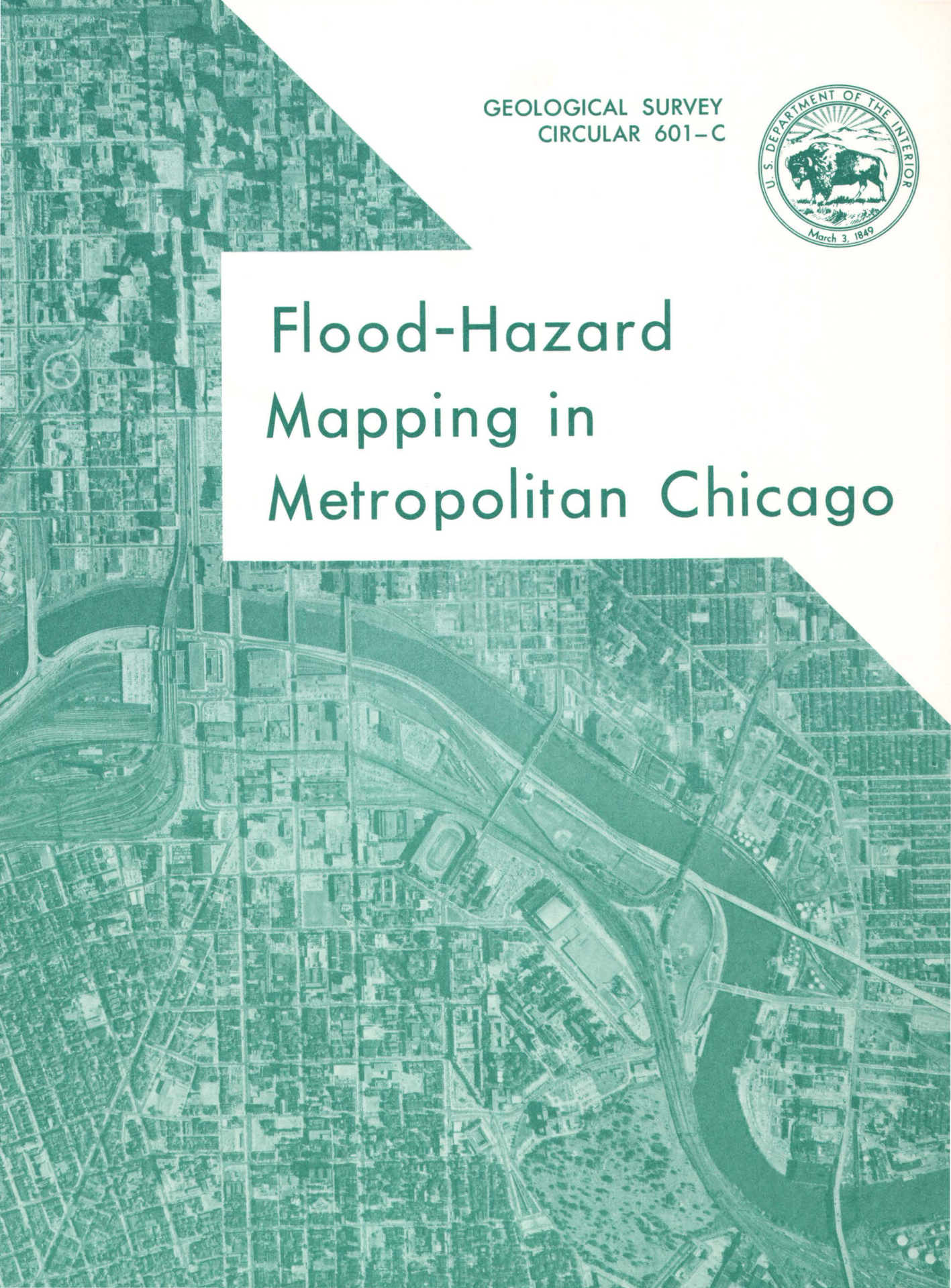
GEOLOGICAL SURVEY
CIRCULAR 601–C

Flood-Hazard Mapping in Metropolitan Chicago



Flood-Hazard Mapping in Metropolitan Chicago

By John R. Sheaffer, Davis W. Ellis,
and Andrew M. Spieker

WATER IN THE URBAN ENVIRONMENT

GEOLOGICAL SURVEY CIRCULAR 601–C

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FOREWORD

Urbanization—the concentration of people in urban areas and the consequent expansion of these areas—is a characteristic of our time. It has brought with it a host of new or aggravated problems that often make new demands on our natural resources and our physical environment. Problems involving water as a vital resource and a powerful environmental agent are among the most critical. These problems include the maintenance of both the quantity and quality of our water supply for consumption, for recreation, and general welfare and the alleviation of hazards caused by floods, drainage, erosion, and sedimentation.

A prerequisite to anticipating, recognizing, and coping intelligently with these problems is an adequate base of information. This series of reports is intended to show the relevance of water facts to water problems of urban areas and to examine the adequacy of the existing base of water information.

E. L. Hendricks,
Chief Hydrologist

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By John R. Sheaffer[1], Davis W. Ellis, and Andrew M. Spieker

INTRODUCTION

The effective management of flood plains consists of more than building detention reservoirs and levees. As urban pressures are forcing more and more developments on flood plains, such devices as flood-plain regulations and flood proofing are coming into wider use. These devices, however, require information as to what areas are likely to be flooded. The need for flood-plain information is further intensified by Federal legislation such as the National Flood Insurance Act of 1968 (Title XIII, Public Law 90–448) and recent Federal policies on use of flood plains (U.S. Congress, 1966; Executive Order 11296).

The present report describes how these needs are being met in the Chicago SMSA (Standard Metropolitan Statistical Area) by a cooperative program involving the six counties of the metropolitan area—Cook, Du Page, Kane, Lake, McHenry, and Will—the Northeastern Illinois Planning Commission, the State of Illinois, and the U.S. Geological Survey. This unique flood-mapping program, in progress since 1961, has resulted in coverage of nearly the entire six-county metropolitan area by maps showing the flood hazard. Figure 1 is a map of the area showing the extent of coverage in June 1969. Quadrangles showing an HA (U.S. Geological Survey Hydrologic Investigations Atlas) number are published and available for sale at the Northeastern Illinois Planning Commission, 400 West Madison Street, Chicago, Ill. 60606, or the U.S. Geological Survey, Washington, D.C. 20242. (Price is 75 cents each.) Quadrangles without an HA designation are in progress or are scheduled for future mapping. At present this coverage is about 85 percent complete. Metropolitan Chicago is the only large metropolitan area in the United States for which this information is so widely available.

The purpose of this report is to describe how the program originated and is being carried out, the outlook for improving this program to meet the changing needs of the rapidly urbanizing metropolitan area, and the various ways flood maps can be used by individuals and public and private institutions.

FLOODING IN METROPOLITAN CHICAGO

Floodflows in the rivers and waterways of Metropolitan Chicago have periodically spilled from their channels and inundated the adjacent lowlands or flood plains. The earliest recorded flood in the Chicago area occurred on March 29, 1674, when the explorer priest Marquette and his companions were driven from their camp near Damen Avenue by high water coming through Mud Lake, from the Des Plaines River. However, such overflows did not become hazards, except possibly to navigation, until

[1]Center for Urban Studies, The University of Chicago; formerly with the Northeastern Illinois Planning Commission.

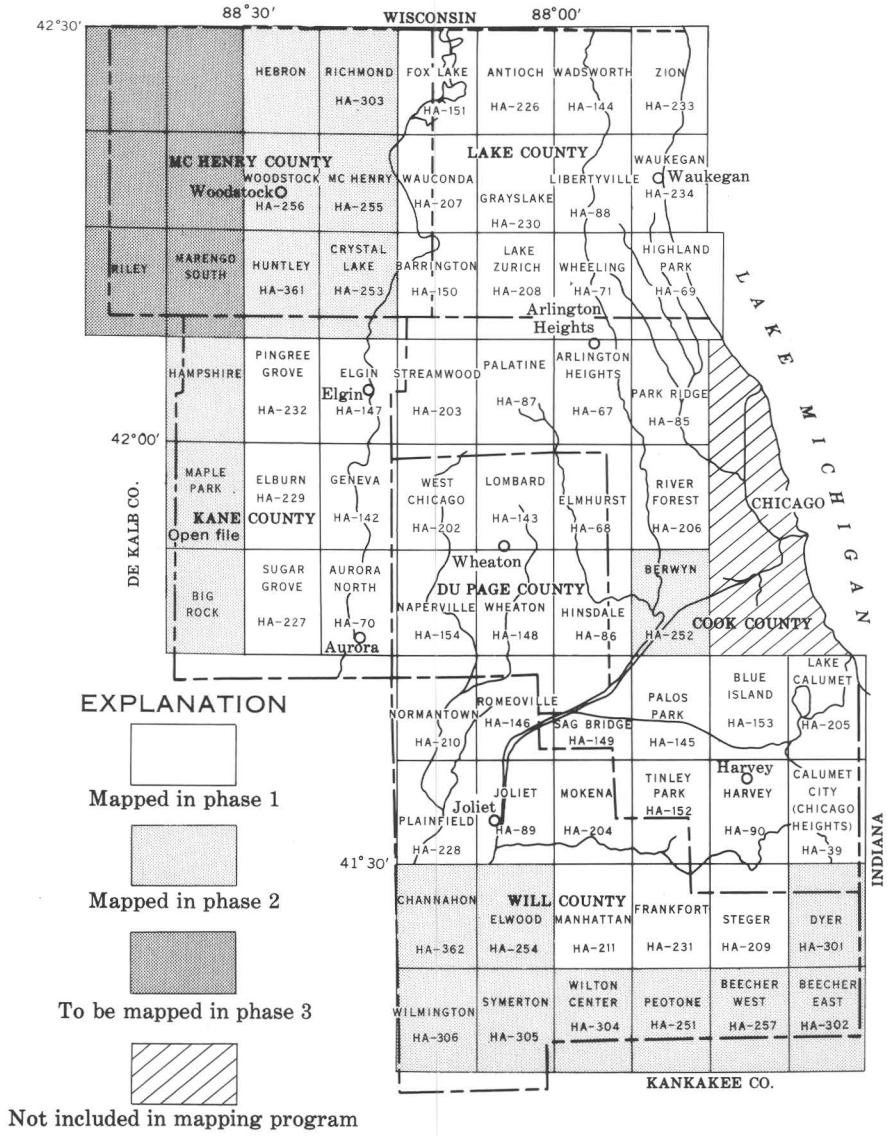

Figure 1.—The Chicago metropolitan area showing location of quadrangles included in flood-hazard mapping program.

development of the flood plains gave the floods something to damage.

In retrospect, it is conceivable that if adequate land-use planning, based on sound hydrologic data in conjunction with regulatory and flood-proofing measures, had guided the development of our flood plains, there would be little, if any, improper use today and no major flood problems would exist.

Flood damages have been steadily increasing as urban sprawl has engulfed many flood plains and subdivisions have been located on sites subject to flooding. The absence of accurate information on these areas subject to flooding has been a limitation on efforts to formulate a comprehensive flood damage reduction program. The need for this information is particularly acute in Metropolitan Chicago and other topographically similar regions of flat terrain and poorly developed drainage, where the flood plains are not readily perceptible to the human eye.

THE CONCEPT OF FLOOD-HAZARD MAPPING

Flood-hazard mapping is a means of providing flood-plain information for planning and management programs. Such information should be designed to assist officials and private interests in making decisions and alternative plans concerning the development of specific lands subject to flooding. Proper use of flood-hazard mapping will help to:

1. Prevent improper land development in flood-plain areas.
2. Restrict uses that would be hazardous to health and welfare and which would lead to undue claims upon public agencies for remedy.
3. Encourage adequate stream channel cross-section maintenance.
4. Protect prospective home buyers from locating in flood-prone areas.
5. Preserve potential for natural ground-water recharge during flood events.
6. Guide the purchase of public open space.
7. Avoid water pollution resulting from the flooding of sewage treatment plants and solid waste disposal sites that were located on flood plains.

WHAT IS A FLOOD-HAZARD MAP?

A flood-hazard map uses as its base a standard U.S. Geological Survey topographic quadrangle which includes contours that define the ground elevation at stated intervals. Each of the quadrangles covers an area 7½ minutes of longitude wide by 7½ minutes of latitude deep, or approximately 57 square miles. The scale of the flood maps is 1:24,000, or 1 inch equals 2,000 feet. The area inundated by a particular "flood of record" is superimposed in light blue on the map to designate the "flood-hazard area." Also marked on the flood-hazard map are distances (at ½-mile intervals) along and above the mouth of each stream and the locations of gaging stations, crest-stage gages, and drainage divides. Figure 2 shows part of the Elmhurst quadrangle, a typical flood map, reproduced at the original scale.

PROFILES AND PROBABILITIES

Accompanying the flood-hazard map are explanatory texts, tables, and graphs, which facilitate their use. One set of graphs shows the linear flood profiles (see fig. 3) of the major streams in the quadrangle; from them, the user can tell how high the water rose at any given point during one or more floods.

Another valuable tool (fig. 4) is a set of graphs showing probable frequency of flooding at selected gaging stations. These charts indicate the average interval (in years) between floods that are expected to exceed a given elevation. Frequencies can also be expressed as probabilities which make it possible to express the flood risk or "flood hazard" for a particular property; for example, a given area may have a 5-percent chance of being inundated by flood waters in each year.

HOW TO USE A FLOOD-HAZARD MAP

To illustrate the use of a flood-hazard map, assume that you own property along Salt Creek, near Elmhurst and about half a mile south of Lake Street. Perhaps you plan to build there, and you want to know the risk of being flooded. You examine the Elmhurst quadrangle flood-hazard map (fig. 2) and note that your property is located at a point 23.5 miles above the mouth of Salt Creek. (The river miles are shown on the map.)

One of the graphs accompanying the map is a flood-frequency curve for Salt Creek (fig. 4). This curve, however, is for a particular point on Salt Creek—the Lake Street Bridge. To apply the flood-frequency relationship to your own property will require an adjustment for the water-surface slope between the two points. So you consult another graph, the one which shows profiles or high-water elevations, of floods along Salt Creek (fig. 3). There, you find that at the Lake Street Bridge (river mile 24) the 1954 flood crested at 671.5 feet, while at the point you are interested in (river mile 23.5) the crest was at 671 feet.

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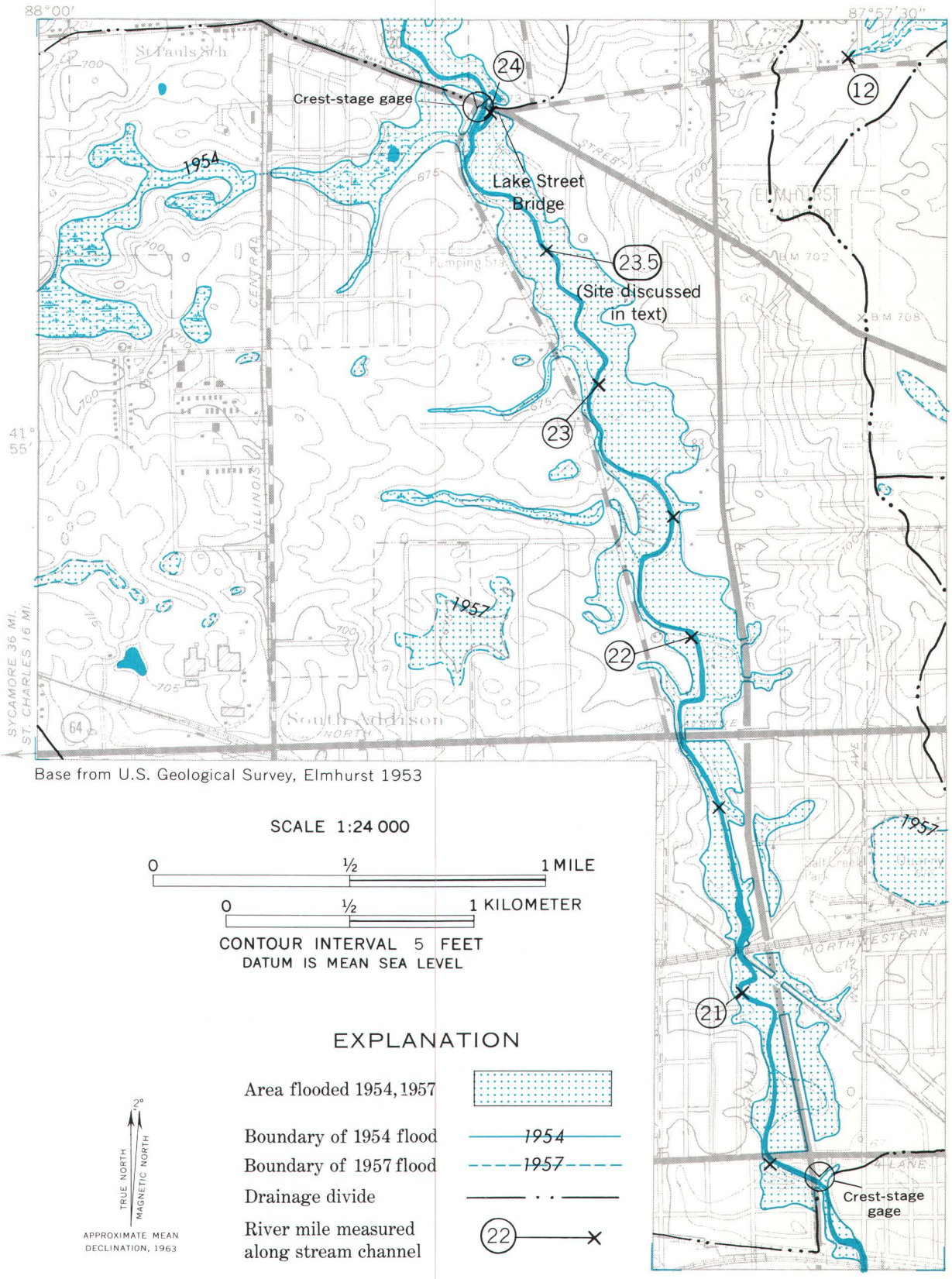

Figure 2.—Flood-hazard map of part of the Elmhurst quadrangle. Adapted from Ellis, Allen, and Noehre (1963).

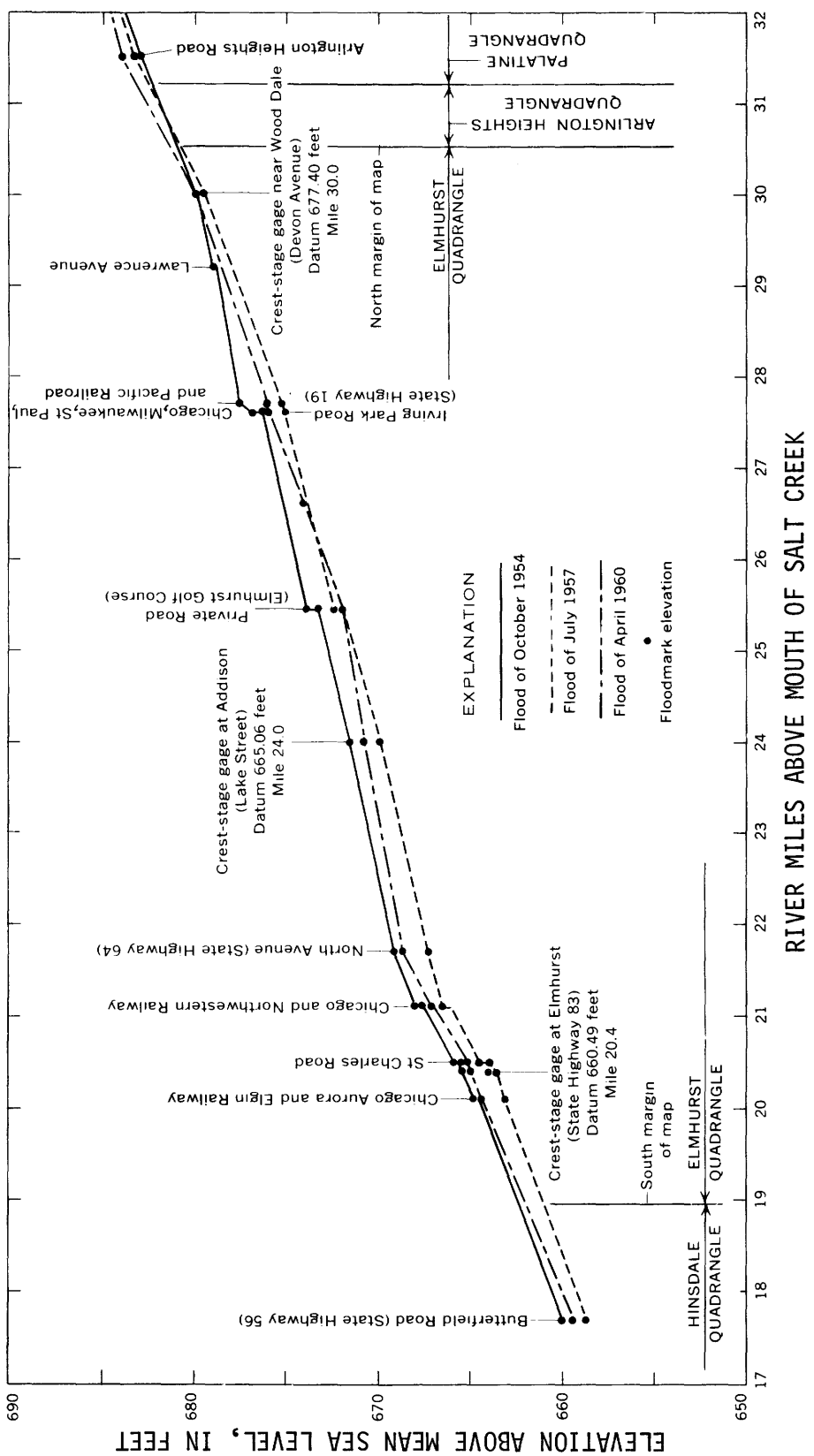

Figure 3.—Profiles of floods on Salt Creek.

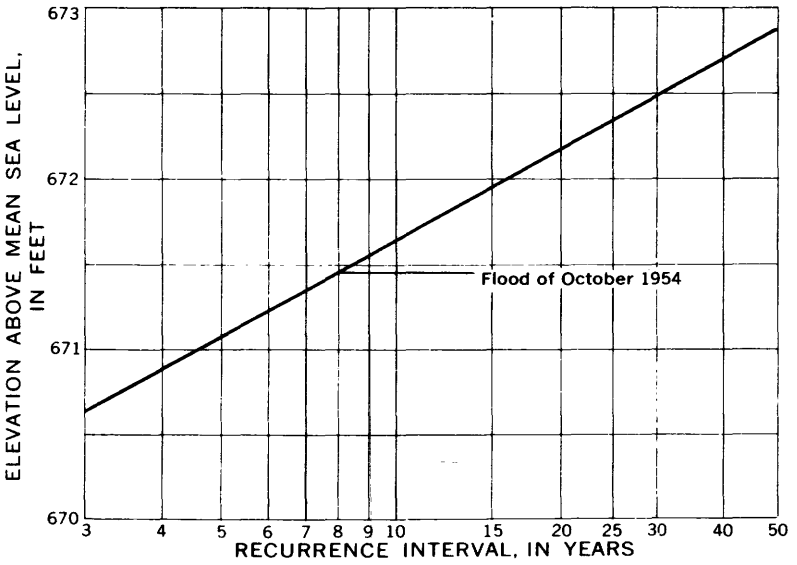

Figure 4.—Frequency of floods on Salt Creek at Addison (Lake Street).

Returning now to the flood-frequency curve, you find that the 1954 flood has an 8-year "recurrence interval," meaning that, over a long period of time, floods can be expected to reach or exceed that level on an average of once every 8 years. That level, you have already found, is 671.5 feet at Lake Street and 671 feet at your property. Another way of thinking of it is this: if you were to erect a building on your property at 671-foot elevation, the chances of a flood reaching the structure in any given year would be approximately one in eight. These are only odds—probabilities—and the actuality may be better or worse. But the odds are poorer than most property owners are willing to accept, so you will probably want to seek better odds at higher ground.

Suppose you were willing to accept a flood risk of one every 25 years: What is the ground elevation at which a building should be situated to enjoy that much security?

The flood-frequency curve indicates that, at the Lake Street Bridge, an elevation of 672.3 feet corresponds to the 25-year recurrence interval. You now plot this elevation at river mile 24 on the flood-profile chart and draw a straight line through the point you have plotted and parallel to the 1954 flood profile. You now have the profile for a flood with a 25-year recurrence interval, and it shows that the elevation reached by such a flood at your property would be 671.8 feet. Using the line you have drawn, you can determine corresponding elevations (for the same recurrence interval) at other points along Salt Creek. And, of course, you can use the method outlined to approximate the elevation at your property for other recurrence intervals—up to 50 years.

THE METROPOLITAN CHICAGO FLOOD-MAPPING PROGRAM

It was determined that flood-hazard mapping could meet some of the needs that had become evident in Metropolitan Chicago. However, it was also recognized that flood-hazard mapping of such a large area could not be accomplished overnight. It would require financing, time, careful planning, and data. The flood-mapping program is a cooperative effort, financed jointly by the six counties of Metropolitan Chicago, the Northeastern Illinois Planning Commission, the State of Illinois, and the U.S. Geological Survey. Funds offered by the six counties through the Planning Commission which serves in an

administrative and coordinating role, are matched on a one-to-one basis with Federal funds. The actual mapping is done by personnel of the U.S. Geological Survey. In 1968 the State of Illinois entered into a separate, though similar, cooperative agreement with the U.S. Geological Survey to assist with part of the financing. The flood-mapping program was carried out in phases. The first phase extended from July 1, 1961 to June 30, 1966. Phase 2 extended from July 1, 1966 to June 30, 1969. The formulation of a phase 3 is currently (1969) being discussed among the principal agencies involved.

PHASE 1

In phase 1 of the program, flood maps were prepared for 43 7½-minute quadrangles in the six-county area. One flood atlas, U.S. Geological Survey Hydrologic Investigations Atlas HA–39, "Floods in the Little Calumet River basin near Chicago Heights, Ill.," had been prepared previously by the Geological Survey as a prototype for the program. Each quadrangle is given the name of a principal city or prominent geographic feature located on the map. The location of these quadrangles is shown in figure 1.

The scope of phase 1 is shown in table 1 and figure 1. The average cost of preparing a flood map initially was estimated as $6,250, or a cost to the local agencies of $3,125, and the initial agreements between local agencies and the Planning Commission were prepared on this basis. Early in the program, however, it was found that, for several quadrangles, particularly in Lake County, there was need for supplemental contours on the flood-plain areas. These were provided under a supplemental agreement among the appropriate agencies. Partly because of this change, and partly because of steadily rising costs throughout the 5-year period of the program, the total expenditure for phase 1, including the supplemental contours, the preparation of inundation maps for 43 quadrangles, and the installation and operation to June 30, 1966, of the initial 229 crest-stage gages, was $299,860, or about $6,975 per quadrangle.

Table 1.—*Scope of phase 1 of flood-mapping program, July 1961 to June 1966*

Counties	Quadrangles mapped
Cook	[1]13
Du Page	6
Kane	6
Lake	10
McHenry	1
Will	8
Total	44

[1]Includes Calumet City quadrangle. Chicago Heights, which was prepared as a pilot project, was not included as part of program.

Another item of possible interest to those who may plan similar programs is the expenditure of manpower. All operations were conducted from the Survey subdistrict office at Oak Park, near the geographic center of the area. A total of 37,372 direct man-hours were required to complete phase 1; this indicates an average of 869 direct man-hours per quadrangle. There was, however, considerable variation for the individual quadrangles, ranging from a maximum of 1,455 man-hours to a minimum of 520 man-hours. Man-hours required for providing the supplemental contours are not included in these figures, as this part of the work was performed under a contractual arrangement with the Topographic Division of the Geological Survey.

Because of insufficient hydrologic data in much of the area, it was necessary to establish 229 crest-stage gages to record instantaneous flood peaks so that flood profiles and flood-plain limits could be better defined along the approximately 1,000 miles of streams located in the 43 quadrangles.

Preparation for phase 2 of the flood-mapping program involved the installation of an additional 165 crest-stage gages in McHenry, Kane, and Will Counties in 1963. The installation of these gages was necessary because

the hydrologic events on many of the streams in southern Will County and western Kane and McHenry Counties had never been recorded. These gages are located in 19 quadrangles which were scheduled for mapping during phase 2. The costs were covered by supplementary cooperative agreements with the affected counties.

A flood-hazard mapping program can lead to other related hydrologic studies. A study of the role of flood-plain information and related water resource management concepts in comprehensive land-use planning (Spieker, 1969) was made by the Geological Survey, at the request of the Planning Commission, in 1965–67. This study used the Salt Creek basin in Cook and Du Page Counties as a demonstration area to illustrate principles which govern the effects of alternative land-use practices, particularly uses of the flood plains, on the overall water resources of the area. Emphasis was placed on the interrelationship of the various components of the hydrologic system, particularly the interrelationship between surface water and ground water.

PHASE 2

Phase 2 involved the preparation of 19 additional flood maps. (See fig. 1.) In addition, the 394 crest-stage gages, including those located in areas already mapped, were kept in operation as part of phase 2 to extend the hydrologic records. The completion of phase 2 will make flood maps available for the entire metropolitan area with the exception of the western part of McHenry County and the completely urbanized area of Chicago and the close-in suburbs in Cook County. This area, which comprises four quadrangles, was not mapped because urbanization has obliterated nearly all the natural flood plains and overbank flooding is generally not a problem.

The scope of phase 2 is presented in table 2. A proportionally larger share of the local cost was allocated to McHenry and Will Counties because a major part of the work was done in those two counties. In 1967, the State of

Table 2.—*Scope of phase 2 of flood-mapping program, July 1966 to June 1969*

Counties	Quadrangles mapped	Total number of gages	Gages having peak discharge data
Cook	2	70	8
Du Page	----------	36	12
Kane	3	58	11
Lake	----------	40	11
McHenry	6	52	8
Will	8	138	19
Total	19	394	69

Illinois, through the Division of Waterways of the Department of Public Works and Buildings, entered into a separate cooperative agreement with the Geological Survey to assume part of Will County's share of phase 2 mapping. The cost of mapping in phase 2 was $174,600, of which $86,200 was provided by local agencies and $88,400, by the Geological Survey. (The difference of $2,200 was due to supplemental allotments of Survey funds, unmatched by local funds, to partially cover interim increases in Federal salary rates.) At the completion of phase 2, the total cost of flood mapping in the metropolitan area was $474,460. (This cost includes operation of the entire network of 394 crest-stage gages to June 30, 1969.)

THE FORMULATION OF PHASE 3

Providing adequate flood information in an urban area is a continuing activity. Floods will continue to occur and will provide new and additional information. Spreading urbanization can alter both the frequency and the patterns of flooding. Paving and covering of the land tends to accelerate storm runoff and increase flood peaks. Manmade changes in the channel cross section can alter flooding patterns. Examples of such changes are bridges, culverts, fill on the flood plain, and building on the flood plain. These changes take place at a rapid pace in a fast growing area such as Metropolitan Chicago.

To keep up with these changes will require periodic revision of the flood-hazard maps. Many of the maps are based on information which is 8 years old. Additional flooding and a great deal of urbanization has taken place during these 8 years. The crest-stage gage network has provided a wealth of data to document these flood events and to help in analyzing the changes resulting from urbanization.

Phase 2 of the flood-mapping program terminated in 1969. In continuing the program into its third phase, the following four activities should be considered.

1. Continued operation of the existing network of crest-stage gages. The crest-stage gage network is believed to be the densest such network in the country. About 8 years of record will be available at the completion of phase 2 of the program. As urban development continues, the continued availability of flood-stage information will be increasingly important. Such data would be valuable in determining rates if a flood-insurance program became operational.

2. Evaluation of the crest-stage gage network for adequacy and relevance. Although the existing network is one of the most comprehensive in the country, there exists a need for its review to eliminate redundant gages and to add new ones where needed. The 8 years of record would be useful in this evaluation.

3. Extension of the program to unmapped areas. At the completion of phase 2 all of the six-county metropolitan areas except the completely urbanized central city and the western 40 percent of McHenry County will be mapped. The remainder of McHenry County is already planned for inclusion in phase 3. Before the metropolitan area expands into Kankakee and Kendall Counties, the flood-mapping program should be extended there to provide a part of the basis for orderly growth.

4. Periodic and systematic revision of the flood maps prepared in phases 1 and 2. All existing maps should be evaluated as to their adequacy and a systematic program should be planned for updating the maps where urbanization and additional flood data warrant it. This should be a continuing process. Examples of maps greatly in need of revision are the Calumet City (HA–39) and Arlington Heights (HA–67) quadrangles. In addition to mapping floods of record, consideration should be given to defining floods of given frequencies: for example, at 25-, 50-, and 100-year recurrence intervals. Even though the cost of such a mapping program would be considerably greater than that of mapping historical floods, the maps would provide a more sound and consistent basis for considering the element of risk in planning and decision making. Profiles at the selected frequencies also should be included in future mapping. This kind of flood information would be especially useful in determining premium rates under the National Flood Insurance Act of 1968. It has been agreed[2] for example, that the area inundated by the 100-year flood should define the regulatory area under the Flood Insurance Act.

Continuation of the cooperative flood-hazard mapping program along these lines will assure that local governmental bodies, industries, utilities, developers, and citizens of Metropolitan Chicago will have more and better flood information which can be used in furthering the region's orderly development.

THE CREST-STAGE GAGE NETWORK

The Northeastern Illinois Planning Commission and the U.S. Geological Survey's cooperative flood-mapping program required the establishment of a network of crest-stage gaging stations. Figure 5 shows the location of these gaging stations along with the locations of other gaging stations in the area which are operated under other cooperative programs.

A crest-stage gage is a rather simple device that records the maximum elevation of floods. These gages are mounted on wingwalls or piers of highway bridges and culverts or anchored in concrete along stream banks. After the gages are

[2]Consensus of Seminar on Flood Plain Management held at the Center for Urban Studies, University of Chicago, December 16–18, 1968, at the request of the U.S. Department of Housing and Urban Development.

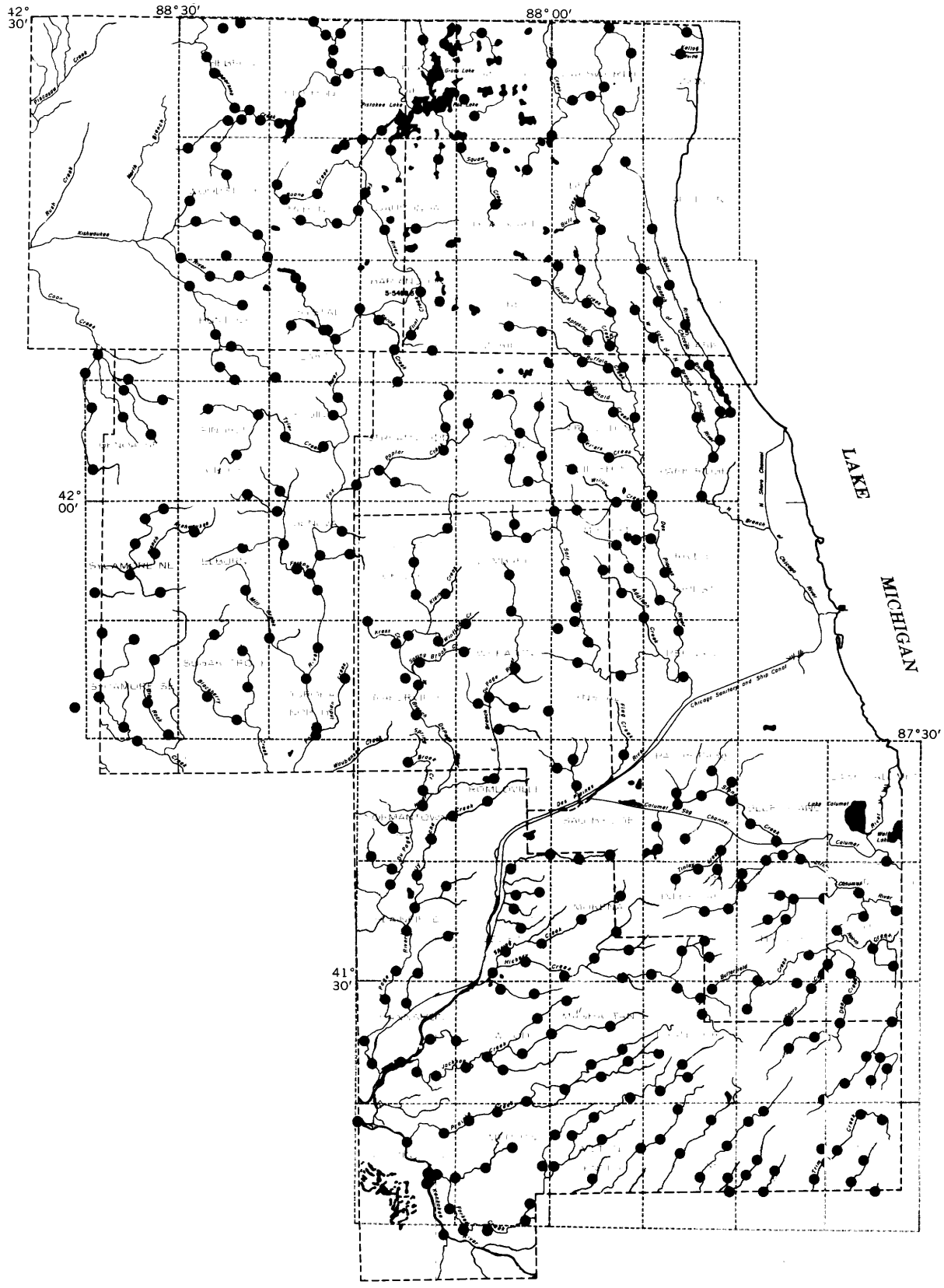

Figure 5.—Location of crest-stage gages in the Chicago metropolitan area.

mounted, levels are run from nearby benchmarks to establish datum (zero) of the gages referred to mean sea level, datum of 1929. The base of these gages is set above normal water levels so that they record only flood elevations. The sketch in figure 6 illustrates how the gage functions. Water enters the gage through specially designed holes at the bottom of the pipe. Finely ground cork at the bottom of the gage floats on the water surface and comes in contact with the wooden staff located inside of the pipe. As the water recedes, the cork adheres to the staff and provides a record of the maximum stage of the flood.

After a flood, the crest-stage gage is serviced by opening the gage, withdrawing the staff, and measuring the distance from the base of the staff to the top of the cork line. After the measurements are made, the cork is removed from the staff, any debris that has collected is removed from the holes at the base of the gage, new cork is added, and the gage is reassembled. It is then ready to record the elevation of the next flood. By adding the depth of water recorded on the staff (gage height) to the gage datum, the elevation of the flood in feet above mean sea level is determined.

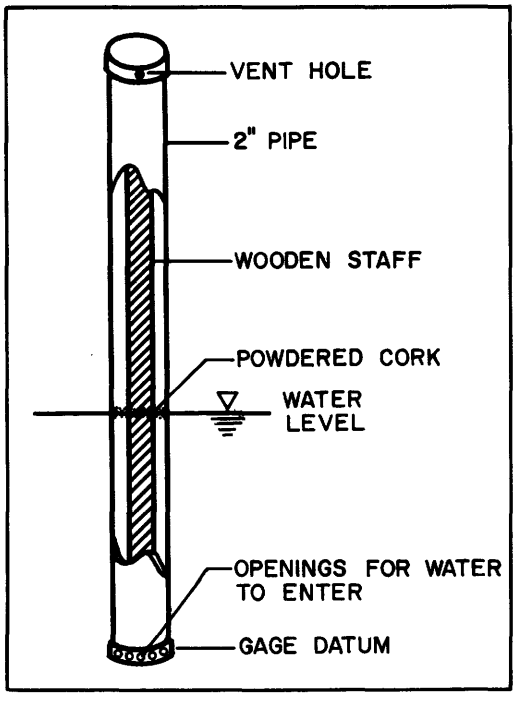

Figure 6.—Typical crest-stage gage.

USEFULNESS OF FLOOD-HAZARD MAPS IN URBAN DEVELOPMENT

The main purpose of flood-hazard mapping, as stated previously, is to make available information which can be used to bring about the orderly and beneficial use of areas subject to flooding. A wide range of institutions and devices exists through which this information can be put to use. The following outline presents the general categories of flood-plain information use:

1. Regulation of private development:
   a. By public institutions:
      (1) Building, subdivision, and zoning regulations.
      (2) Sewer connection permits.
      (3) Public financial institutions (that is, Federal Housing Administration, Veterans Administration).
      (4) Land management and use criteria of the flood insurance program.
   b. By private institutions:
      (1) Financial institutions.
      (2) Private utilities (that is, gas, electric).
2. Purchase of property for public use:
   a. Forest preserve districts (county).
   b. Parks and recreation facilities.
   c. Municipal parking lots.
3. Development of public facilities:
   a. Highways and streets.
   b. Sewer extensions, treatment plant locations.
4. Guidelines (planning) for future development.

Following is a résumé of how the flood-hazard maps have actually been used to give direction to urban development in the Chicago metropolitan area.

REGULATION OF PRIVATE DEVELOPMENT

One of the most frequently employed devices of flood-plain management is flood-plain zoning. The zoning authority is usually delegated to local governments, villages, and cities. County governments may exercise zoning powers in the unincorporated areas.

The Northeastern Illinois Planning Commission (1964) has prepared a model flood-plain zoning ordinance for the assistance of county and local governments. This model is the basis for many of the flood-plain zoning ordinances that have been adopted by Metropolitan Chicago communities.

Progress in the adoption of flood-plain zoning ordinances by county and municipal governments has been varied. As of late 1968 three of the six metropolitan counties—Cook, Du Page, and Lake—had adopted such ordinances. Kane County does not have a flood-plain zoning ordinance as such, although its zoning ordinance and subdivision regulations set forth conditions for subdivision development in flood-hazard areas. As of October 1968, 94 of the 117 Cook County municipalities located in the Metropolitan Sanitary District had adopted flood-plain zoning ordinances. There are 20 Cook County municipalities within the Sanitary District which do not have recognized flood hazards. An additional three are revising ordinances which have been rejected as unsatisfactory. Outside of Cook County, only a few municipalities have adopted flood-plain zoning ordinances.

One of the reasons for the large number of Cook County municipalities taking action is the policy adopted in 1967 by the Metropolitan Sanitary District regarding the issuance of sewer permits. The policy states that: "No permits shall be issued by the Metropolitan Sanitary District for sewers to be constructed within a flood-hazard area, as delineated on the maps prepared by the United States Geological Survey in cooperation with the Northeastern Illinois Planning Commission, until the local municipality has adopted a flood-plain zoning ordinance which meets the approval of the Sanitary District."

"Permits in undeveloped areas will not be approved until Cook County adopts flood-plain zoning regulations."

"The ordinance shall include but not be limited to the following:

1. Restriction on residential development.
2. Provisions for establishing permanent flood way channels through acquisition of rights-of-way, including easements for maintenance and improvements.
3. Requirements for flood proofing buildings within the flood-hazard areas. The ordinance shall be adopted before September 1, 1967."

This policy has proved highly effective in encouraging municipalities to adopt flood-plain zoning ordinances. In addition, Cook County has adopted a flood-plain ordinance which applies to all its unincorporated areas.

Financial institutions, public and private, can exert a powerful influence over the location of private urban development. Where flood-plain information is available, these institutions are generally reluctant to finance housing development in flood-hazard areas. The financing of housing in flood-prone areas is a risk that financial institutions would rather not assume, provided that there exists a knowledge of this risk. In the Chicago metropolitan area, the Veterans Administration and the Federal Housing Administration routinely check the location on the U.S. Geological Survey's flood-hazard maps of any new housing developments which they are considering financing. These agencies as a matter of policy will not finance developments in areas known to be subject to flooding. A large number of private financial institutions (banks, savings and loan companies) make similar use of the flood-hazard maps.

Private utility companies can influence urban development by where they choose to extend—or not to extend—gas and electric lines. By recognizing that development on flood plains is not wise, utility companies are in an excellent position to prevent their development by refusing to service them. Flood-hazard maps thus can be useful to utility companies by helping them to identify those areas where they might wish to discourage development.

PURCHASE OF PROPERTY FOR PUBLIC USE

The public development of flood-hazard areas for recreation or aesthetic purposes has long been recognized as a technique of flood-plain management. Green belts, or undeveloped areas along streams, can provide breaks in the monotony of urban sprawl. The construction of municipal parking lots is another example of public use of flood plains. Identification on flood-hazard maps of those areas subject to flooding can assist public officials in acquiring these lands at a reasonable price.

The Du Page County Forest Preserve District is now engaged in a long-range program of land acquisition whose purpose is to develop a major green belt along the West Branch of the Du Page River. The U.S. Geological Survey's flood-hazard maps have been extremely useful in providing guidelines for land purchase. Also, they have been helpful in negotiations for public open space acquisition in Cook and Lake Counties.

DEVELOPMENT OF PUBLIC FACILITIES

Public facilities frequently lead urban development into flood-hazard areas. The State Division of Highways has made frequent use of the flood-plain maps in their highway planning process. Proper planning of access can tend to discourage improper flood-plain development.

The location of sewage treatment plants and sanitary landfills is also influenced by flood-plain information. An example of such use is found in "Rules and Regulations for Refuse Disposal Sites and Facilities" (Illinois Department of Public Health, 1966, p. 1). This document states that: "sites subject to flooding should be avoided * * * or protected by impervious dikes and pumping facilities provided." Thus, flood-plain information becomes involved in all decisions regarding the establishment of disposal sites and facilities and is cited by the State Geological Survey in their site-evaluation reports.

GUIDELINES (PLANNING) FOR FUTURE DEVELOPMENT

Planning, or the formulation of guidelines for future development, provides the overall framework in which the previously discussed uses of flood-hazard maps are implemented. It is in the planning process that the broad, long-range goals and objectives are set out. These objectives can be attained by alternate tactics.

The importance of wise management of the flood plains has been recognized by the Regional Planning Agency for Metropolitan Chicago, Northeastern Illinois Planning Commission, almost from its inception. Examples of how the flood-hazard maps are influencing long-range planning can be found in the two following policy statements taken from the Northeastern Illinois Planning Commission's comprehensive general plan for Metropolitar Chicago (Northeastern Illinois Planning Commission, 1968, p. 7): "Lands unsuited for intensive development due to flooding, unstable soil conditions, or where the provision of essential public services and facilities is difficult, should be maintained in suitable open space use." And on page 11: "Intensive urban development should be directed so as to avoid flood plains, protect ground water deposits, and preserve lands particularly suited for multi-purpose resources management programs."

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