(a) U. S. Highway 31A bridge. This newly constructed concrete bridge has a floor five feet above the 1939 flood. The channel was widened both above and below the bridge during construction.



(b) East Church Street bridge looking downstream toward the bridge. The 1939 flood topped this bridge floor about two feet. On the left is part of the Lewisburg business district. On the right is the ball park and walking horse training track.

(c) State Highway 50 bridge east on Commerce Street from the left bank of Big Rock Creek. Bridge constructed in 1939. The June 1939 flood was 1.3 feet above the bridge floor. The USGS gaging station is on the center pier of bridge.

Flood of Reasonable Regional Expectancy, Big Rock Creek at Lewisburg, Tenn.

The preceding section of this report has presented an account of the floods that have occurred at Lewisburg during the past century. Along with such historical floods, it is important to consider the magnitude of floods that may occur in the future, particularly those that may reasonably be expected to occur on Big Rock Creek at Lewisburg. It is with the flood of reasonable expectancy at Lewisburg that this report is chiefly concerned because floods of this type are usually more significant in studies of local flood problems, such as flood zoning, than those of greater magnitude and rarity of occurrence.

Determination of peak discharge and elevations

Determinat on has been made of the peak flood discharge and elevations of the water surface at the flood crest for a flood that may reasonably be expected to occur on Big Rock Creek at Lewisburg, Tenn. In these determinations, consideration has been given to (1) great storms which have already occurred in the general vicinity of the Big Rock Creek Basin and of observed rainfall and flood hydrographs at Lewisburg and (2) the greatest flood discharges that are known to have occurred on streams in the general region of Lewisburg. As a result of these studies, the flood of reasonable regional expectancy at Lewisburg has been determined to have a discharge of 28,000 cubic feet per second.

Water surface elevations were computed using stream characteristics for selected reaches as determined from topographic maps, valley cross sections and observed floods.

The flood discharge and elevations for this flood of reasonable regional expectancy are applicable in studies of flood problems, particularly those connected with flood zoning, in the Lewisburg vicinity.

Crest profile and overflow areas

The crest profile for the flood of reasonable regional expectancy is shown on plate 4.

The limits of the area that would be overflowed by the flood are shown on plate 3. The horizontal area covered by the flood is generally only a little more than that covered by the flood of June 1939.

While the elevations and areas overflowed shown on plates 3 and 4 are sufficiently accurate for the intended purpose, actual elevations for a flood of the magnitude of that under consideration may vary slightly from those shown on the profile and maps. The contour interval of the maps is 20 feet which does not permit precise plotting of the boundaries of the flooded areas so that the actual positions on the ground of the flooded areas may vary somewhat from those shown on the maps. To determine flood elevations and limits with a higher degree of accuracy would require costly surveys and studies which present purposes do not warrant.

Frequency

The frequency of a flood of the magnitude of that of the flood of reasonable regional expectancy is not susceptible of definite determination. This flood would be about 75 percent larger in peak discharge than any known to have occurred at Lewisburg. It would be

about 2½ feet higher than the 1939 or 1955 floods at the USGS stream gage on the Highway 50 bridge at Lewisburg. These two floods are the greatest known to have occurred at Lewisburg and are about 1 foot above the largest previously known flood in March 1902. Over perhaps several centuries of record, the flood of reasonable regional expectancy will occur on the average only at rather long intervals of time, but such a flood could occur next year or in any succeeding year.

Larger floods possible

Larger floods than that of reasonable regional expectancy are meteorologically possible. However, the combination of meteorological factors that would be necessary to produce such floods would occur at very rare intervals, if at all. While the possibility of floods of this magnitude are of greater importance in some flood problems than in others and should not be overlooked in the study of any flood problem, such floods, because of their rarity and uncertainty of occurrence usually need not be given significant consideration in flood problems such as that of flood zoning.

Acknowledgments

Determination of the magnitude of the flood of reasonable regional expectancy was made by the Flood Control and Hydraulic Data Branches of the Division of Water Control Planning under the general direction of James S. Bowman, Chief Water Control Planning Engineer, and the immediate supervision of Charles W. Okey, Chief, Flood Control Branch, and Albert S. Fry, Chief, Hydraulic Data Branch. For the Hydraulic Data Branch, flood studies were under the direction of Alfred J. Cooper, Head, Hydrology Section, and for the Flood Control Branch, flood studies were under the direction of Edward J. Rutter, Head, Project Studies Section, and computation of water surface elevations were under the direction of B. J. Buehler, Head, Operation Studies Section.

Flood of March 21–22, 1955

On March 20 and 21, 1955, heavy precipitation totaling up to 11 inches in some places fell in approximately 24 hours over a long narrow area extending northeastward from Louisiana across the western half of the Tennessee Valley to Kentucky. Within the Tennessee Valley the axis of heaviest rainfall extended from the Bear Creek watershed across the watersheds of Shoal Creek, Richland Creek, and Duck River to the vicinity of Great Falls Dam. Major floods resulted on these and other streams in the western half of the valley. Heavy damage occurred to roads and bridges in rural areas, particularly in the Richland and Shoal Creek watersheds. Residential and business sections in or near Shelbyville, Lewisburg, Columbia, and Fayetteville, Tenn., were flooded.

General description

The distribution of precipitation on March 20–21 was similar to that of the February 1948 storm and other large winter storms in the Tennessee Valley region. Rainfall of 3 to 11 inches fell over an oval-shaped area 650 miles long and up to 170 miles wide beginning in northern Louisiana and extending northeastward into south central Kentucky. Some 85,000 square miles were covered by this heavy

precipitation. Maximum storm totals were 11.07 inches at Pontotoc, Miss., and 10.32 inches at Bruce, Miss., both southwest of the Tennessee Valley, and 10.12 inches at Iron City, Tenn., within the valley boundary. Along this center of heavy rain inside the valley, the storm lasted from the late afternoon of March 20 to the late afternoon of March 21, almost exactly 24 hours.

Approximately 5 to 8 inches of rain fell over the valley area in the month prior to the storm. During the week before the storm, about 2 inches fell in the western half of the valley and up to 6 inches in the eastern half.

On Richland Creek near Pulaski, Elk River near Prospect, and Shoal Creek at Iron City, Tenn., the flood crests on March 21–22, 1955, were the highest since, but did not exceed, the record flood of 1902. Big Rock Creek at Lewisburg, Tenn., approximately equaled its previous record crest of June 1939. Cypress Creek near Florence, Ala., rose 10 feet higher than any flood in 21 years of streamflow record and exceeded the 1902 crest. On the Duck River at Columbia and Centerville, Tenn., the March 1955 flood ranked third in the history of floods, being exceeded only by the rises of February 1948 and March 1902. Shelbyville on the Duck River experienced its fourth highest flood of record.

Investigation of flood

Investigations of the floods caused by the March 1955 storm were made by engineers of the Hydraulic Data Branch immediately after the storm. These investigations covered the flood story and the effects of the floods upon property. On a number of streams high water marks were obtained and were tied in to define the high water profiles of the exceptional floods on these streams. Overflow areas were outlined in some instances where urban property was affected. Discussions of the storm rainfall and the flood runoff follow.

STORM RAINFALL

Prior precipitation

Precipitation in the Tennessee Valley prior to the storm of March 20–21, 1955, was generally above normal. February, with 140 percent of normal rainfall, was the 13th wettest February in the valley in 65 years of record. In the area below Chattanooga, the February 1955 precipitation averaged 7.07 inches, or 2.19 inches above the long-term mean. Nearly half of this amount fell after February 20. During the 3 weeks from February 20 to March 11, some 3 to 5 inches of rain fell in the valley, principally in three storms. On March 12 a period of almost daily rainfall began and continued until the time of the storm covered by this report. Precipitation in the western half of the valley in this period was generally about 2 inches.

Storm of March 20–21

The distribution of precipitation over the Southeastern States during March 20–21 is shown on plate 1. The pattern was typical of many outstanding storms in the region, being characterized by a long, narrow oval of heavy precipitation, the long axis of which extended generally northeastward. Maximum amounts along the axis were 11.07 inches at Pontotoc, Miss., 10.32 inches at Bruce, Miss., and 10.12 inches at Iron City, Tenn. Precipitation totaling 6 to 11 inches

SYMBOLS:

Precipitation in Inches

State Lines

Tennessee River Watershed

Dams

ILL

IND

KY

W VA

VA

MO

TENN

N C

ARK

MISS

ALA

GA

S C

LA

LA

TENNESSEE VALLEY AUTHORITY

HYDRAULIC DATA BRANCH

STORM OF MARCH 20—21, 1955 IN SOUTHEASTERN STATES

SCALE 0 20 40 60 80 100 MILES

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PLATE 1

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fell on an area 450 miles long by 40 miles wide. The northeastern third of this heavy rainfall area bisected the western half of the Tennessee Valley.

For an area equal to that of the Tennessee Valley, 40,910 square miles, the storm of March 1955 averaged 5.8 inches. This amount is 77 percent as large as for the storm of March 1902 which caused the greatest known flood on several of the streams near the center of the 1955 storm.

Storm in the Tennessee Valley

Storm precipitation was heaviest on the watersheds of Shoal Creek, Richland Creek, Cypress Creek, Bear Creek, Yellow Creek, Big Rock Creek, the Duck River above Columbia, Tenn., and the Elk River below Fayetteville, Tenn. The storm was heavy enough to produce high floods also on Horse Creek, Spring Creek near Tuscumbia, Ala., and Little Bigby Creek near Columbia.

Twelve rainfall stations in the southwestern part of the valley recorded 8 inches or more for the storm period. Maximum amounts were 10.12 inches at Iron City and 8.91 inches at Loretto in the Shoal Creek area, and 9.20 inches at Red Bay, Ala., in the Bear Creek watershed. In the Richland Creek watershed in middle Tennessee, Pulaski reported 8.65 inches and Lynnville 8.10 inches. In this area of heaviest rainfall the storm lasted for approximately 24 hours, beginning at about 4 p.m. on March 20 and ending at about 4 p.m. on March 21.

The rainfall along the storm axis, represented by recording gages at Colbert steamplant, Victory, and Lewisburg, occurred in two heavy bursts, the first shortly before midnight of March 20 and the second between about 5 a.m. and 5 p.m. on March 21. Amounts in the first downpour were between 2 and 3 inches and in the second burst 4 to 5 inches. A total of 3.67 inches fell at Lewisburg in the 3 hours between 2 and 5 p.m. on March 21, and the 12-hour total was 5.05 inches. Total rainfall for the 25-hour storm period at Lewisburg was 7.88 inches.

Hourly intensities were below 1.5 inches at all locations. The Lewisburg station recorded 2 consecutive hours of 1.33 inches and 1.47 inches which exceeded hourly totals at any of the other recording gages. Colbert steamplant, Addison, Shady Grove, and Victory registered 1-hour maximum catches of about 1.30 inches.

FLOOD RUNOFF

Crest rates

High crest rates of discharge were recorded on streams in the area of heavy rainfall. Maximum flow per square mile was 658 cubic feet per second from 24.9 square miles of Big Rock Creek at Lewisburg. Shoal Creek at Iron City recorded 359 cubic feet per second per square mile for 348 square miles. On Little Bigby Creek near Columbia, the crest rate was 278 cubic feet per second per square mile for an area of 43.2 square miles. Horse Creek, with a drainage area of 104 square miles at the gage, had a crest rate of 260 cubic feet per second per square mile. Table 1 shows crest stages and provisional discharges for all gaging stations on unregulated streams in the western part of the valley.

Considering the size of the drainage area together with the total runoff, the greatest flood in the Tennessee Valley was that on Shoal Creek. Next in order were Richland Creek, Cypress Creek, and Big Rock Creek.

Comparison with past floods

The right-hand columns of table 1 list data on the greatest previous flood of record on each stream. On Cypress Creek near Florence, Ala, and Horse Creek near Savannah, Tenn., the March 1955 flood exceeded all known floods of record. On Big Rock Creek at Lewisburg, Tenn., the 1955 crest was slightly higher than the previous record crest of June 1939 at the gaging station in the city. On Shoal Creek at Iron City, Tenn., Elk River near Prospect, Tenn., and Richland Creek near Pulaski, Tenn., the March 1955 crest was the highest since 1902. On the Duck River the March 1955 floods ranked third or fourth in the long history of floods at Shelbyville, Columbia, and Centerville, Tenn.

Flood Story and Damages on Big Rock Creek in Vicinity of Lewisburg, Tenn.

Big Rock Creek flows through the center of Lewisburg, Tenn. The flood history of the creek shows that in the last 100 years it has overflowed its banks on the average about once every 3 years. Great and damaging floods in Lewisburg occurred in May 1856, March 1902, and June 1939, the latter exceeding the other two in height by a foot or more.

The March 21, 1955, flood crest at Lewisburg equaled that of June 1939 at the site of the U.S. Geological Survey gaging station at the Tennessee Highway 50 bridge. The creek, which is normally only 10 feet wide and about 1 foot deep, spread out in March 1955 to widths exceeding 800 feet and depths over 15 feet.

As shown on plate 2, the creek at Lewisburg began rising at 10 p.m. on March 20. At 2 a.m. on March 21, after 2.5 inches of rain had fallen, it crested at a stage of 14.8 feet, approaching the height of the important flood of February 1945. The creek dropped below bankfull stage at 5 a.m. and rose again slowly during the day as another 1.6 inches of rain fell.

At 2 p.m. on March 21 an extremely heavy 3-hour rain began. Three miles upstream from Lewisburg the recording rain gage at the U.S. Experimental Dairy Farm recorded a total rainfall from 2 p.m. to 5 p.m. of 3.67 inches. Big Rock Creek responded immediately to this heavy downpour, rising from a stage of 9 feet to a crest of 17.62 feet in less than 3 hours. The rise was so rapid that people were trapped in their homes and even in their automobiles which they were trying to move to higher ground. A tourist driving east across the creek on Highway 50 was caught in the raging waters. His car was stalled and water covered the seats before he and his family could be rescued. The National Guard unit with trucks, and volunteer citizens with boats, evacuated residents of flooded homes and pulled partially submerged automobiles to safety.

The creek fell almost as fast as it rose. City employees, National Guard members, and volunteers from all over the city pitched in to help with cleanup operations. All worked far into the night cleaning mud and debris from stores and homes.

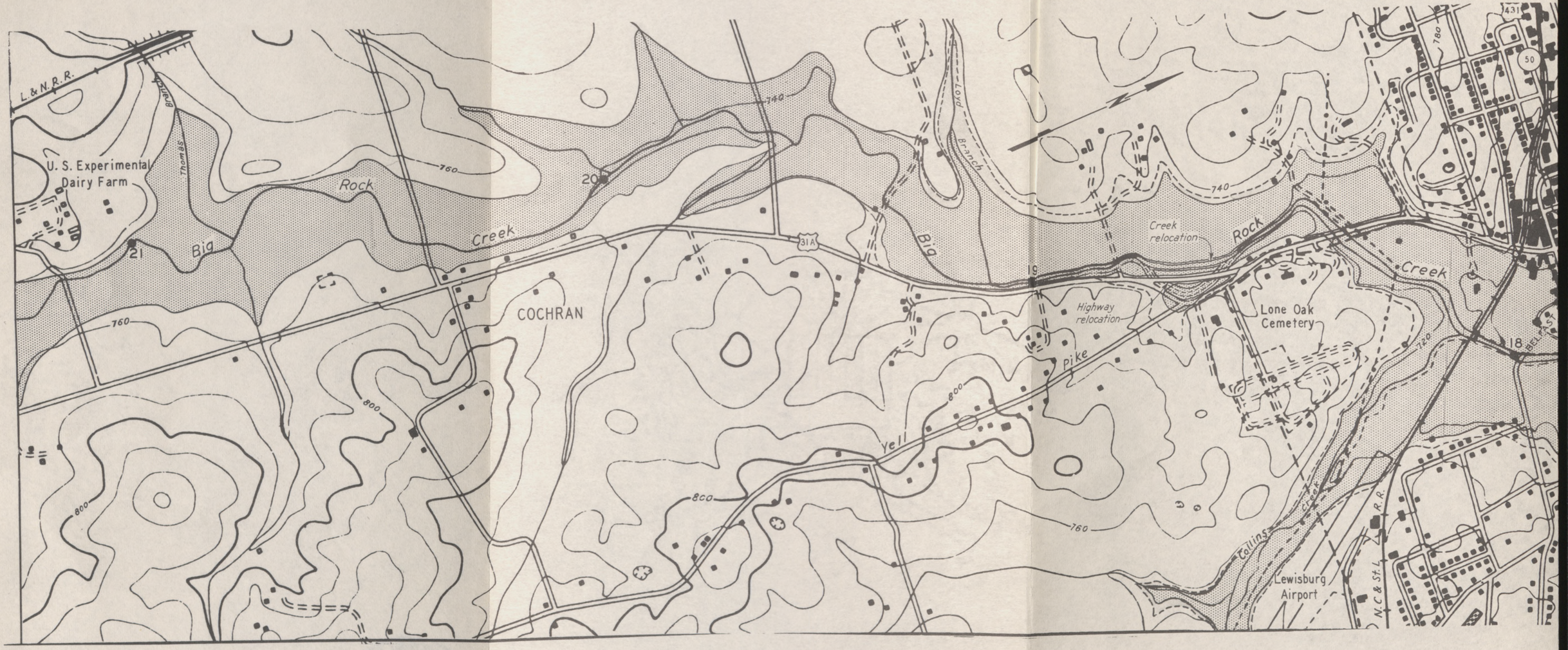
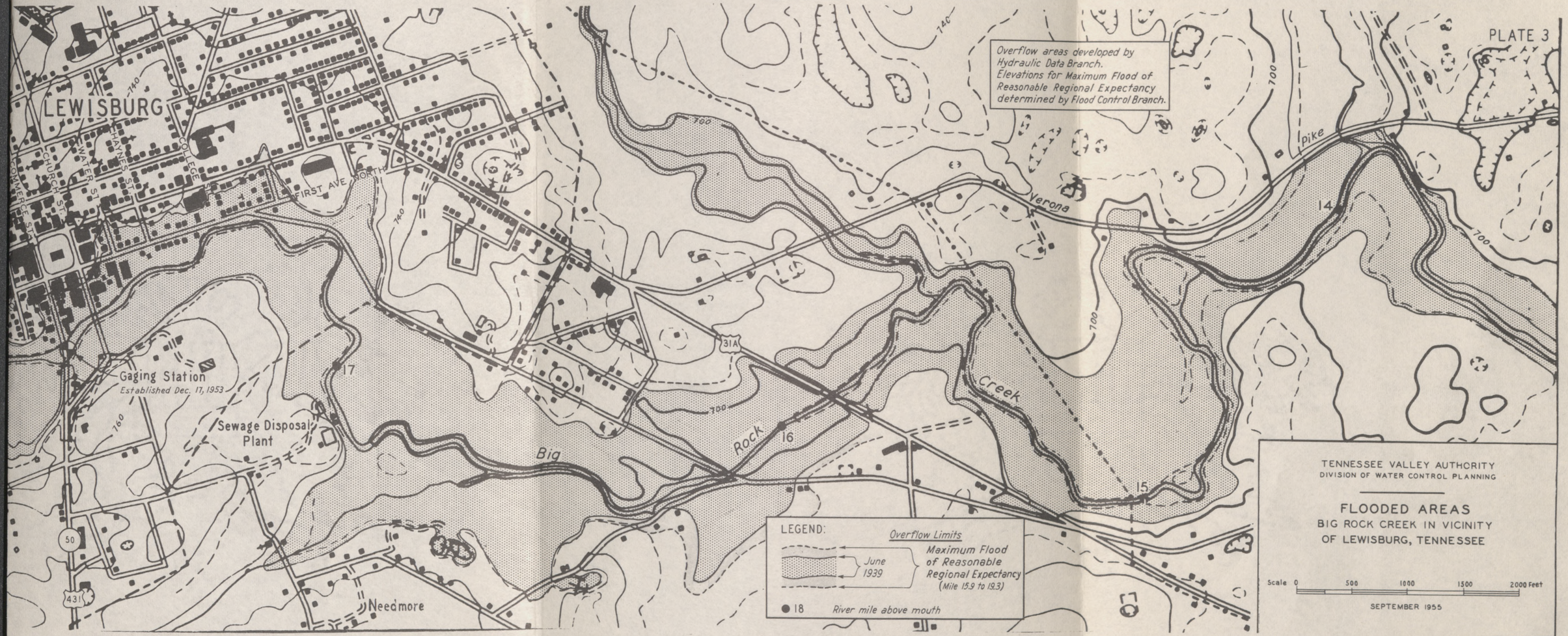

L & N. R. R.
Branch
Thomas
U. S. Experimental
Dairy Farm
Rock
Creek
Big
21
20
760
740
COCHRAN
800
31A
Big
Lloyd
Branch
19
Creek
relocation
Rock
Creek
Highway
relocation
Lone Oak
Cemetery
Pike
Yell
800
760
740
780
431
50
18
Collins
Creek
N. C. & St. L. R. R.
Lewisburg
Airport

PLATE 3



TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

FLOODED AREAS
BIG ROCK CREEK IN VICINITY OF LEWISBURG, TENNESSEE

Scale 0 500 1000 1500 2000 Feet

SEPTEMBER 1955

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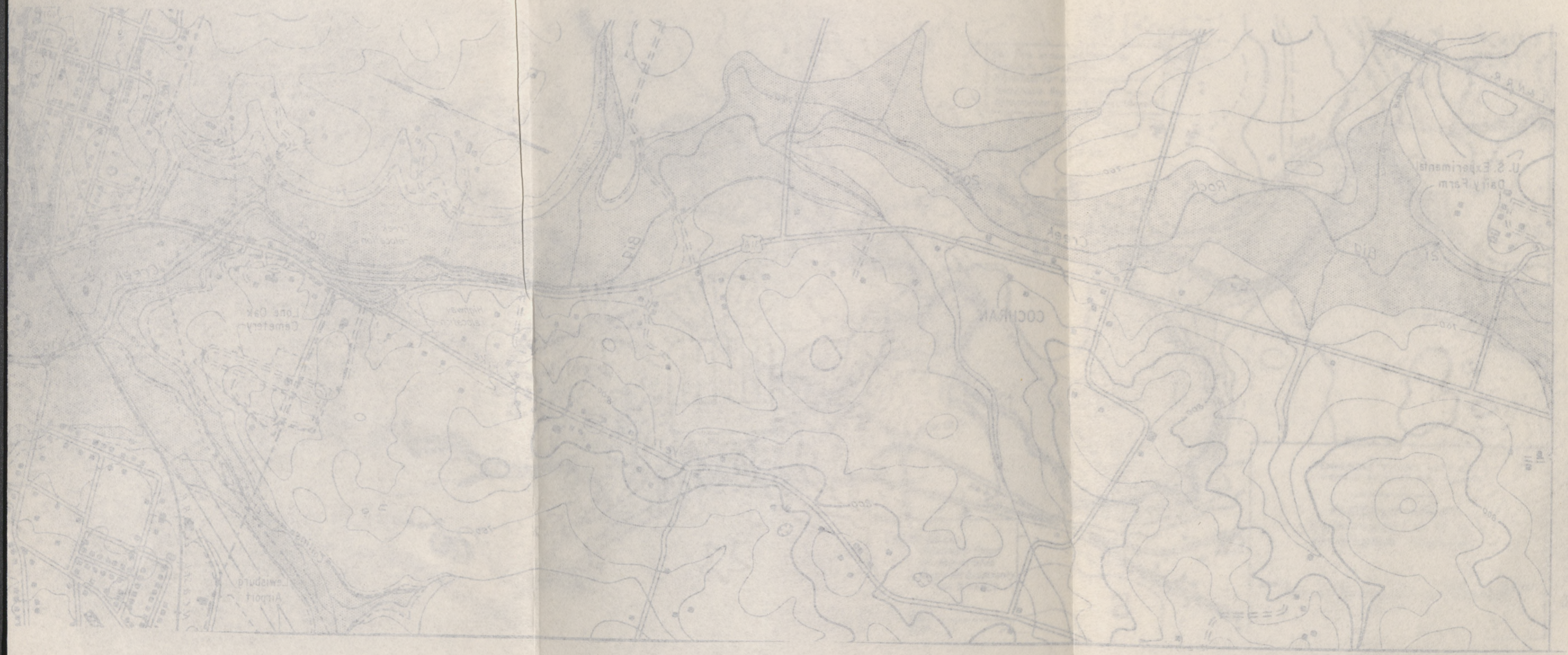
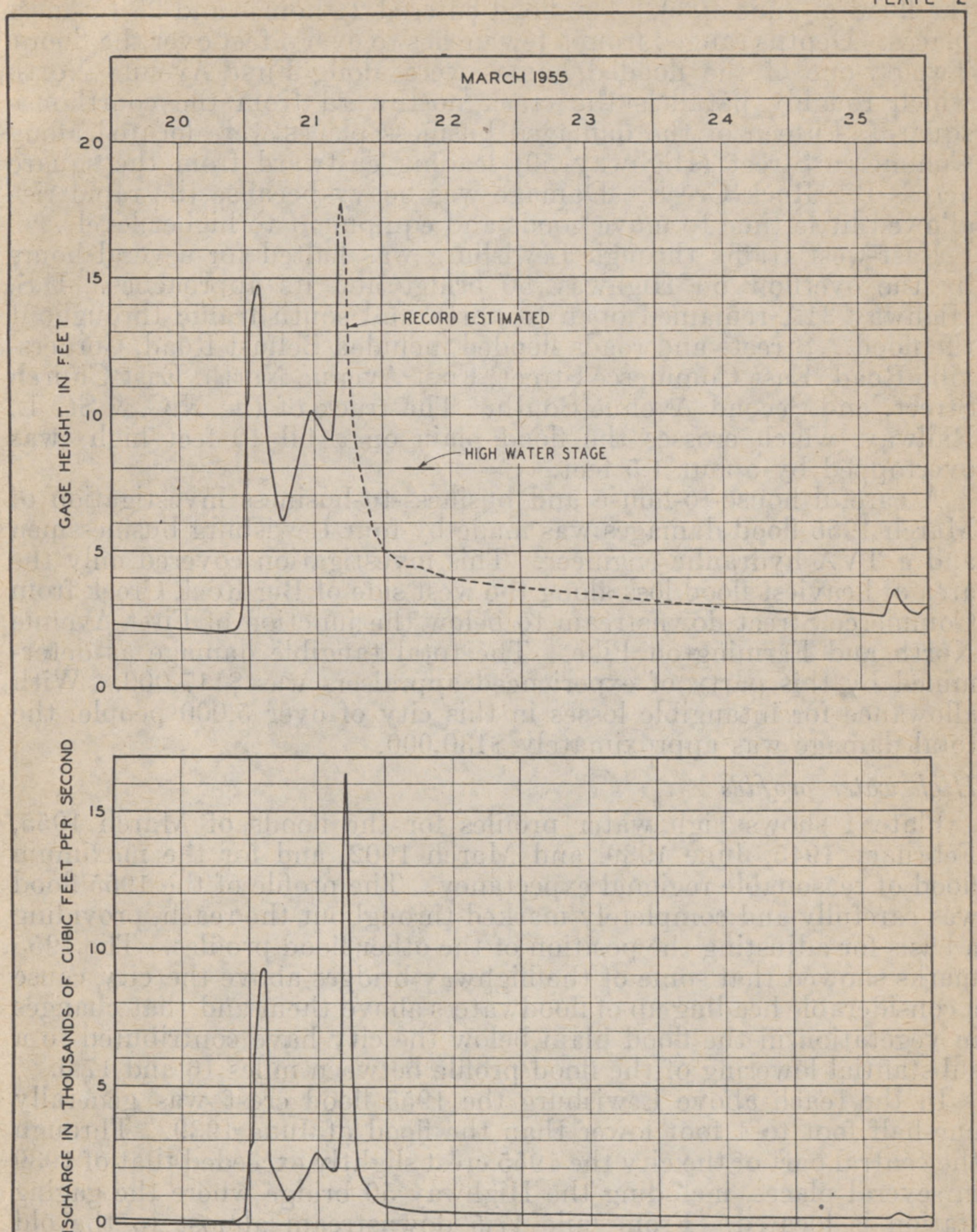


PLATE 2



TENNESSEE VALLEY AUTHORITY

DIVISION OF WATER CONTROL PLANNING

HYDRAULIC DATA BRANCH

FLOOD OF MARCH 1955

STREAM STAGES AND DISCHARGES

BIG ROCK CREEK AT LEWISBURG, TENNESSEE

The area inundated in the Lewisburg vicinity in March 1955 was almost identical with that shown on the accompanying plate 3 for the flood of June 1939. The flood entered 24 homes and 28 business places. Depths ranged from a few inches to over 4 feet over the floors. Twenty-one of the flooded homes were along First Avenue North which roughly parallels the creek northward from the courthouse square. Fifteen of the damaged business places were located along Commerce Street (Highway 50) leading eastward from the square across Big Rock Creek. Damage was heavy because the rapid rise allowed little time to move goods and equipment to higher levels.

East-west traffic through Lewisburg was halted for several hours by the overflow on Highway 50 bridge and its approaches. U.S. Highway 31A remained open to north and south traffic throughout the flood. Streets and roads flooded included Belfast Road, Cornersville Road, East Commerce Street, First Avenue North, East Church Street, and Second Avenue South. The track of the N.C. & St. L. Railway, which crosses the flood plain on a fill 10 feet high, was overtopped by about 1.5 feet.

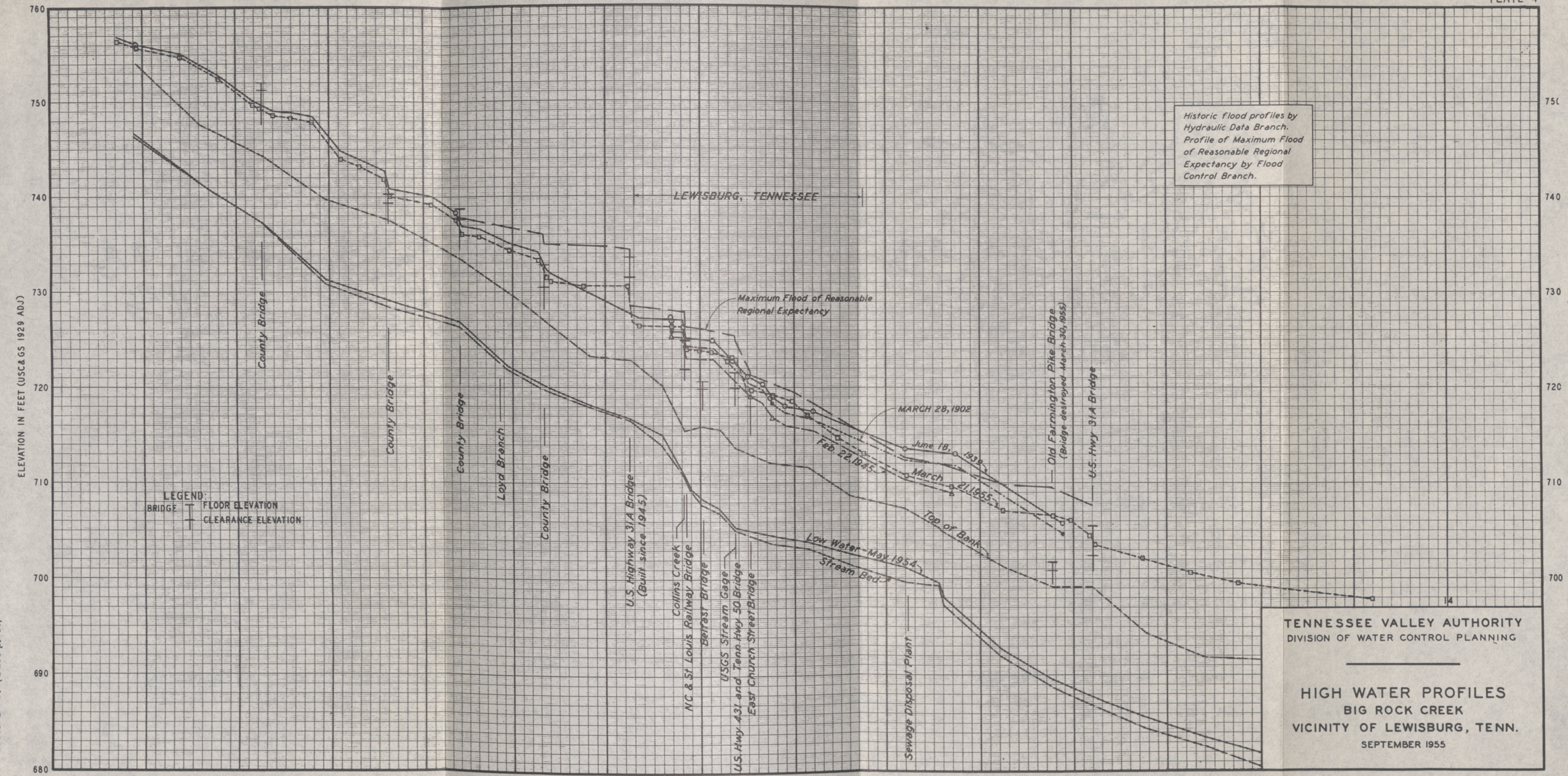
A careful house-to-house and business-to-business investigation of March 1955 flood damages was made by four Lewisburg businessmen and a TVA hydraulic engineer. This investigation covered only the area of heaviest flood loss along the west side of Big Rock Creek from Commerce Street downstream to below the junction of First Avenue North and Farmington Pike. The total tangible damage as determined by this party of experienced appraisers was $117,000. With allowance for intangible losses in this city of over 5,000 people, the total damage was approximately $130,000.

High water profiles

Plate 4 shows high water profiles for the floods of March 1955, February 1945, June 1939, and March 1902, and for the maximum flood of reasonable regional expectancy. The profile of the 1955 flood was carefully and completely marked throughout the reach, providing a basis for adjusting the position of the other flood profiles. The 1955 marks showed that some of the highway bridges above the city cause a considerable heading up of floodwaters above them and that changes in vegetation in the flood plain below the city have contributed to a substantial lowering of the flood profile between miles 16 and 17.5.

In the reach above Lewisburg the 1955 flood crest was generally one-half foot to 1 foot lower than the flood of June 1939. Through the central part of the city the 1955 crest slightly exceeded that of 1939 in several places, including the Highway 50 bridge where the gaging station is located. From mile 17.5 downstream almost to the old Farmington Pike bridge the 1955 flood was below both the 1939 and the 1902 flood profiles. Investigation indicates that much of the overflow area in this reach has been cleared since 1939, greatly improving the flow characteristics.

PLATE 4



TENNESSEE VALLEY AUTHORITY
DIVISION OF WATER CONTROL PLANNING

HIGH WATER PROFILES
BIG ROCK CREEK
VICINITY OF LEWISBURG, TENN.
SEPTEMBER 1955

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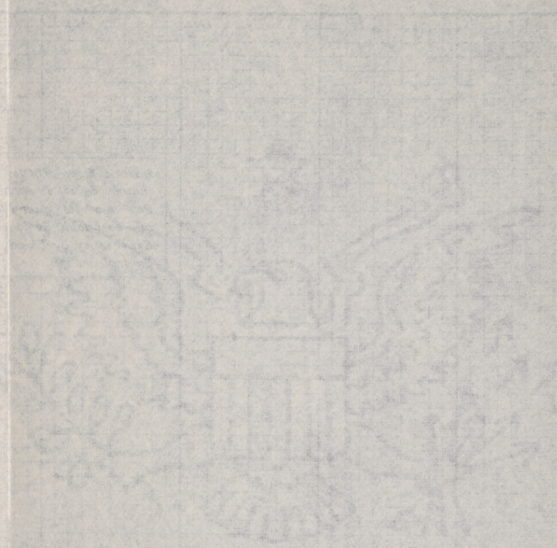


TABLE 1.—*Floods of March 1955—Crest stages and discharges for unregulated streams*

Stream and station	Drainage area	Flood of March 1955				Maximum previous flood			
		Date	Stage	Peak discharge		Date	Stage	Peak discharge	
				Amount	Per square mile			Amount	Per square mile
	Square miles		*Feet*	*Cubic feet per second*	*Cubic feet per second*		*Feet*	*Cubic feet per second*	*Cubic feet per second*
East Fork Clarks River near Benton, Ky	227	22	13.90	7,300	32	January 1937	17.8		
East Fork Clarks River at Murray, Ky	89.7	21	10.92	4,000	45				
Cypress Creek drainage district near Gilbertsville, Ky	27.6	22	7.18	224	8	February 1949	9.23	291	11
Big Sandy River at Bruceton, Tenn	205	22	13.11	5,480	27	March 1897	18	25,000	122
Birdsong Creek near Holladay, Tenn	44.9	21	12.39	3,020	67	January 1946	13.24	8,200	183
Buffalo River near Lobelville, Tenn	707	23	20.43	60,000	85	February 1948	23.76	100,000	141
Buffalo River near Flat Woods, Tenn	447	22	30.45	60,000	134	do	32.00	90,000	201
Duck River above Hurricane Mills, Tenn	2,557	23	26.38	78,000	31	do	30.22	122,000	47
Duck River at Centerville, Tenn	2,048	22	32.00	68,500	33	do	37.58	97,700	48
Duck River at Columbia, Tenn	1,208	23	44.78	46,300	38	do	51.75	61,100	51
Duck River near Shelbyville, Tenn	481	22	32.84	43,400	90	March 1902	40	87,000	181
Duck River below Manchester, Tenn	107	22	17.87	25,100	235	March 1929	23.2		
Piney River at Vernon, Tenn	193	21	15.53	18,500	96	December 1926	16.5	32,500	169
Big Bigby Creek near Mount Pleasant, Tenn	25.8	21	10.20	3,740	145				
Big Bigby Creek near Sandy Hook, Tenn	17.5	21	11.22	2,200	126				
Little Bigby Creek near Columbia, Tenn	43.2	21	(1)	12,000	278				
Rutherford Creek near Carters Creek, Tenn	68.8	22	24.38	11,800	172				
Big Rock Creek at Lewisburg, Tenn	24.9	21	17.62	16,400	658	June 1939	17.6	16,300	655
Beech River near Lexington, Tenn	15.9	21	5.50	840	53	January 1954	6.43	1,285	81
Beech River near Chesterfield, Tenn	115	22	10.51			January 1946	11.15	16,000	139
Beech River near Darden, Tenn	165	22	9.38	6,340	38	do	[2] 12.97		
Big Creek near Darden, Tenn	10.6	21	11.10	1,090	103	January 1954	11.30	1,200	113
Browns Creek near Chesterfield, Tenn	20.2	21	7.50	1,540	76	May 1953	7.65	1,570	78
Cane Creek near Shady Hill, Tenn	16.8	21	12.04	1,772	106	do	12.18	1,850	110
Cane Creek near Chesterfield, Tenn	22.2	21	9.18			January 1954	9.38	1,150	52
						January 1946	9.13	5,330	235
Flat Creek near Middleburg, Tenn	13.8	21	9.10	1,480	107	January 1954	9.22	1,740	126
Haley Creek near Chesterfield, Tenn	8.30	21	5.29	939	113	May 1953	5.50	1,180	142
Harmon Creek near Lexington, Tenn	6.87	21	5.55	480	70	do	5.64	808	118
Piney Creek at Highway 104, Tennessee	19.2	21	7.84	1,368	71	do	8.00	2,380	124
Rushing Creek near Decaturville, Tenn	17.	21	8.69	2,000	118	January 1954	8.68	1,990	117

[1] No gage on stream; discharge determined by contracted opening.
[2] Affected by Tennessee River backwater in Beech River.

TABLE 1.—*Floods of March 1955—Crest stages and discharges for unregulated streams*—Continued

Stream and station	Drainage area	Flood of March 1955				Maximum previous flood			
		Date	Stage	Peak discharge		Date	Stage	Peak discharge	
				Amount	Per square mile			Amount	Per square mile
	Square miles		*Feet*	*Cubic feet per second*	*Cubic feet per second*		*Feet*	*Cubic feet per second*	*Cubic feet per second*
Turkey Creek near Decaturville, Tenn	8.40	21	6.05	1,600	191	May 1953	6.15	660	79
Wolf Creek at Graper Springs, Tenn	11.7	21	7.10	1,040	89	January 1954	7.42	1,264	108
Indian Creek near Cerro Gordo, Tenn	201	22	16.63	28,300	141	February 1948	16.80	30,000	149
Middleton Creek near Milledgeville, Tenn	45.5	21	10.33	3,120	69	January 1954	10.55	6,780	149
White Oak Creek near Milledgeville, Tenn	46.1	21	8.41	7,300	158	January 1946	8.8	9,800	212
Turkey Creek near Savannah, Tenn	53.7	21	12.65	10,300	192	do	12.70	10,500	195
Horse Creek near Savannah, Tenn	104	21	16.18	27,000	260	February 1948	14.70	17,400	167
Snake Creek near Adamsville, Tenn	49.4	21	16.00	5,200	105	do	16.80	10,000	202
Chambers Creek No. 2 opposite Kendrick, Miss	21.1	21	8.78	4,480	212	January 1946	10.12		
Yellow Creek at Moser Bridge, Miss	143	22	11.59	18,000	126	February 1948	11,84	19,000	133
Bear Creek at Bishop, Ala	667	22	21.98	37,000	55	October 1892	25	38,000	57
Cypress Creek at Florence, Ala	209	21	29.9	50,000	239	March 1951	19.20	25,100	120
Shoal Creek at Iron City, Tenn	348	21	27.22	125,000	359	March 1902	28		
Big Nance Creek at Courtland, Ala	166	22	20.27	7,310	44	January 1950	22.60	12,300	74
Elk River near Prospect, Tenn	1,784	22	38.96	110,000	62	March 1902	40.9	130,000	73
Elk River above Fayetteville, Tenn	827	22	23.65	25,100	30	1842	27.5	37,000	45
Elk River near Pelham, Tenn	65.6	22	11.35	3,680	56				
Richland Creek near Pulaski, Tenn	366	21	27.49	74,900	205	March 1902	27.5	100,000	273
West Fork Mulberry Creek at Mulberry, Tenn	41.2	21	13.15	10,300	250				
Bradley Creek near Prairie Plains, Tenn	41.3	22	11.95	2,700	65				
West Flint Creek near Hartselle, Ala	158	22	15,74	4,830	31	January 1949	18		
West Flint Creek near Oakville, Ala	87.6	22	20.28	3,200	37				
Flint Creek near Hartselle, Ala	200	22	22.09	6,240	31	March 1951	24.91		
Flint Creek near Falkville, Ala	86.3	21	14.17	5,200	60				
Limestone Creek at U.S. Highway 72, Alabama	119	21	10.19	6,020	51	January 1954	14.32	21,000	176
Flint River near Chase, Ala	342	22	17.79	20,200	59	September 1929	25	42,000	123
Paint Rock River near Woodville, Ala	320	22	17.92	9,640	30	December 1942	[3] 20.50	31,300	98

[3] Maximum gage height on Paint Rock River=20.84 feet Jan. 5, 1949.

NOTE.—All data on the March 1955 floods are provisional.

Appendix B

PLANNING FOR FLOOD DAMAGE PREVENTION, LEWISBURG, TENN.

This study is typical of the approach that TVA and the States have encouraged. It outlines the various alternatives that should be and were considered in determining a solution to the local flood problem.

It should not be assumed that the particular decisions reached by Lewisburg are applicable elsewhere. For example, the maximum flood of reasonable regional expectancy (maximum probable flood) was adopted by Lewisburg as the controlling flood stage because several historical floods had closely approached this stage. In other instances where the stage of the maximum probable flood substantially exceeds any historical flood and where other conditions warrant it, a lower flood stage might be adopted as controlling.

This study was made by the Lewisburg Regional Planning Commission with the technical assistance of the Tennessee State Planning Commission and the Tennessee Valley Authority.

Introduction

Twenty-four times in the past 60 years floodwaters from Big Rock Creek have topped the creek banks in the vicinity of Lewisburg. Not all these floods have caused serious damage. Nevertheless, at relatively frequent intervals great floods have occurred with the result that communications and transportation are interrupted; families living in outlying areas are forced to evacuate their homes; business and industrial establishments, as well as such essential public services as water and sewage disposal, are disrupted and buildings and equipment damaged.

Because floods are a constant threat to the city, the Lewisburg Planning Commission has been concerned with the effects of these floods on the development of the city. This report is a result of the planning commission's study made with the assistance of the Tennessee State Planning Commission. It analyzes the local flood problem, investigates alternative ways for meeting the situation and suggests a specific program which might be undertaken by Lewisburg to reduce flood damage.

The proposed additions and revisions to the zoning ordinance and subdivision regulations were subsequently adopted. Further studies are to be made regarding the remainder of the suggested program to determine how and when it will be best to implement it or portions of it.

The flood data on which this study is based are found in the following two reports prepared by the Tennessee Valley Authority: "Floods on Big Rock Creek in the Vicinity of Lewisburg, Tennessee" (November 1954) and Supplement No. 1 to the above report entitled "Flood of March 21, 1955" dated October 1955. Additional information in the form of cross sections of the stream and in estimates of stream

velocities in time of flood has been provided by the Tennessee Valley Authority.

I. Nature of the Flood Problem

Since the Tennessee Valley Authority's reports contain detailed data on flood profiles, the extent, depth, and period of inundation, rate of rise and frequency of flooding, this report will only summarize the major characteristics of flooding in the Lewisburg area. Those persons requiring detailed information on the effects of flooding on particular properties or for use in the design of structures are referred to other Tennessee Valley Authority reports. Additional information and assistance may be available from TVA in solving specific problems.

Figure 1 shows the drainage area of Big Rock Creek and its relation to Lewisburg. The reach of the stream adjacent to the town has an average fall of approximately 11 feet per mile. Slightly more than 20 percent of the total watershed is located upstream from the city; most of the watershed is gently rolling. During intensive storms with rapid runoff of rain the topography of the watershed and the gradient of the stream are conducive to the rapid collection of water and its swift passage downstream.

Any watershed has a distinct combination of land conditions which produce flood conditions peculiar to it. The following are principal characteristics of flooding in the Lewisburg area which must be understood in devising a broad plan for meeting the problem:

The major problems of flooding are adjacent to Big Rock Creek

There are no major flood problems on the tributaries of Big Rock Creek in the reach of the stream under consideration in this study. The lower portion of Collins Creek, just upstream from the New York, Chicago & St. Louis Railroad, is subject to backwater from Big Rock Creek, but with this exception, flooding in the Lewisburg area is confined to land along Big Rock Creek. (See fig. 5.)

Serious floods can be expected at frequent intervals

Figure 2 shows the height and year of occurrence of major floods of Big Rock Creek. In general, flooding begins when the water reaches elevation 713 at the gage on the downstream side of Highway 50 Bridge. Flooding of business places begins at approximately elevation 718, and serious flooding occurs at elevation 719 and above. Figure 2 shows that there have been 12 floods equal to or exceeding this elevation in the past 60 years.

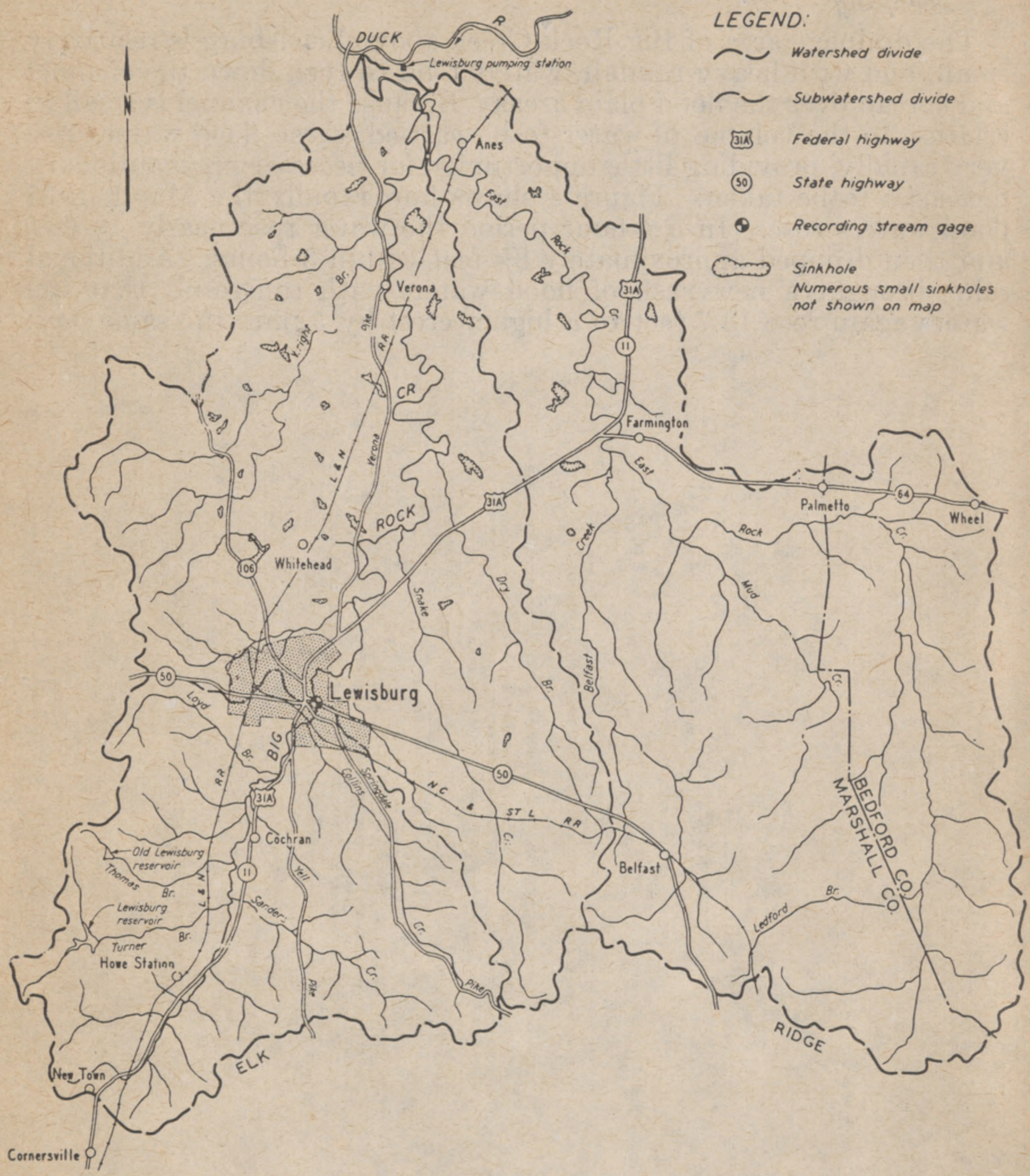
The elevations of the four highest floods of record in the vicinity of Lewisburg are shown in figure 3. This figure also shows the elevation of a flood which could reasonably be expected to occur in the future. Perhaps the most notable fact drawn from these data is the extremely small difference in elevation between these four floods; they are separated by only a little more than 2 feet. The flood that can reasonably be expected is only slightly higher.

To illustrate, in Lewisburg the 1939 and 1955 floods were of about equal magnitude; the 1902 flood was a foot lower, and the 1945 flood was only 2 feet below the 1939 flood level. Floods of approximately the same height as the 1945 flood occurred in 1912 and 1926. This frequency of near record floods suggests that floods of the 1939 magnitude will continue to occur periodically and that development

plans should recognize that even higher floods are likely to occur in the future.

Floods on Big Rock Creek rise rapidly, giving little opportunity for warning

The drainage area of Big Rock Creek above Lewisburg is relatively small, and with heavy rainfall, waters tend to rush down the channel and spread over the flood plain areas. Because the channel is small in relation to the volume of water to be carried, these flood waters rise very rapidly, providing little opportunity for necessary precautionary measures to be taken. Figure 4 shows how rapidly the March 1955 flood waters rose. In a 4-hour period the water rose nearly 13 feet and then dropped approximately 8½ feet within 3 hours. Additional rains brought a new rush of flood waters with the result that the waters again rose 13.7 feet to a higher crest by 5 p.m. the same day.



DRAINAGE AREAS SHOWN ON THIS MAP:

Big Rock Creek above mouth---121 sq mi
Big Rock Creek above Lewisburg---24.9 sq mi
East Rock Creek above mouth---52.8 sq mi

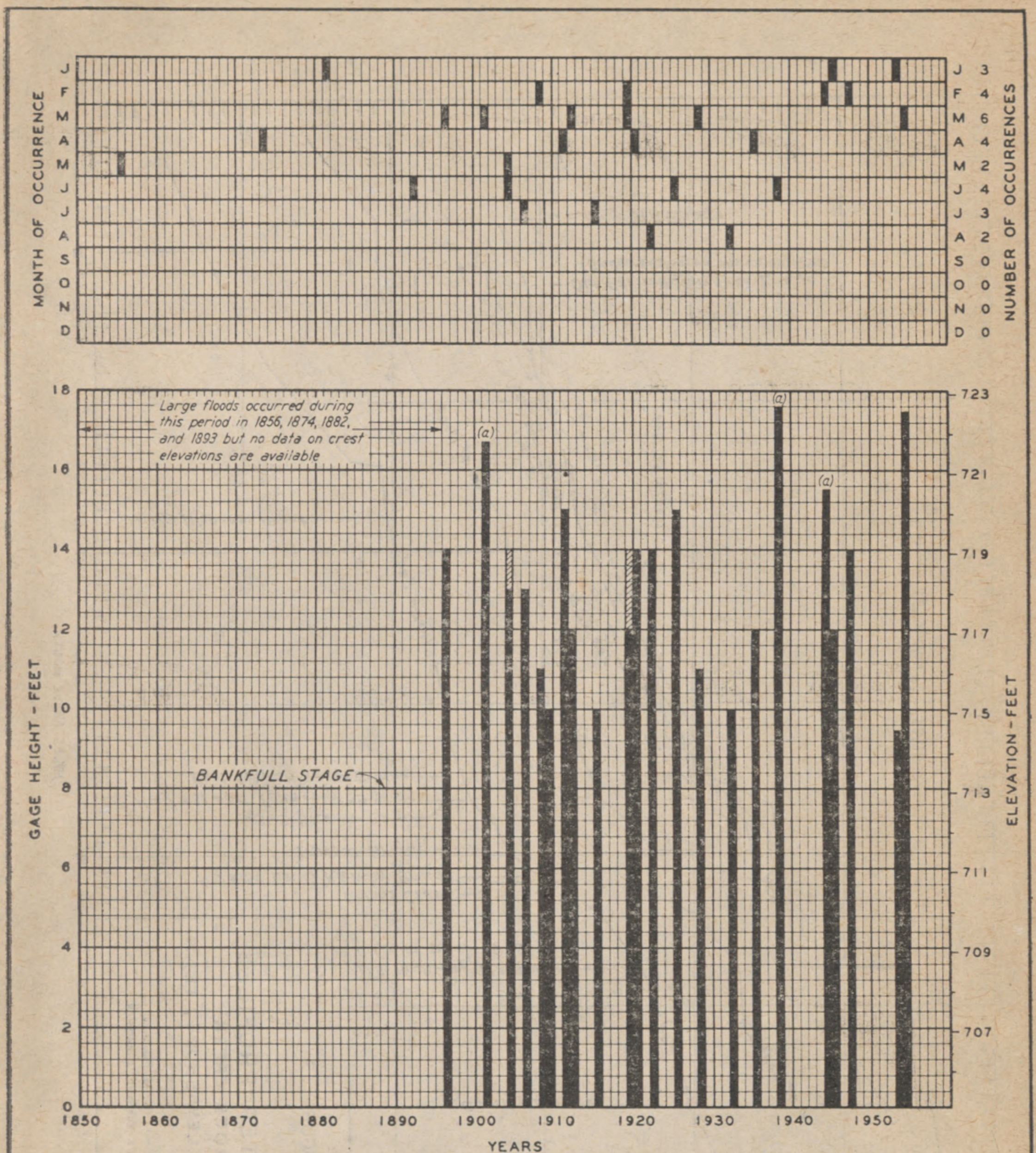
FIGURE 1

BIG ROCK CREEK WATERSHED

Scale 0 1 2 3 4 5 Miles

JUNE 1954

Lewisburg Regional Planning Commission
TENNESSEE STATE PLANNING COMMISSION



Dates of occurrence of floods were determined from newspaper accounts. Crest elevations were estimated for all floods except those of 1902, 1939, 1945, and 1954 from the newspaper descriptions. Crests were referred to the gaging station established at Tenn Hwy 50 bridge on December 17, 1953, drainage area 24.9 square miles, zero elevation--705.1 (USC & GS 1929 ADJ)

(a) Crest elevation from high water profiles

FIGURE 2

FLOODS ABOVE BANKFULL STAGE

BIG ROCK CREEK AT LEWISBURG, TENNESSEE

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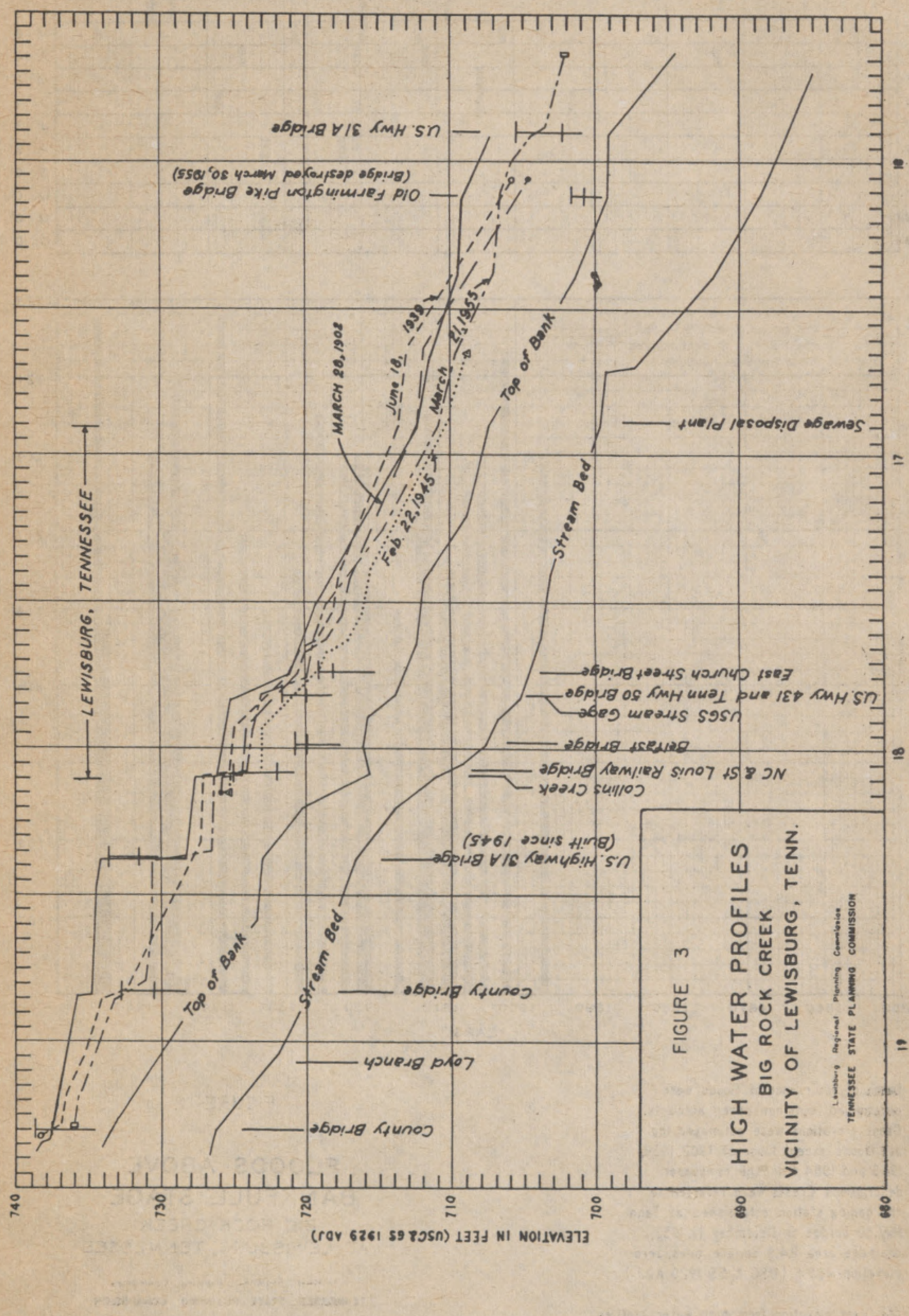


FIGURE 3

HIGH WATER PROFILES
BIG ROCK CREEK
VICINITY OF LEWISBURG, TENN.

Lewisburg Regional Planning Commission
TENNESSEE STATE PLANNING COMMISSION

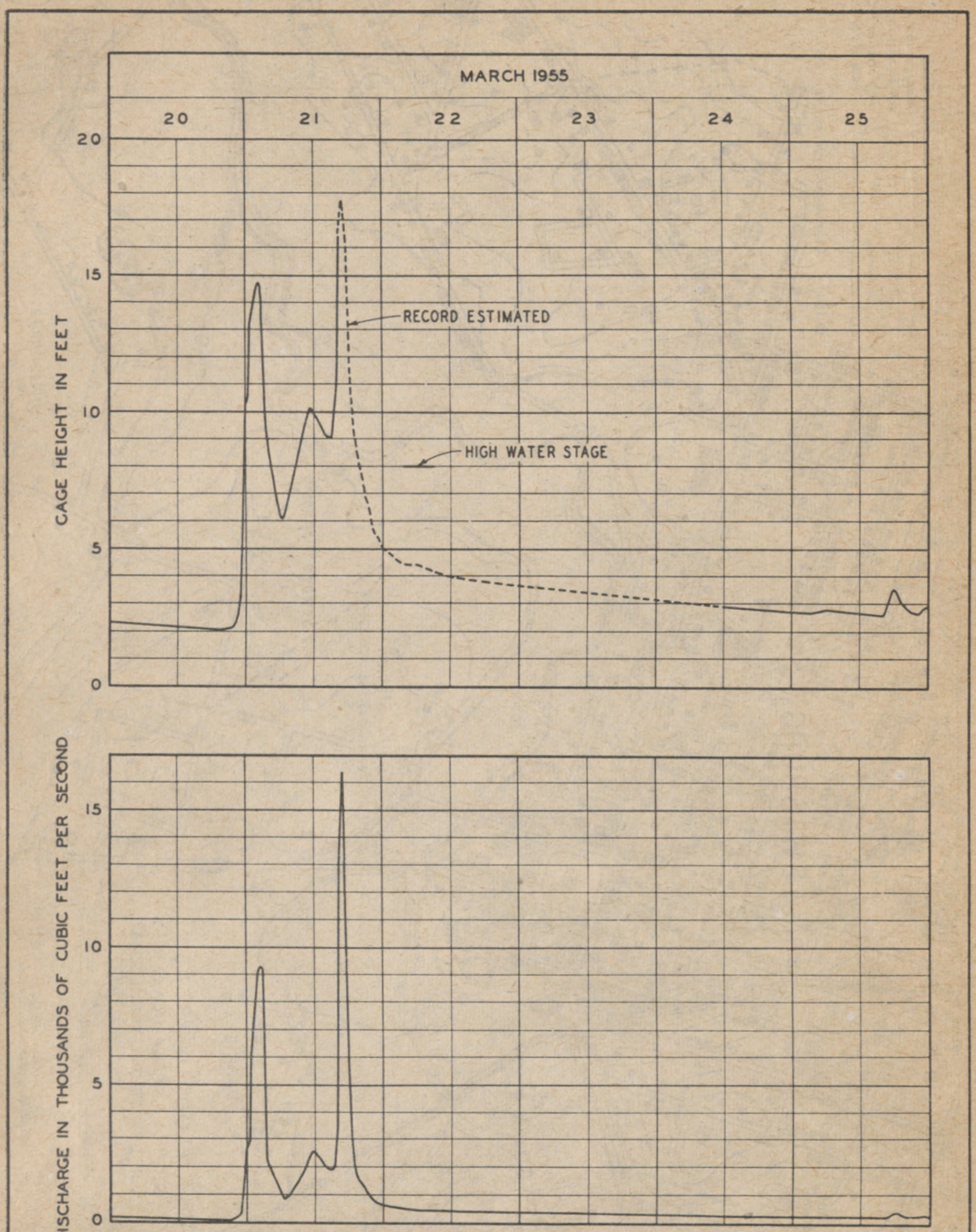


FIGURE 4

FLOOD OF MARCH 1955

STREAM STAGES AND DISCHARGES

BIG ROCK CREEK AT LEWISBURG, TENNESSEE

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TENNESSEE STATE PLANNING COMMISSION

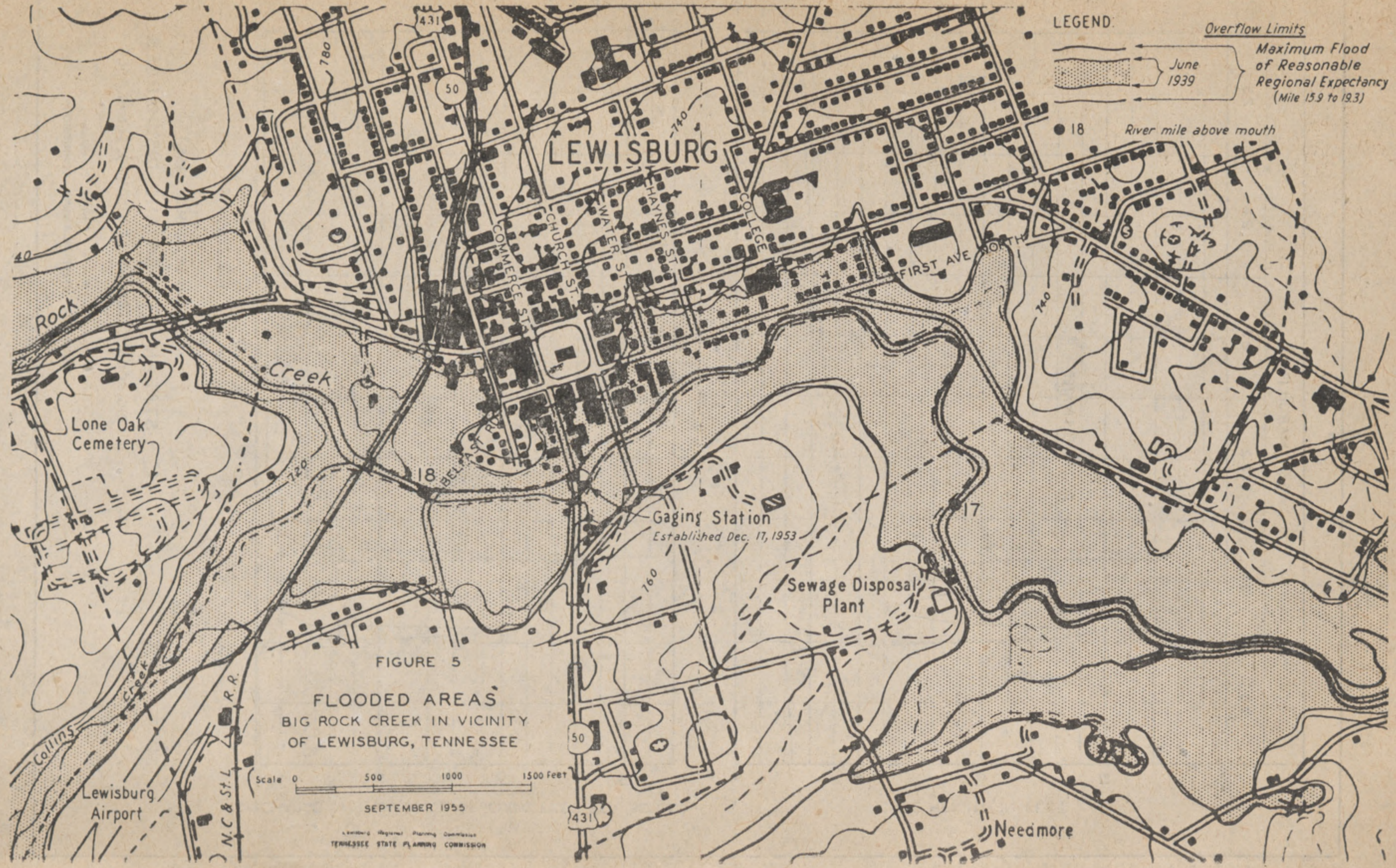


FIGURE 5

FLOODED AREAS
BIG ROCK CREEK IN VICINITY
OF LEWISBURG, TENNESSEE

II. Effects of Flooding on Development in the Lewisburg Area

Figure 5 shows the extent of flooding which took place during the 1939 flood. This area is approximately that which was also covered by the flood of 1955. In addition, the map shows the area that would be covered by a flood which can reasonably be expected as determined by a study of storms which have occurred in the same general area as Lewisburg.

Inspection of this map shows the two major types of areas subject to flood: (1) the open, and at present largely undeveloped, flood plain areas located outside the intensively developed portion of Lewisburg, and (2) the built-up section of Lewisburg extending along Big Rock Creek from Belfast Road to Bates Street. The effects of flooding are different in each of these areas.

Open and undeveloped flood plain

In this area most of the land is used for agricultural purposes. Although a few buildings are located on low-lying land, most farm structures are located on the higher flood-free ground. Since a major characteristic of flooding in the Lewisburg area is that the floods are of short duration, there is some minor damage to land, but generally no serious property damage.

For the most part these outlying areas present no serious development problem at the present time. The major problems arise from the fact that flooding of these areas interrupts communications from one section of the city to another; many of the bridges are flooded at the time the large floods occur. Some major public facilities such as the sewage disposal plant and the waterworks are affected by flood waters, and these services may be interrupted during times of flood.

From the point of view of planning for the future development of Lewisburg, studies of land-use requirements and the land in and adjacent to the city suggest that ample suitable land is available for residence, business, and industry without using flood plain areas. If steps are taken to guide the use of outlying areas so as to assure that future growth will not occur in areas subject to flood, the flood plain areas should not create additional problems for the community.

It is important, however, in planning for the development of Lewisburg that any improvements to highways and bridges place these structures above possible flood elevations and that causways or bridges have ample openings so that they will not form restrictions to the flow of water. If this is not done, flood heights are likely to be increased in the upstream areas and transportation interrupted at critical times.

Any improvements to public facilities in this area such as sewage disposal plant, waterworks, and substations should be so designed that they will not be damaged when floods occur. With these precautions most of the flood problems could be handled in these flood plain areas through the strict application of zoning and subdivision standards.

Built-up area of Lewisburg

The major flood problem in Lewisburg results from the flooding of land in and adjacent to the central business district, particularly those lands along Commerce Street and along First Avenue North.

This built-up area with places for business, industry, and residence is where major flood damage occurs. Figure 6 shows in detail the location of individual structures in the portion of downtown Lewisburg subject to flooding. This map shows also the elevation of the first floor of the structures as well as the areas flooded by the 1939 flood and the flood which may reasonably be expected.

After the 1955 flood, estimates were made of the amount of damage suffered by the community. This flood entered 26 homes and 23 business places. The depths of water ranged from a few inches to several feet on floors. Twenty-one of the flooded homes were along First Avenue North; 15 of the damaged business places were located along Commerce Street east of First Avenue North; and most of the remaining damaged business places were along First Avenue North. The damage was heavy because the rapid rise of water allowed little time to remove goods and equipment to higher levels. The estimate of the total amount of damage resulting from this flood is $117,000. If additional structures are built in areas subject to flood, the amount of damage will increase. A flood to heights which can reasonably be expected in the future could result in damage estimated at $700,000.

From a planning point of view the flooding which occurs in the built-up section of Lewisburg is serious because it involves the direction in which the central business district can expand so as to provide a reasonably level and efficient shopping area. Because the land surface rises sharply west of Second Avenue North there is little likelihood that major additions to the central business district will be made in this direction. To the south to the flood plain itself strictly limits growth and does not appear to offer much opportunity for expansion. It is for this reason that the general land-use plan of the city proposes that the business district expand to the north along First Avenue and Second Avenue. Unfortunately much of this area is subject to severe flooding. A large portion, in fact, would be flooded to depths of 5 to 7 feet during a flood which can be reasonably expected and depths of 3 to 4 feet in times of floods which will occur quite frequently. (See sec. III.)

The question is: What steps can be taken by the city of Lewisburg to provide for the orderly expansion of its central business district and at the same time to prevent the flood damage potential in the city from increasing?

III. Alternatives for Meeting the Flood Problem

There are two basic methods of alleviating flood damage—protective works and the making of necessary land-use adjustments. Protective works includes the construction of floodwalls and levees, channel improvements, upstream detention reservoirs, and the use of soil conservation practices. The second method—land-use adjustments—involves the adjusting of existing and proposed land uses to minimize damage resulting from floods. Usually it is necessary to use elements of both methods in any given area. These two methods and variations of each are presented in some detail to facilitate wise, deliberate choice of the best feasible program for Lewisburg.


FIGURE 6

FLOODED AREAS

DOWNTOWN LEWISBURG

Scale 0 50 100 200 300 Feet

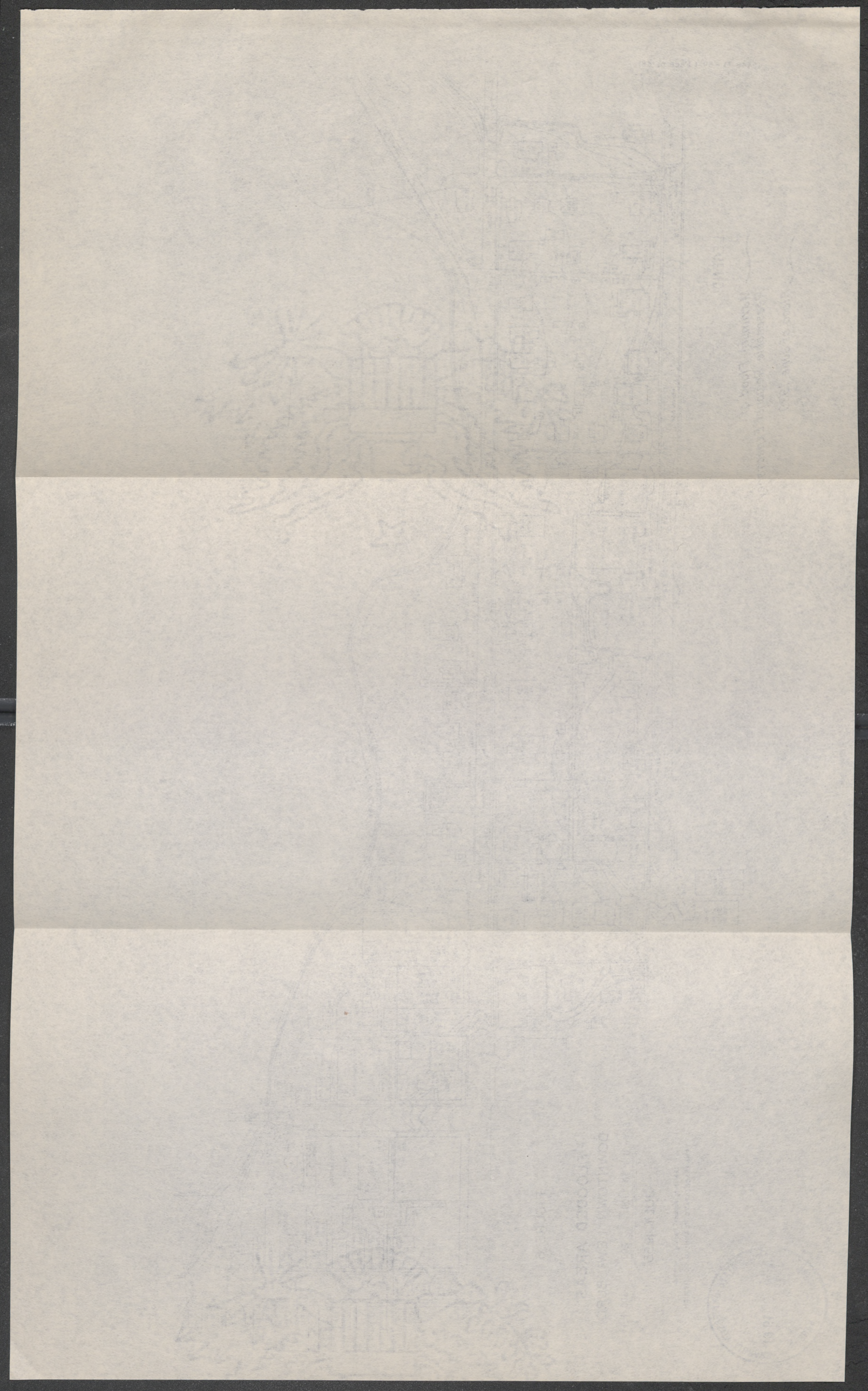
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Lewisburg Regional Planning Commission

TENNESSEE STATE PLANNING COMMISSION

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A. PROTECTIVE WORKS

Nature's flood plain is necessary for passage of floodwaters if the elevation of a flood is to be held to the minimum. There may be other considerations, however, that could economically justify restricting the flood section even though such action would naturally cause higher flood elevations upstream as well as at the site of restriction. Prior to considering the use or practicability of protective works, it is necessary to balance the cost of such facilities against the value of the land to be protected. In this section of the report various type of protective devices will be reviewed and the feasibility of their use in Lewisburg determined.

Walls or levees

Earth levees or reinforced concrete walls are devices commonly used for protecting waterfronts of cities from the ravages of floodwaters. Their location is generally selected to protect as large an area as possible and at the same time to encroach on the flood section of the stream as little as possible. This latter consideration is quite important as undue encroachment or the decreasing of the flood section will increase the elevation of floodwaters at the site and for a distance upstream.

When considering a wall or levee for protection against water several feet deep, it is important to remember the flood hazard that may result if the structure is overtopped. For that reason it is necessary that they be constructed to protect against greater floods than would be considered for other methods. Generally about three feet of "freeboard" should be added to the structure above the maximum expected flood to prevent overtopping by waves. An effective wall or levee would have a top or crown varying from 6 to 10 feet in width in accordance with the type of earth fill and the local situation. The slopes of such levees would vary from 2:1 (two feet horizontal to one foot vertical) to 3:1. The slopes must also be protected from erosion by sodding or riprapping. When the scale of such a structure is considered (horizontal and vertical widths), its cost can be readily envisioned; consequently, such devices are generally used only where the development to be protected is quite valuable and limited space in which to construct a wall or levee is available.

In addition to the cost of the structure itself, there are other factors which must be considered in determining the feasibility of a wall or levee for Lewisburg. Due to the limited space between the creek and some of the buildings to be protected and the location of the sewer line along the left or west bank of the creek, it would be necessary to excavate a new channel east of the present channel, fill the old channel, and build the levee along the general line of the old channel or just east of it. This undertaking would increase the cost considerably. The construction of a levee to the height required to afford protection for Lewisburg would necessitate the costly raising of existing streets and bridges crossing the flood plain. The cost of raising these streets and bridges could be saved if it were practical to leave openings in the levees that would be closed during time of flooding; however, the necessary flood forecasting service required for the safe operation of such a levee system would not be possible on Big Rock Creek.

Based on an estimated average annual damage of $6,800, an expenditure of $100,000 for flood protection would be justified. However, a

preliminary examination of possibilities for flood protection as outlined in preceding paragraphs indicates that the cost would be $200,000 or $300,000. This relation of benefit to cost suggests the impracticability of this form of flood protection.

Channel improvements

At many sites it is feasible to increase the capacity of the creek channel by means of straightening, clearing of vegetation, paving, increasing the slope, widening or deepening, and thereby decrease the flood stages. Such improvements, which increase the velocities and the size of the channel section, permit greater flows without increasing the height of the flood waters. This approach is particularly feasible when the channel is badly overgrown, winds sinuously across the landscape, and is large in proportion to the section of the overflow.

Two methods often suggested as solutions to Lewisburg's flood problems are the widening and deepening of the Big Rock Creek channel. Since the increased capacity of the creek channel for carrying flood waters is recognized as an important factor in lowering the flood stage, these two methods at first appear to be feasible solutions. However, Big Rock Creek has a relatively small channel. Cross sections show that during major floods the channel area is generally only a small fraction of the area of the total overflow section; even if the channel is enlarged to twice its present width, there will be only a small reduction in the height of floods. Deepening of the same channel would have but small effect on the height of the flood for the same reason that widening the channel would have a small effect. Moreover, a study of the profile of the stream shows that deepening the channel in Lewisburg would require that the channel be deepened for quite a distance downstream in order for floodwaters to escape freely. The fact that rock formations along the stream bed would make excavation quite costly is another factor which discourages deepening as a solution.

Other steps such as clearing, paving, and straightening the creek channel have been studied. The clearing of the channel would improve flow conditions for those floods that do not overtop the banks and for those that overtop the banks slightly. In view of this, a certain amount of channel clearance does appear to be worth considering. Such clearance, however, would have little effect on major floods. Paving of the channel would be very expensive and benefits from the effects of the increased capacity of the channel would not be sufficient to warrant the necessary expenditures. The feasibility of straightening the channel to expedite the flow of floodwaters past Lewisburg was considered. The cost of adequately straightening the creek channel would be excessive, however, as compared to the benefits to be derived from the small reduction in flood elevations. This cost, coupled with the formidable task of obtaining the necessary rights-of-way for the new channel, makes such a project seem impracticable.

Of the various methods of channel improvements it appears that only channel clearance would have any effect on Lewisburg's floods. The undergrowth in the flood plain area north of the town has been sufficiently high and thick to impede floodwaters, thus increasing flood height and flood damage. It should be emphasized, however, that

clearing the "floodway" will affect the local flood problem only to a limited degree and will not aid appreciably in lowering the damage caused by major floods.

Detention reservoirs

Construction of reservoirs that would detain and store rapid runoff and to prevent excessive quantities reaching the limited creek channel in the Lewisburg vicinity where serious flood conditions could develop have been considered. These reservoirs could regulate the flow of water along Big Rock Creek—storing floodwaters during periods of heavy rain and permitting the passage of water at regulated rates when the danger of flood had passed. A favorable site for a detention reservoir is one where the valley is narrow, affording good construction conditions, above which there is a broad relatively undeveloped area where large volumes of water can be stored. However, on the basis of a preliminary investigation, it is doubtful if the $100,000 expenditure justifiable for the construction of protective works for Lewisburg would be sufficient for a project of such magnitude.

Soil conservation

Another method of alleviating the flood danger is the application of proper soil conservation practices of "holding the water where it falls." These conservation practices include the construction of numerous small upstream ponds or reservoirs to retain water runoff, and the reduction of water runoff by planting trees in gullied areas, construction of terraces, contour strip cropping, crop rotation, and similar practices. This land treatment approach to flood protection seeks to cut down and delay the runoff before it reaches the main channel, thus reducing the flood crest.

Proponents of the soil conservation plan claim that all floods can be reduced drastically by good farm and forest management, while others contend that they have little effect. While such practices are definitely recommended as they would have an effect on smaller floods, it is unlikely that they would materially affect major floods.

B. LAND-USE ADJUSTMENTS

In the preceding section, the feasibility of constructing walls and levees, improving the channel, building detention reservoirs, and making better use of soil conservation practices was discussed. It was pointed out that the construction of walls and levees and detention reservoirs was not financially feasible, and that clearing the channel and using better soil conservation practices would have little effect on major floods. Therefore, making adjustments in existing and proposed land uses appears to be the most realistic approach to reduce flood damage to a minimum.

An investigation of the future land-use plan adopted by the Lewisburg Planning Commission in June of 1955 reveals the need to revise the land-use plan itself, the major road plan, and plans for expansion of the central and intermediate business districts. In this section of the report, these adjustments in the downtown commercial and the outlying areas will be discussed.

Downtown commercial area

The present boundary of the central business district, as defined by the Lewisburg zoning ordinance, extends generally as far north as Water Street, as far east as Big Rock Creek, as far south as Ewing Street, and as far west as Third Avenue. The Marshall County Court House forms the core of the downtown district and commercial uses have expanded radially from that center. Intermediate business districts are located around the central business district. On the north the intermediate business district extends to College Street and on the west to the rear of the lots fronting on Third Avenue to Haynes Street, at which point it extends west to include the lots on both sides of Third Avenue. The intermediate business district located east of the central business district extends from Big Rock Creek to the city limits and includes all of the property fronting on Commerce Street. An industrial district is located immediately south of the central business district along both sides of the N.C. & St. L. Railroad.

The value of the property (including buildings) located either partially or wholly within the limits of the central and intermediate business district in the flood plain is estimated to be $850,000.[1] Most of the existing commercial and light industrial uses located in the flood plain in the central and intermediate business districts are located along Commerce Street, Church Street, and First Avenue as far north as Krogers store.

The Lewisburg future land-use plan envisions the expansion of the central business district further north to Haynes Street and as far west as Fourth Avenue; the eastern and southern boundary would remain unchanged. The plan calls for the eventual expansion of the intermediate business district along the western and northern side of Second Avenue to the city limits and as far north as Bate Street on the eastern side of Second Avenue. Big Rock Creek would form the boundary of the district on the east. The intermediate business district along Commerce would remain unchanged.

To lower the damage potential of major floods or to prevent it from increasing, steps must be taken to restrict further business development in the maximum flood plain of Big Rock Creek. A thorough study of the Lewisburg flood plain, particularly that portion lying within the central and intermediate business districts, as defined by the future land-use plan, indicates that the flood plain can be divided into two parts and treated separately. Ponding and eddy areas generally located immediately east of the limits of the flood of maximum regional expectancy can be developed if the land is first filled and the ground floors of proposed structures are built above the high waterline. Filling or constructing small levees which would not materially restrict the flow of flood waters should be considered. In the remaining portions of the flood plain, further intensification of development should be restricted. The ultimate solution to the Lewisburg flood problem will require that this area be cleared in order to permit the unobstructed flow of flood waters. In order to accomplish this objective it will be necessary eventually to redevelop that portion of the central and intermediate business district lying within

[1] Estimate based on Lewisburg tax records and the estimated actual value of property as listed by the Nineteenth Annual Survey of County, City, and Town Government in Tennessee, published by Tennessee Taxpayers Association, May 1955. Valuations of public property (city hall and jail) provided by city of Lewisburg.

the flood plain, since zoning alone is not sufficient to accomplish the objective (see section IV).

This plan does not mean that the area would have to remain totally unused when cleared, however, Uses auxiliary to business and commercial purposes, parking lots, used car lots, etc., could be developed in those areas adjacent to the central and intermediate business districts. Large permanent structures would not be required by these uses and, in the event of flood they could be hastily evacuated. Those portions of the flood plain further removed from the commercial districts where development for such auxiliary uses would not be feasible could be used for farming or developed for park or recreational purposes.

The plans for the expansion of the downtown commercial area had to be reviewed, once it was determined that the ultimate solution of the flood problem would involve clearing the portion of the flood plain needed for the passage of flood waters. Not only would it be necessary to discourage further development in the flood plain and reorient the direction of growth of the central and intermediate business districts, but it would eventually be necessary to provide room outside the flood plain for many of the uses presently located there. The need to completely review the plans for the downtown commercial district and to develop a plan which would allow for the expansion of the central business uses and at the same time make maximum use of the flood plain was made evident by these considerations.

Problems of the downtown commercial area

The first and probably most difficult problem in redevelopment of the central business district was to determine the direction in which this district is likely to expand. The railroad and existing industrial uses tend to block further development in the south. The terrain tends to mitigate against further development toward the west except possibly along Commerce Street, and, of course, the flood plain limits further development toward the east. It, therefore, appears that further expansion of the central business district will probably occur in the north with a limited expansion along Commerce Street in the west.

Another problem confronting Lewisburg is increasing traffic congestion in the central business district. At present four major through-traffic arteries (the Nashville Highway, the Fayetteville Highway, and Mooresville, and the Cornersville Road) converge on the central business district and intersect at the crossing of Second Avenue and Commerce Street in the very heart of the downtown district. Unless this congestion is relieved, the downtown commercial district will become increasingly less attractive as a shopping center.

The third problem, to provide adequate parking facilities to customers in the downtown area, is one common to most cities. While the problem may not be quite as critical in Lewisburg as in other cities, it is sufficiently serious to warrant consideration. Unless steps are taken to meet the present need and future demand for parking, the Lewisburg central business district will suffer.

DOWNTOWN COMMERCIAL DISTRICT

(Numbers are keyed to plan on p. 55)

1. The proposed inner loop would tie in all major through traffic arteries leading into the central business district and would separate through from local traffic. The loop would provide access to the commercial establishments fronting on First Avenue as well as the proposed parking facilities to serve the central business district located in the flood plain.

2. Second Avenue would be closed from Church to Water Street. This right-of-way would be developed into a pedestrian mall.

3. The Church Street Bridge across Big Rock Creek would be abandoned.

4. The Columbia Highway would be moved to the south tying in with the southernmost portion of the inner loop.

5. An access drive would be developed to serve the churches and other structures presently located along Second Avenue.

6. Parking facilities to serve the central business district would be developed in the flood plain immediately east of the inner loop.

7. Parking facilities, used car lots, etc., auxiliary to the uses located along Second Avenue in the intermediate business district would be developed to serve the existing or later developed commercial uses.

8. A park or recreational area would be developed east of the auxiliary uses serving the intermediate commercial district, since the area is too far removed from the downtown commercial uses. This Park or recreational area would serve the entire community.

It therefore appears that a plan which takes into account these three major problems—provision for further expansion of the central business district, improvement of access into the central business district, and development of adequate parking facilities to serve existing and future needs of the central business district—must be developed.

Approach to a solution

The suggested plan (fig. 7) should be considered as the preliminary approach to an ultimate solution of the problems; further study will be required before this or a similar plan can be accomplished, and effectuation of any plan will depend upon whether or not this area would qualify as an urban renewal project (see sec. IV). The plan envisions the expansion of the central business district north to Haynes Street and as far west along Commerce as Fourth Avenue North. This would allow sufficient room for the relocation of commercial uses presently within the flood plain area. Many of these uses will probably seek locations outside the central business district either in the intermediate business district along Second and Third Avenues North or in the intermediate business district in the east along Commerce Street. It is conceivable that some of the uses might seek locations in one of the local shopping centers in other parts of the city.

In addition to allowing room for the relocation of uses presently within the flood plain, there would be sufficient room for the expansion of the downtown commercial district as the city of Lewisburg continues to grow.

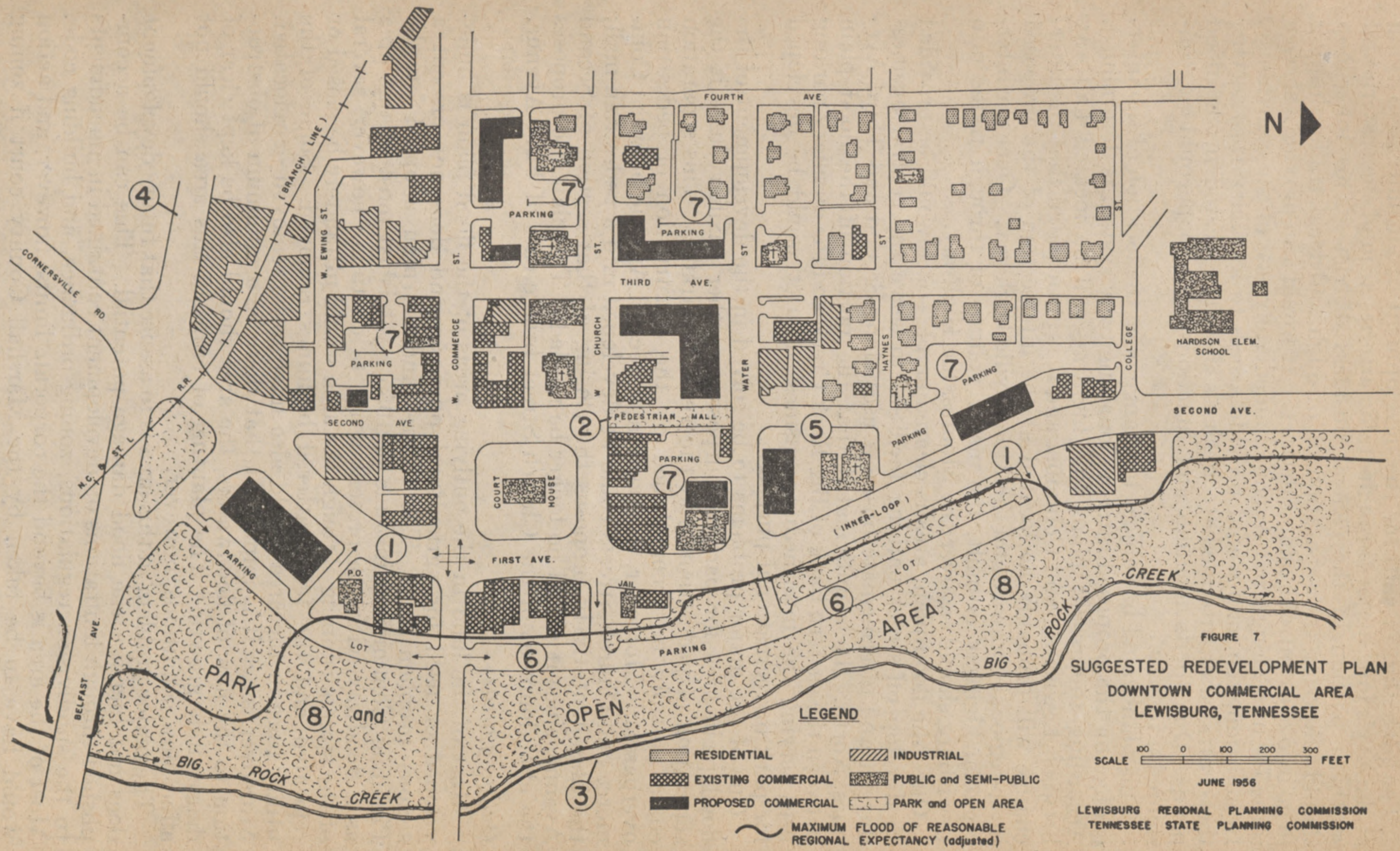


FIGURE 7

SUGGESTED REDEVELOPMENT PLAN
DOWNTOWN COMMERCIAL AREA
LEWISBURG, TENNESSEE

JUNE 1956

LEWISBURG REGIONAL PLANNING COMMISSION
TENNESSEE STATE PLANNING COMMISSION

The plan (fig. 7) calls for the development of an inner loop tying in the city's four major through-traffic arteries around the eastern and southern portion of the central business district. This inner-loop should allow for the separation of through and local traffic desiring to go into the central business district. It would also provide a service route for uses along First Avenue immediately east of the courthouse. In addition, the loop would provide access to auxiliary uses serving the central and intermediate business districts located in the flood plain. Due to its location and functions, this loop could be considered a bypass.

This plan would be subject to change once the location of the interchange on the proposed inter-regional highway system is determined. According to present plans this highway will be located half-way between Lewisburg and Columbia and it is anticipated that the interchange will probably be located at the intersection of the proposed inter-regional highway and the Mooresville Highway. Once the inter-regional highway is built, the major volume of through traffic into Lewisburg should be over the Mooresville Highway.

Once the flood plain area is cleared ample space would be provided to develop off-street parking facilities to serve the central business district and intermediate business uses along Second and Third Avenues North. It is anticipated that the portion of the flood plain between the eastern bank of Big Rock Creek and the auxiliary parking uses serving the intermediate business district would be developed for park or recreational purposes.

One of the major problems to be solved in the development of the flood plain area for parking purposes or other auxiliary uses is the separation of pedestrians and the vehicular traffic. This separation could possibly be accomplished by the construction of pedestrian overpasses. Moreover, the portion of Second Avenue between Commerce and Church Streets could be developed into a pedestrian mall; the plan tentatively proposes the closing of that section of Second Avenue, since it would no longer be needed. The plan also proposes the abandonment of the Church Street bridge east of First Avenue.

Outlying areas

Most of the land in the outlying areas of the flood plain is undeveloped or used for agricultural purposes and does not present a serious problem now. The future land-use plan adopted by the Planning Commission in June of 1955 established most of this area as a floodway with the present usage to continue; however, several of the streets running through the area would ultimately be closed or relocated and the few scattered buildings removed. Some of the utility lines in the area would also have to be removed or relocated. Moreover, since it is important that there be a minimum of obstruction to the flow of floodwaters, the area should also be kept clear of dense undergrowth. The planting of crops in this area should not affect flow conditions, however.

The major problem in this area is to assure that future development does not increase the flood damage potential. This can be accomplished through limitations on development contained in amendments to the subdivision regulations, zoning ordinance, and building code. Most of the area is beyond the corporate limits, however, and action would have to be taken by the Marshall County court if zoning

regulations or a building code is to be enacted to protect this outside area (see section IV).

IV. Program

Reduction of flood damage in Lewisburg will require a broad program to be carried out over a period of years. It involves the use of a variety of measures designed to prevent the more intense use of areas subject to flood and to help reduce both present and possible future flood damage potential. If consistently applied, this program will result in substantial savings to the city and to citizens of the community because future floods will have only a very limited effect in the area.

To start the program certain steps may be taken immediately. The Lewisburg zoning ordinance, approved in December 1950, can be revised and amended to contain provisions for guiding future development of the flood plain and to adjust development in the ponding and eddying areas. The subdivision regulations can be amended to discourage or halt further development in the flood plain both in the city and in areas beyond the corporate limits but within the Lewisburg planning region.

Certain parts of the program require more study before they can be started. The building code when adopted should contain provisions regulating construction in the flood fringe area. Consideration might be given to the feasibility of an urban renewal project which would allow for Federal participation in the redevelopment of built-up areas now subject to flood. While it is not possible to determine the exact degree to which channel improvements and soil conservation practices would lower the crest of future floods, benefits sufficient to make continued efforts in this direction worthwhile would be realized. And finally, procedures can be established to assure that flood data available will be considered in the design and construction of all public improvements so that such facilities will not be damaged by flooding.

This section of the report will review the use of zoning, subdivision standards, and a building code to adjust future development to flood conditions in Lewisburg. The feasibility of establishing an urban renewal project and the channel improvements and soil conservation practices which may lessen flood heights are also considered.

Zoning

The present zoning ordinance adopted December 1950 should be revised to provide for a floodway of sufficient size to carry floodwaters past Lewisburg with the practical minimum in interference. For this reason two additional use districts, as shown in figure 8, are proposed: a downtown floodway district and an outlying floodway district.

Uses permitted in the downtown floodway district would include those auxiliary to uses permitted in adjacent central and intermediate business districts such as parking and used car lots. Additional permitted uses might include public and private recreation facilities; circus, carnival, and similar transient amusement enterprises; and general farming. However, all uses in this district except farming, but not excepting farm structures, would be permitted only upon review and approval of the Lewisburg planning commission and subject to such conditions as the planning commission may require to prevent increased flood heights and damage in the city and adjacent areas.

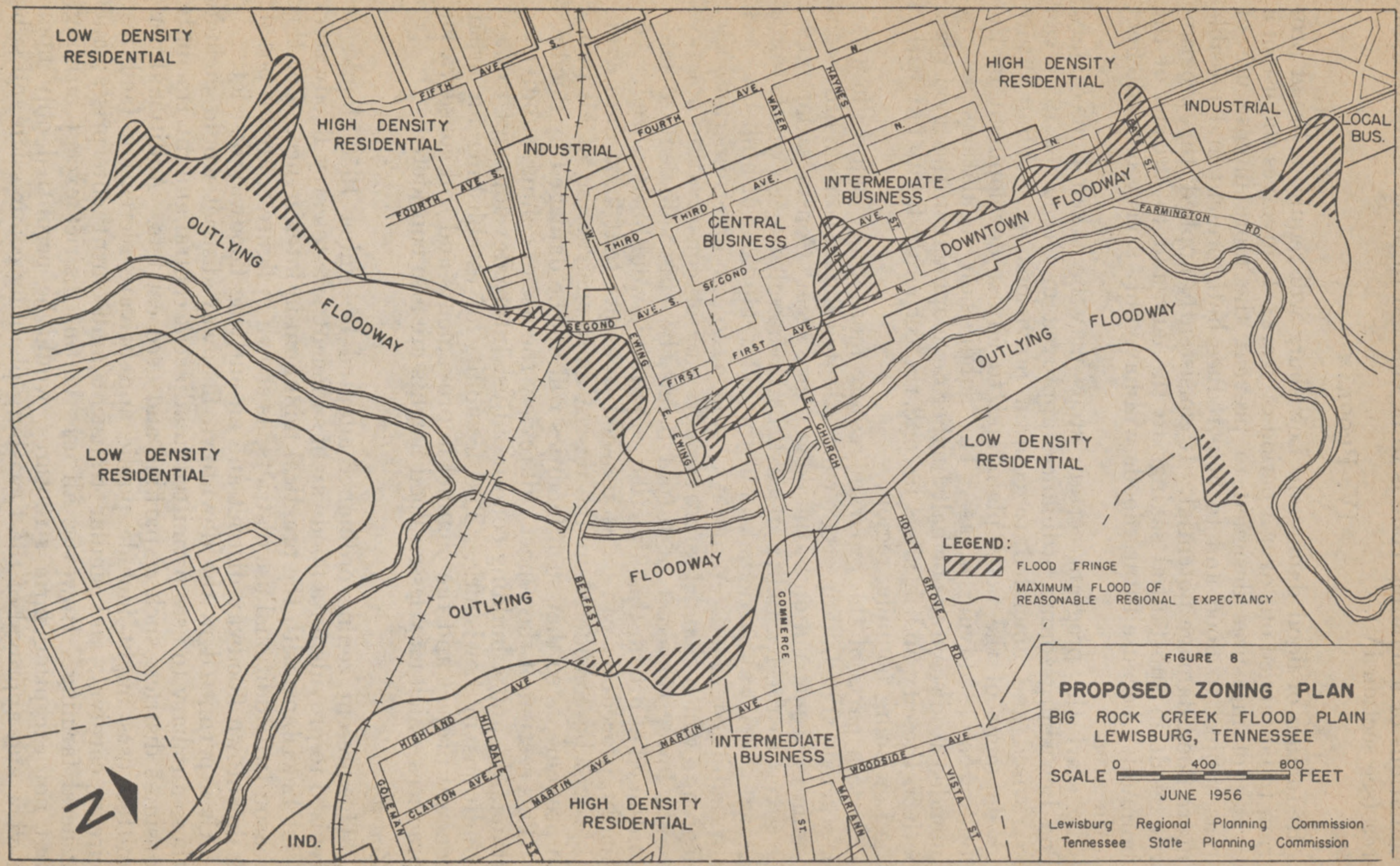


FIGURE 8

PROPOSED ZONING PLAN

BIG ROCK CREEK FLOOD PLAIN
LEWISBURG, TENNESSEE

SCALE 0 400 800 FEET

JUNE 1956

Lewisburg Regional Planning Commission
Tennessee State Planning Commission

In the outlying floodway district as shown on the zoning map, uses should be more limited since this area is at present largely undeveloped. In general, those uses which do not require structures would be encouraged. As in the case of the downtown floodway district, permanent structures for occupancy by residential, commercial, and industrial uses should be prohibited.

Under the general provisions of the Lewisburg zoning ordinance, provision should be made to govern construction in the flood fringe areas between the floodway and the limits of maximum flood of reasonable regional expectancy. These flood fringe areas would not be classed as use districts since the uses allowed under the existing ordinance would continue to be permitted, but construction would be adjusted to the flood conditions which exist.

Appendix A to this report contains specific suggested revisions to the Lewisburg zoning ordinance.

It should be noted that revision of the present zoning ordinance alone will not guide the future development of that portion of the Big Rock Creek flood plain outside the corporate limits. Zoning could not be extended to this area unless it is annexed to the city and brought under the city zoning ordinance or unless the quarterly county court enacts a zoning resolution containing provisions similar to those suggested for the city.

Subdivision regulations

The Lewisburg subdivision regulations should be amended to provide for consideration of the flood hazard in the design and development of subdivisions. Land should not be platted for residential occupancy or for other uses that would tend to increase the danger to health, life, and property. Proposed revisions to the regulations would require that each lot in a subdivision contain a building site which has an elevation at least as high as the maximum flood of reasonable regional expectancy. Since flooding is of short duration and the floors of structures built would be above flood elevations, streets would be permitted to be 2 feet below the elevation of the maximum flood of reasonable regional expectancy. Septic tanks should not be permitted unless the ground elevation is at least as high as that required for building sites.

Appendix B to this report contains specific suggested revisions to the Lewisburg subdivision regulations.

Building code

Provisions containing requirements for construction which would withstand the effects of floods on any particular site could be included in a building code. These provisions should specify the depth and stength of foundations and wall, should require the first floor elevations to be at least as high as the maximum flood of reasonable regional expectancy, and include any other restrictions considered necessary from the point of view of building construction to insure the health and safety of occupants of structures in hazard areas.

Urban renewal

The feasibility of classifying the portion of the flood plain adjacent to the central and intermediate commercial districts in downtown Lewisburg as an urban renewal project should be investigated. The accomplishment of the suggested plan reviewed in the preceding

section (fig. 7) would be entirely dependent upon whether or not this area could be classified as a renewal project. Under the Housing Act of 1954 all causes of blight may be considered in urban renewal projects. Many of the buildings located in the flood plain might be considered as substandard due to their hazardous location, even though they may be of substantial construction and contain adequate facilities. Should it be possible to classify all or a portion of this area as a renewal project, Federal funds would be available for the redevelopment of the area to the extent of $2 from the Federal Government for every $1 provided by the local government.

Since it is obvious that the final solution of the Lewisburg flood problem cannot be accomplished through zoning but will require the redevelopment of that portion lying within the flood plain, it is recommended that the city explore the possibility of an urban renewal project in this area with officials of the Housing and Home Finance Agency.

Protective works

In a preceding section of this report the feasibility of constructing walls or levees, channel clearance, detention reservoirs, and the application of soil conservation practices were reviewed. Of these possibilities only channel clearance and improved soil practices appear to be feasible. It is recommended that the city and county cooperate in clearing the main channel of undergrowth and other obstructions and in clearing the flood plain itself of undergrowth, as well as maintaining the improved conditions which would result. It is further recommended that the city and county give consideration to encouraging a program to improve soil conservation practices in the watershed.

Appendix A

Additions to the Lewisburg Zoning Ordinance

(Approved by Lewisburg City Commission on April 13, 1957)

The following additions are for inclusion in the Lewisburg Zoning Ordinance for the purpose of guiding future development in the floodway and in the flood fringe areas. The proposed location in the zoning ordinance relates to that adopted by the Lewisburg Board of Commissioners December 2, 1950.

1. Under "Article II—Purposes", insert on line 5, after the word "panic", "flooding along natural water courses". The phrase in this line will then read "To secure safety from fire, panic, flooding along natural water courses, and other dangers."

2. Under "Article III—General Provisions", insert a new section 9 entitled "Floodway Fringe Area Requirements".

"Section 9—Floodway Fringe Area Requirements

"Within the floodway fringe areas lying outside the floodway districts but within the area that would be covered by the maximum flood of reasonable regional expectancy (as shown on the Zoning Map of Lewisburg, Tennessee) the following regulations shall apply: No building or structures shall be moved unless the ground upon which said building or structure is to be erected and twenty-five (25) feet beyond the limits of said building or structure shall, prior to or at the time of construction, be raised to an elevation within at least two (2) feet of the elevation of the maximum flood of reasonable regional expectancy and the main floor of said building or structure shall not be less than the elevation of the maximum flood or reasonable regional expectancy. No basement floor or other floor shall be constructed below or at a lower elevation than the main floor."

3. Under article IV, section 1, subsection 1.1, two new districts should be added.

"Downtown Floodway

"Outlying Floodway"

4. A new article entitled "Article VIII" should be added, with a renumbering of the articles which follow.

"ARTICLE VIII.—PROVISIONS GOVERNING DOWNTOWN FLOODWAY DISTRICT

"*Section 1—Downtown Floodway District*

"A Downtown Floodway District, as shown on the Zoning Map of Lewisburg, Tennessee, is established to meet the needs of Big Rock Creek to carry the abnormal flows of water in times of flood; to prevent encroachment into the district which will increase flood heights and flood damage; and to prevent the loss of life and excessive damage to property in the area of greatest flood hazard. In the Downtown Floodway District the following regulations shall apply:

"1.*1 Uses Permitted*

"1.*11* The following uses are permitted subject to approval by the planning commission and to such conditions as the planning commission may specify to protect the public interest.

"1.*111* Uses such as loading and unloading areas, parking lots and used car lots auxiliary to uses permitted in the adjoining Central Business and Intermediate Business Districts.

"1.*112* Open-type public and private recreation facilities such as parks, driving range, and drive-in theaters.

"1.*113* Circus, carnival, or similar transient amusement enterprises.

"1.*114* Storage yards for equipment and material not subject to major damage by flood waters.

"1.*115* The sale of food, refreshments, and other commercial enterprises that would not require the construction of permanent structures.

"1.*116* Agricultural uses including farming, grazing, and livestock raising.

"1.*117* Any other uses customarily accessory or incidental to the above uses.

"1.*2 Approval of Planning Commission.* Prior to the construction of any building, structure, or any improvement within this district the plans for such construction shall be submitted to the planning commission for review and approval or disapproval. In its review of plans submitted the planning commission shall be guided by the following standards:

"In applying these standards the planning commission should keep in mind that the purpose of this district is to prevent encroachment of the flood plain which will unduly increase flood heights and danger to life and property.

"1.*21* Any use permitted shall be a type not appreciably damaged by flood waters provided no structures for human occupation shall be permitted.

"1.*22* No fill shall be permitted.

"1.*23* On developed lots the percentage of the lot occupied by the main structure at the time of the adoption of this ordinance shall not be increased, and any new structure shall occupy not more than ten (10) percent of the lot.

"1.*24* Any structures permitted shall be constructed and placed on the lot so as to offer the minimum obstruction to the flow of water, such as placing a stadium with open ends parallel to the flow of water, rather than at right angles to such flow.

"1.*25* Any structure permitted should be designed to have a minimum effect upon the flow of water. To illustrate: an enclosed stadium would not be permitted, but an open-end stadium may be permitted if flood heights are not increased appreciably by such structure.

"1.*26* Any structure permitted shall be firmly anchored to prevent the structure from floating away and thus threatening to further restrict bridge openings and other restricted sections of the creek.

"1.*27* Where, in the opinion of the planning commission, topographic data, engineering studies, or other studies are needed to determine the effects of flooding on a proposed structure and/or the effect of the structure on the floodway, the planning commission may require the applicant to submit such data and/or studies prepared by competent engineers or other technical people.

"1.*28* The granting of such approval shall not constitute a representation, guarantee, or warranty of any kind or nature by the City of Lewisburg or the Planning Commission, or by an officer or employee of either thereof of the practicability or safety of any structure or other plan proposed and shall create no liability upon, or a cause of action against such public body, officer, or employee for any damage that may result pursuant thereto."

5. A new article IX should be added, with a renumbering of the articles which follow.

"ARTICLE IX—PROVISIONS GOVERNING OUTLYING FLOODWAY DISTRICTS

"*Section 1—Outlying Floodway District*

"An Outlying Floodway District, as shown on the Zoning Map of Lewisburg, Tennessee, is established to meet the needs of Big Rock Creek to carry the abnor-

mal flows of water in times of flood; to prevent encroachment into the district which will increase flood heights and flood damage; and to prevent the loss of life and excessive damage to property in the area of greatest flood hazard. In the Outlying Floodway District the following regulations shall apply:

"1.*1* *Uses Permitted*

"1.*11* The following uses are permitted subject to approval by the planning commission and to such conditions as the planning commission may specify to protect the public interest.

"1.*111* Public and private recreation facilities.

"1.*112* Circus, carnival, and similar transient amusement enterprises.

"1.*113* Agricultural uses, including farming, grazing, and livestock raising.

"1.*114* Open-type uses, such as loading and unloading areas and gardens which do not require structures, auxiliary to uses permitted in any adjoining district.

"1.*2* *Approval of Planning Commission.* Prior to the construction of any building structure or improvement or the use of land within this district, the plans for such construction or use shall be submitted to the planning commission for review and approval or disapproval. It its review of plans submitted the planning commission shall be guided by the following standards. In applying these standards the planning commission should keep in mind that the purpose of this district is to prevent encroachment into the flood plain which will unduly increase flood heights and danger to life and property.

"1.*21* The standards and requirements set forth in Article VIII, Subsections 1.21, 1.22, 1.24, 1.25, 1.26, 1.27, and 1.28 shall apply to the Outlying Floodway District."

6. Add to existing "Article X—Definition", the following new subsection 1.7 with other subsections which follow renumbered.

1.7. Maximum Flood of Reasonable Regional Expectancy. For purposes of this ordinance the elevation of the maximum flood of reasonable regional expectancy shall be determined by the chart entitled "High Water Profiles, Big Rock Creek, Vicinity of Lewisburg, Tennessee," Tennessee Valley Authority, Division of Water Control Planning, September 1955, which is made a part of this ordinance.

Appendix B

Revisions of Lewisburg Subdivision Regulations

(Adopted by Lewisburg Regional Planning Commission on October 2, 1956)

The following provisions for addition to the Lewisburg subdivision regulations are to provide for consideration of the flood hazard in the design and development of subdivisions. The proposed location in the subdivision regulations relate to those adopted by the Lewisburg Planning Commission December 12, 1951.

1. Under article II insert a new section entitled "Suitability of Land."

"Land subject to flooding shall not be platted for residential occupancy nor for such other uses as will increase the danger to health, life, and property. In applying this provision, land below the elevation of the maximum flood of reasonably regional expectancy shall be considered subject to flood. This elevation shall be determined by the chart entitled 'High Water Profiles, Big Rock Creek, Vicinity of Lewisburg, Tennessee,' Tennessee Valley Authority, Division of Water Control Planning, September 1955, which is made a part of these regulations."

2. Under article II, section A, insert a new section 6 entitled "Street Elevation"; renumbering the sections which follow.

"No street shall be approved unless it is at or above the elevation of the maximum flood of reasonable regional expectancy. The planning commission may require where necessary profiles and elevations of streets and areas subject to flood."

3. Under article II, section C, add a new subsection 2, entitled "Adequate Building Sites"; renumbering the sections which follow.

"Each lot in a subdivision shall contain a building site with an elevation not less than the elevation of the maximum flood of reasonable regional expectancy."

4. Under article III, section B, add a new subsection d, as follows; renumbering the sections which follow.

"If any portion of the land being subdivided is below the elevation of the maximum flood of reasonable regional expectancy, the limit of the maximum flood of reasonable regional expectancy shall be shown on the final plat as recorded."

Appendix C

LETTERS OF COMMENT

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., February 24, 1959.

Hon. HERBERT D. VOGEL,
Chairman, Board of Directors,
Tennessee Valley Authority,
Knoxville, Tenn.

MY DEAR GENERAL VOGEL: This is in further reply to the letter of September 26, 1958, transmitting a report of the Board of Directors of the Tennessee Valley Authority entitled "A Program for Reducing the National Flood Damage Potential."

This report reviews briefly the origins and growth of Federal flood control programs, including the joint Federal-State-local program for dealing with localized flood problems developed in recent years by the TVA. The report goes on to recommend that the TVA approach to local flood damage reduction be adapted to national flood control programs and that legislation be considered to accomplish this purpose.

We are in general agreement with the basic proposal in the report that measures other than Federal construction of flood control works, such as flood damage abatement through better local land use planning, should be considered in determining solutions to local flood problems. The report contemplates that the initiative and responsibility for formulating and accomplishing these measures in connection with local projects would be assumed largely by local interests with only such Federal assistance as may be warranted under the prevailing circumstances in each case. This high degree of participation by local interests in solving their own immediate flood problems by means other than Federal construction is certainly desirable and should be encouraged.

In connection with Federal flood control projects authorized by the Congress, the President has recommended the enactment of legislation requiring increased cost sharing by local interests. While the administration is not prepared at this time to recommend additional legislation to put into effect all the aspects of the program suggested in the TVA report, we believe that the report is a valuable contribution and should be submitted to the Congress for its consideration.

The comments of other interested Federal agencies on the report are enclosed for your information. It is suggested that these comments, together with this letter, accompany your report to the Congress.

Sincerely yours,

MAURICE H. STANS.

DEPARTMENT OF THE ARMY,
OFFICE OF THE ASSISTANT SECRETARY,
Washington, D.C., December 18, 1958.

Hon. MAURICE H. STANS,
Director, Bureau of the Budget.

DEAR MR. STANS: Your letter of November 12, 1958, requests the views of the Department of the Army on a report entitled "A Program for Reducing the National Flood Damage Potential," prepared by the Tennessee Valley Authority.

We concur in the finding in the report that the flood problem is increasing in severity due, as the report points out, primarily to the rapid urbanization of the Nation, with consequent development and use of areas subject to flood hazards. Under the national flood control policy established by the Flood Control Act of 1936 and subsequent acts, substantial protection against floods has been provided to many communities. But it has not been possible within the available means to provide protection to all areas, or complete all authorized projects. In addition there are areas where protection may be feasible but surveys have not been completed. There are also many areas for which protection is either physically or economically unfeasible.

The Department of the Army occurs, therefore, in a principal conclusion of the report that there is a need for better recognition of the flood hazard in developing and using areas that are subject to floods. States and communities can play an important role in encouraging sound land use through the enactment and enforcenemt of appropriate regulations, standards and codes.

Up to the present time only limited use has been made of zoning, and other devices for regulation of flood plain use as a means of avoiding or reducing flood losses. The Corps of Engineers has been studying this problem for some time, and is in general agreement with the TVA report that basic flood plain information is needed to aid States, communities and individuals in adjusting the use, or in continuing the use, of flood plain areas. The Corps of Engineers is now giving consideration to steps which might be taken to accomplish this purpose.

The TVA report also recommends that the States and communities shall assume greater responsibility for the solution of local flood problems including the construction of protective works, with Federal responsibility limited to the provision of technical and financial assistance. Federal assistance would be contingent upon appropriate regulation of flood plain development. The Congress established the policy of Federal responsibility for construction of local flood control projects in the Flood Control Act of 1936 and has reaffirmed this policy in subsequent enactments. The Department of the Army would certainly have no objection to a greater degree of State and local participation in flood control. This would be in accord with the recommendations of the Presidential Advisory Committee on Water Resources Policy; but would, of course, require congressional action to change existing law.

Sincerely yours,

DEWEY SHORT,
Assistant Secretary of the Army
(Civil-Military Affairs).

DEPARTMENT OF AGRICULTURE,
Washington, D.C., December 18, 1958.

Hon. MAURICE H. STANS,
Director, Bureau of the Budget:

DEAR MR. STANS: This is in reply to the letter of November 12, 1958, from the Assistant Director, Bureau of the Budget, transmitting for our review and comment a report entitled "A Program for Reducing the National Flood Damage Potential" submitted to the Bureau of the Budget by the Board of Directors of the Tennessee Valley Authority for transmittal to the President.

The report is principally concerned with urban and industrial development in flood hazard areas and points out that the national flood damage potential is increasing despite large Federal expenditures for flood control. The TVA has undertaken a program whereby cities and communities are provided with information which they may use as a basis for adopting land-use controls to restrict developments in flood hazard areas to help in solving their flood problems. According to the report, the powers to adopt land-use regulations belong to the State and local governments and these powers must be used if new developments are to be prevented from spreading into flood hazard areas.

In view of the progress which has been achieved with the program of Federal-State-local cooperation in the Tennessee Valley area, the TVA suggests that this approach be implemented on a national scale. The report recommends an expanded program for collection, analysis, and use of flood data, a broad approach to flood damage abatement which includes preventive as well as corrective measures, and more active participation by State and local governments.

We feel that these are worthwhile objectives in national flood control policy. Similar recommendations were made in the report by the President's Advisory Committee on Water Resources Policy. Participation by local organizations is a basic part of the watershed program administered by the Department of Agriculture under the provisions of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, as amended). The requirement under that program for land treatment in a watershed above proposed structures is comparable in principle to the proposal for flood plain zoning contained in the report. Our experience has indicated that both technical and financial assistance are needed to facilitate local flood prevention efforts. We believe that flood control policy should recognize the necessity of teamwork between various levels of government.

We feel that the cost-sharing aspects of the proposed program should be given full consideration before firm policies are established. The report recommends Federal planning and development of projects which are parts of major stream regulation systems and the continued financing of these improvements largely by Federal funds. On the other hand, the report recommends increased financial participation by local beneficiaries in single purpose flood protection projects whose benefits are primarily local. If we correctly understand the proposal, such a program would result in inequitable cost sharing between beneficiaries on "small" and "large" projects. The Department of

its experience local interests have encroached on the flood plain downstream from completed reservoir projects that provide almost complete control of floods to the extent that normal planned reservoir releases during flood periods cause damage to these subsequently constructed improvements and consequent complaints against reservoir operation. This has occurred despite widespread posting of areas that would be inundated by anticipated reservoir releases during reservoir operations for flood control.

We recommend that consideration be given to preparation of a joint report which would show the contributions of all agencies, including TVA, to such a program and which could appropriately be given the stamp of approval of the entire executive branch. This Department would be glad to participate in the preparation of such a report. If the report, notwithstanding, is to be printed in its present form, we recommend that this letter, or its substance, and those of any other Federal agencies be printed and included with the report in order to cover the related activities of the Federal agencies in this field other than TVA.

Sincerely yours,

ELMER F. BENNETT,
Under Secretary of the Interior.

VETERANS' ADMINISTRATION,
Washington, D.C., December 5, 1958.

Hon. MAURICE H. STANS,
Director, Bureau of the Budget, Washington, D.C.

DEAR MR. STANS: We have reviewed the Tennessee Valley Authority's report entitled "A Program for Reducing the National Flood Damage Potential". The recommendations contained in the report would provide valuable material presently difficult to procure and often unobtainable. Such material is important to us in determining the flood potentials of housing developments. It is also important to us in selecting sites for our hospitals, supply depots, and other VA installations.

At all our installations, we make every effort to cooperate with local and Federal authorities to reduce flood potential. We have granted easements for drainage projects, and we have built levees, pending areas, and other flood diverting structures.

We certainly agree with the recommendations contained in the report and appreciate the opportunity of offering our comments on this program.

Sincerely yours,

BRADFORD MOORE,
Deputy Administrator
(For and in the absence of
Sumner G. Whittier, Administrator).

TENNESSEE VALLEY AUTHORITY,
Knoxville, Tenn., March 31, 1959.

Hon. RICHARD M. NIXON,
The President of the Senate,
U.S. Senate, Washington, D.C.

DEAR MR. NIXON: By letter of March 9, 1959, the Board of Directors of the Tennessee Valley Authority submitted for the information of the Congress a report entitled, "A Program for Reducing the National Flood Damage Potential." Comments of the Bureau of the Budget and other interested Federal agencies accompanied the report.

Transmitted herewith are additional comments by the Bureau of the Budget and another Federal agency which were received after the report had been submitted.

Respectfully yours,

HERBERT D. VOGEL,
Chairman of the Board.
ARNOLD R. JONES,
Director.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D.C., March 19, 1959.

Hon. HERBERT D. VOGEL,
Chairman, Board of Directors,
Tennessee Valley Authority,
Knoxville, Tenn.

MY DEAR GENERAL VOGEL: There is enclosed for your information a copy of a letter from the Administrator of the Housing and Home Finance Agency, dated March 11, 1959, commenting on a report of the Board of Directors of the Tennessee Valley Authority entitled "A Program for Reducing the National Flood Damage Potential."

In addition to the comments of other Federal agencies forwarded to you with my letter of February 24, 1959, it is suggested that the views of the Housing and Home Finance Agency, particularly with respect to a possible interpretation of the second part of recommendation No. 4, also accompany your report to the Congress.

Sincerely yours,

ELMER B. STAATS, *Deputy Director.*

HOUSING AND HOME FINANCE AGENCY,
OFFICE OF THE ADMINISTRATOR,
Washington, D.C., March 11, 1959.

Hon. MAURICE H. STANS,
Director, Bureau of the Budget,
Washington, D.C.

DEAR MR. STANS: This is in reply to your request for the views of the Housing and Home Finance Agency upon a report with recommendations submitted by the Board of Directors of the Tennessee Valley Authority entitled "A Program for Reducing the National Flood Damage Potential." This letter will serve to confirm the comments provided informally to your staff at an earlier date.

Basically, the Housing and Home Finance Agency agrees with the substance of the TVA report and can endorse the recommendations set forth therein, with the exception noted below.

As the report points out, this Agency has adopted policies which are consistent with the main part of recommendation No. 4 that Federal Government agencies having responsibilities related to site selection or financing of physical structures observe local flood plain zoning and other standards in carrying out their responsibilities. The Federal Housing Administration, for example, has been of material assistance in forwarding local flood damage prevention objectives through withholding of mortgage insurance in areas and on structures which are not consistent with local flood plain zoning and other regulations. In the administration of the urban renewal program, the Agency endeavors to assure that the locality give appropriate recognition to existing or threatened flood damage conditions in designing the urban renewal plan and in its execution.

The Agency agrees with the recommended Federal policy of encouraging local recognition of flood damage situations and encouraging adoption of appropriate flood zoning ordinances and regulations by local bodies. However, we believe very strongly that the adoption of flood zoning ordinances and regulations is a matter for local determination. In my opinion, it would be neither feasible nor wise to try to withhold all Federal assistance from the community as a means of bringing pressure for the adoption of appropriate flood area regulations.

We would have to object rather strongly to one possible interpretation of the second part of recommendation No. 4, which reads as follows:

> * * * in cities without land-use controls but subject to flood damage (the Federal Government) require establishment of such controls *before Federal programs are approved and put into execution.* [Emphasis supplied.]

Read literally, this recommendation would prevent, for example, the insurance of a mortgage on a single-family home located in any part of a city—whether or not that part of the city were exposed to the danger of flood—if any other part of the city were so exposed and were without effective control regulations. The recommendation should be modified to make clear that the withholding of Federal support and assistance would be related solely to those areas within a community which are exposed to flood damage and which require zoning or other controls, rather than to the community as a whole. I assume that this is the actual intent, but the present language is broad enough to cover the other interpretation.

The Agency agrees with the rest of the recommendations included in the report upon which it feels in a position to comment.

Apart from the recommendations, we feel that the language of the report dealing with the Federal flood insurance program (appearing on p. 6 of the draft) is not a necessary part of the argument and seems unnecessarily critical of administration policy in this field. This comment, as well as those on the recommendations, has been communicated to your staff.

If we can provide any further assistance in this connection, please let me know.

Sincerely yours,

NORMAN P. MASON, *Administrator.*

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