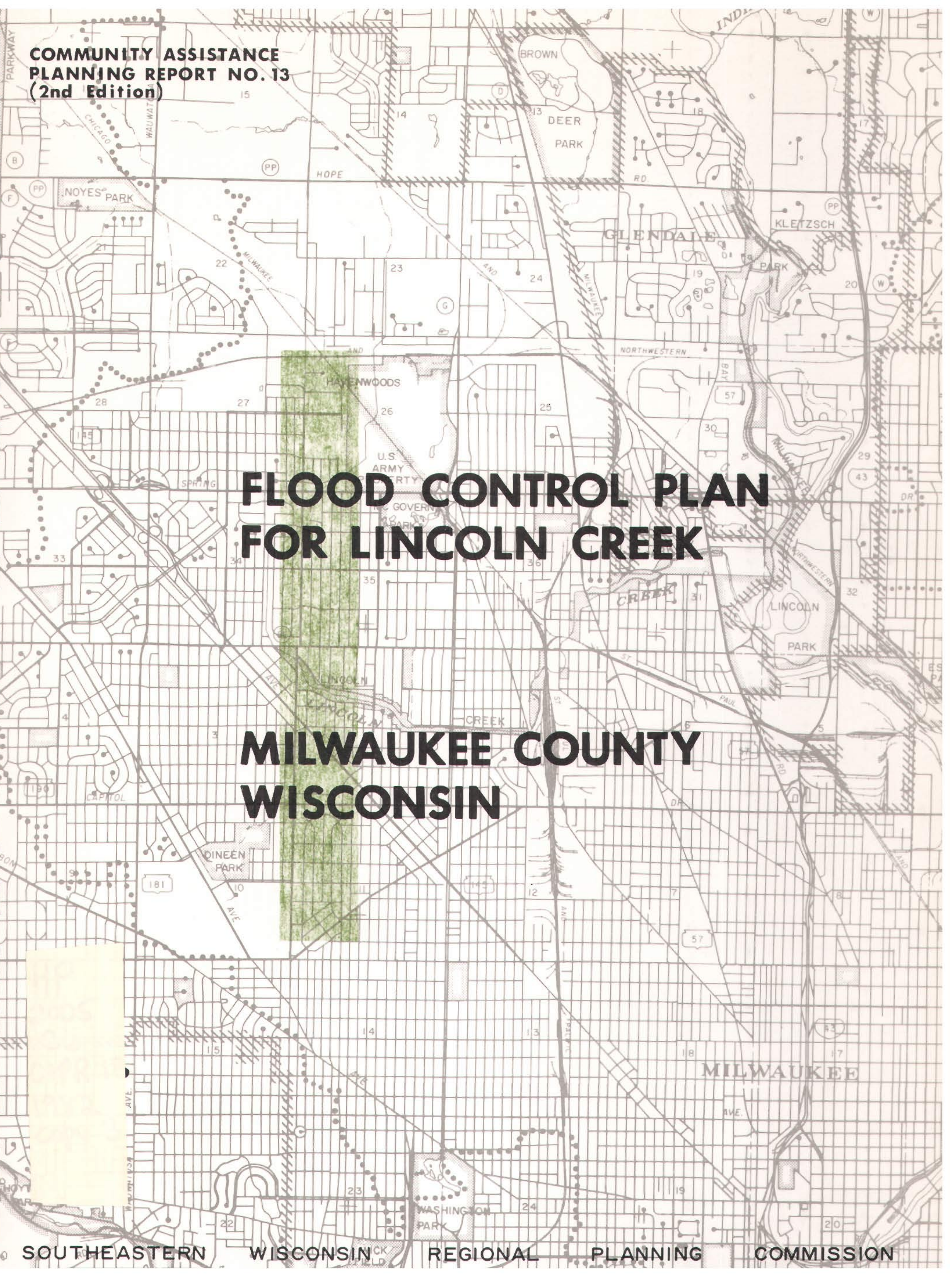
COMMUNITY ASSISTANCE PLANNING REPORT NO. 13
(2nd Edition)



FLOOD CONTROL PLAN FOR LINCOLN CREEK

MILWAUKEE COUNTY WISCONSIN

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

COMMUNITY ASSISTANCE PLANNING REPORT
NUMBER 13
(Second Edition)

FLOOD CONTROL PLAN FOR LINCOLN CREEK

Milwaukee County, Wisconsin

Prepared by the
Southeastern Wisconsin Regional Planning Commission
P. O. Box 769
Old Courthouse
916 N. East Avenue
Waukesha, Wisconsin 53187-1607

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SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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735 N. Water Street
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Gentlemen:

The Commission is pleased to transmit to you herewith a recommended flood control plan for Lincoln Creek in the City of Milwaukee. This plan was prepared pursuant to a resolution by the Common Council of the City of Milwaukee dated March 10, 1981 (File No. 80-2073). The plan included in this document supercedes and replaces in its entirety the previous flood control plan for Lincoln Creek set forth in the first edition of SEWRPC Community Assistance Planning Report No. 13, Flood Control Plan for Lincoln Creek, prepared at the request of the Milwaukee Metropolitan Sewerage District and dated September 1977.

The report transmitted herewith presents information on flood discharges and stages under existing and probable future land use conditions within the Lincoln Creek watershed and identifies the extent and magnitude of existing and probable future flood damage problems in the watershed. The report includes an analysis of all practicable alternative means for resolving those flood damage problems, including structure floodproofing and removal, the construction of detention reservoirs, the construction of dikes and floodwalls, and the construction of major channel improvements. In preparing the Lincoln Creek flood control plan, two important but conflicting objectives—flood damage abatement and the maintenance of an environmental corridor along Lincoln Creek—had to be considered; and channel improvements along portions of the stream system were reluctantly recommended as the only practicable means of resolving the existing flood damage problems along Lincoln Creek.

The report being transmitted herewith includes revised and updated information on the existing 100-year recurrence interval floodplain along Lincoln Creek. This floodplain is less extensive than the floodplain established under the flood insurance study for the City of Milwaukee published by the Federal Emergency Management Agency (FEMA). Accordingly, it is suggested that the City of Milwaukee request the FEMA to revise the federal flood insurance study incorporating the information contained herein. In addition, this report contains a proposed regulatory floodway intended to be used by the City of Milwaukee in its floodplain management efforts along Lincoln Creek until such time as the flood control works recommended herein may be constructed.

The Commission staff is very appreciative of the help received from other agency staffs during the conduct of this important study. Staff members from the City of Milwaukee Departments of City Development and Public Works, from the Milwaukee Metropolitan Sewerage District, and from the Wisconsin Department of Natural Resources were particularly helpful in reviewing and commenting on draft report materials. The Commission also wishes to express its appreciation to Alderman John R. Kalwitz, who so capably chaired the public hearing held on the preliminary plan recommendations.

This report is being transmitted as a Commission staff document. It is, however, ready for consideration and formal adoption by both the Common Council of the City of Milwaukee and the governing body of the Milwaukee Metropolitan Sewerage District. Upon notification of such adoption actions, the Regional Planning Commission would be pleased to entertain a request to formally amend the Milwaukee River watershed plan to include the flood control recommendations contained herein.

Sincerely,

Kurt W. Bauer
Executive Director

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Chapter I

INTRODUCTION

The purpose of this report, and of the supporting inventories and analyses, is to develop and present a flood control plan for the Lincoln Creek subwatershed of the Milwaukee River watershed, located largely within the City of Milwaukee, Wisconsin. More specifically, this report presents an analysis of the flood control needs of the Lincoln Creek subwatershed, proposes and evaluates alternative means of meeting those needs, and recommends a plan that will best alleviate the flooding problems of the subwatershed. This report is an extension and refinement of the Milwaukee River watershed plan completed by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) in 1972,[1] and of the flood control plan for Lincoln Creek prepared by the Commission in September 1977, and presented in an earlier edition of this report.[2]

The first edition of this report was prepared by the Commission in response to a formal request received from the Sewerage Commission of the City of Milwaukee on January 3, 1974, for a study directed at the resolution of the serious flooding problems along Lincoln Creek. The study described in the first edition was conducted by the SEWRPC over the period from April 1975 through June 1977. A great deal of the background information and data base for this initial study was taken from the SEWRPC Milwaukee River watershed study. Other data for the initial study were provided by the Milwaukee-Metropolitan Sewerage Commissions; the City of Milwaukee Bureau of Engineers, Sewer Engineering Division; a SEWRPC study pertaining to flood surface profiles along Lincoln Creek, completed in September 1973 and entitled "Backwater Submodel Project 23"; and additional data prepared especially for that study by the SEWRPC staff.

It was explicitly recognized in the first edition of this report that the study was conducted in the absence of large-scale topographic mapping, and that recomputation of the flood discharges and stages would have to be undertaken when additional topographic information became available. Additional topographic data were subsequently obtained in 1979 by the U. S. Geological Survey when 63 stream valley cross-sections were surveyed for Lincoln Creek downstream of Silver Spring Drive for use in the City of Milwaukee federal flood insurance study; in 1980 by the Wisconsin Department of Natural Resources when topographic maps were prepared at a scale of 1" = 100' for a 0.69-square-mile area along Lincoln Creek between W. Silver Spring Drive and the Chicago & North Western Railway; and in 1981 by the Milwaukee Metropolitan Sewerage District when 24 stream valley cross-sections and seven hydraulic structures were surveyed for Lincoln Creek upstream of W. Silver Spring Drive.

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[1]See SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volume One, Inventory Findings and Forecasts, and Volume Two, Alternative Plans and Recommended Plan.

[2]See SEWRPC Community Assistance Planning Report No. 13, Flood Control Plan for Lincoln Creek, Milwaukee County, Wisconsin, First Edition, September 1977.

In February 1981, the Commission initiated a review and revision of the first edition of the Lincoln Creek flood control study, utilizing the recently developed topographic information to confirm, or revise as necessary, the flood flows and stages and flood control recommendations made in that initial study. In a resolution adopted on March 10, 1981, the Common Council of the City of Milwaukee authorized the Commissioner of the Department of City Development to provide financial support to the Commission for the conduct of this review and revision, particularly as related to the evaluation of the potential flood control benefits of a multi-purpose wetland basin proposed to be located at the Havenwoods Urban Environmental Education Center, owned by the Wisconsin Department of Natural Resources. The inclusion of this analysis was also suggested by the members of the Havenwoods Ad Hoc Advisory Committee, established by the Secretary of the Wisconsin Department of Natural Resources in September 1979.

The resulting study which forms the basis for this second edition was conducted by the Commission during the period from February 1981 through March 1982. The background information sources include all of those used in the preparation of the first edition as heretofore described; the Flood Insurance Study for the City of Milwaukee, 1981, prepared by the U. S. Geological Survey for the Federal Emergency Management Agency; and the Havenwoods Master Plan, April 1981, prepared by the Wisconsin Department of Natural Resources. The findings and recommendations of the revised study are presented in summary form in this report.

In addition to this introductory chapter, this report consists of the following 10 chapters which describe the findings of the inventory and analysis phases of the project and present the study recommendations: Chapter II, "Overview of the Study Area"; Chapter III, "Historic Flood Events"; Chapter IV, "The Hydrologic-Hydraulic System"; Chapter V, "The Hydrologic-Hydraulic Model"; Chapter VI, "Flood Discharges and Stages"; Chapter VII, "Flood Problems and Damages"; Chapter VIII, "Alternative Flood Control Plans"; Chapter IX, "Recommended Flood Control Plan"; Chapter X, "Plan Implementation"; and Chapter XI, "Summary and Conclusions."

Chapter II

OVERVIEW OF THE STUDY AREA

LINCOLN CREEK SUBWATERSHED

Lincoln Creek is a tributary of the Milwaukee River. The Lincoln Creek subwatershed is located almost entirely within the City of Milwaukee. A small part of the subwatershed is located in the Village of Brown Deer and a small part in the City of Glendale. Lincoln Creek flows in a generally southeasterly direction through the City of Milwaukee for a distance of approximately nine miles, and drains an area of about 19.26 square miles (see Map 1).

Originating in the northwestern part of the City of Milwaukee in the vicinity of N. 76th Street and W. Good Hope Road, Lincoln Creek flows in a generally southerly direction to N. 60th Street and W. Hampton Avenue. From this point the Creek flows in a generally easterly direction to its confluence with the Milwaukee River in Lincoln Park near N. Green Bay Avenue and W. Villard Avenue. For the purpose of this report, that portion of Lincoln Creek lying north of W. Silver Spring Drive has been designated "Upper Lincoln Creek," and that portion lying south of W. Silver Spring Drive has been designated "Lower Lincoln Creek" (see Map 2).

Upper Lincoln Creek drains an area of about 4.09 square miles. In 1975, about one-half of this area had been developed for urban use. The remaining one-half is undergoing rapid conversion from rural to urban use, as evidenced by the amount of new urban development which has occurred in the last five years. Remaining open space land uses consist primarily of golf courses and cemeteries, with some agricultural and unused land.

Lower Lincoln Creek drains an area of about 15.17 square miles lying between W. Silver Spring Drive and the Milwaukee River. This area is almost completely developed for urban use, including residential, commercial, industrial, institutional, and urban open space uses. The open space uses are composed of public parks, cemeteries, and a parkway system adjacent to Lincoln Creek from W. Hampton Avenue to Lincoln Park. The developed areas of the Lincoln Creek subwatershed are generally provided with a full range of municipal street improvements, including paved streets with curbs and gutters and attendant storm sewers. Accordingly, surface runoff is generally conveyed from each individual site to Lincoln Creek through storm sewers.

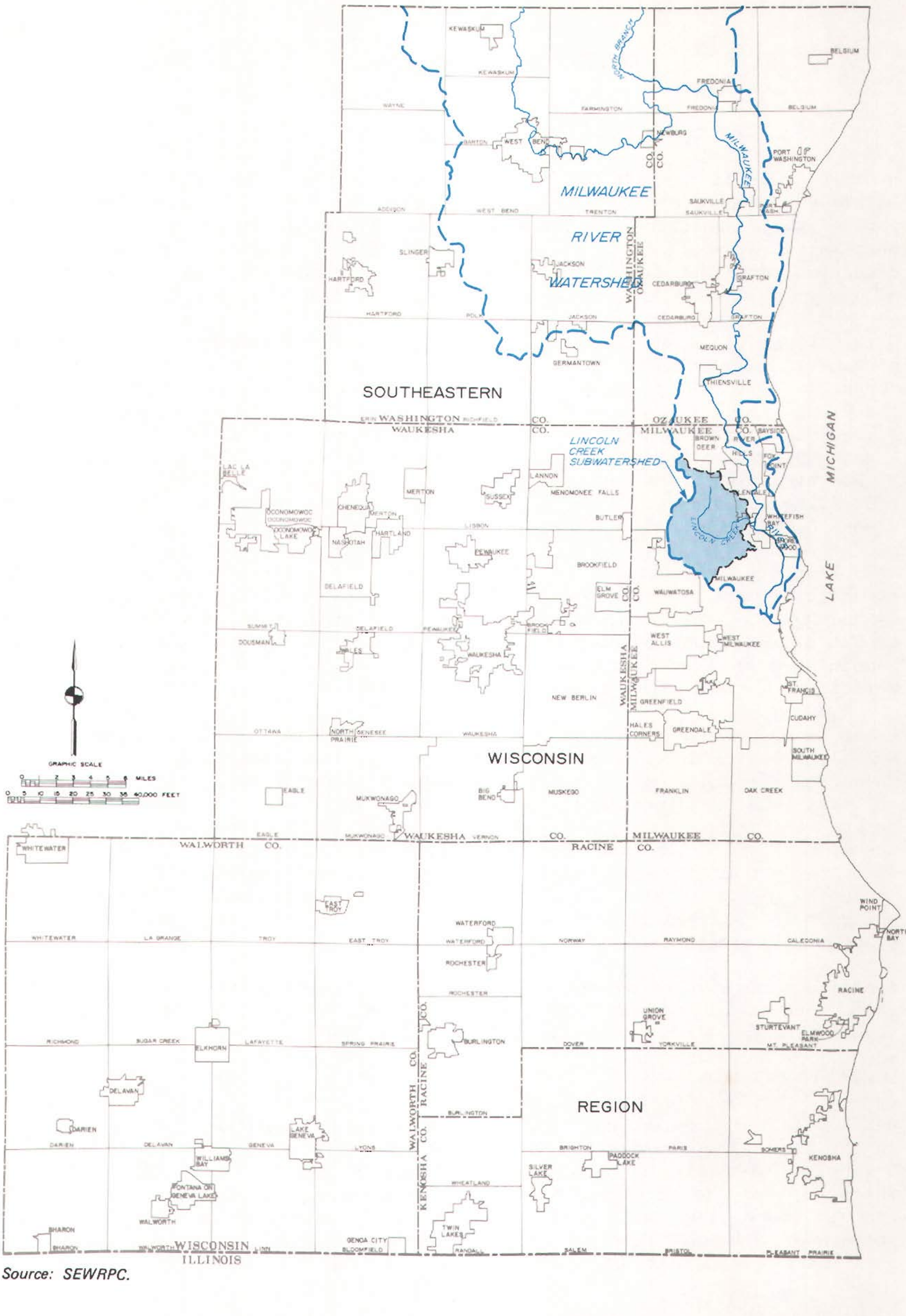
Specific quantitative data on certain pertinent characteristics of the watershed, such as soil types, land slopes, and land use, appear in Chapter IV of this report entitled "The Hydrologic-Hydraulic System."

HAVENWOODS

Until relatively recently, the U. S. Army owned an approximately 358-acre site in the Upper Lincoln Creek subwatershed. The site is bounded by N. Hopkins Street on the east, W. Silver Spring Drive on the south, N. 55th Street on the west, and the Chicago & North Western Railway right-of-way on the north. Lincoln Creek flows in a generally north-south direction through the western portion of this site. The land was originally utilized by the U. S. Army for a military disciplinary barracks and a reserve training center.

Map 1

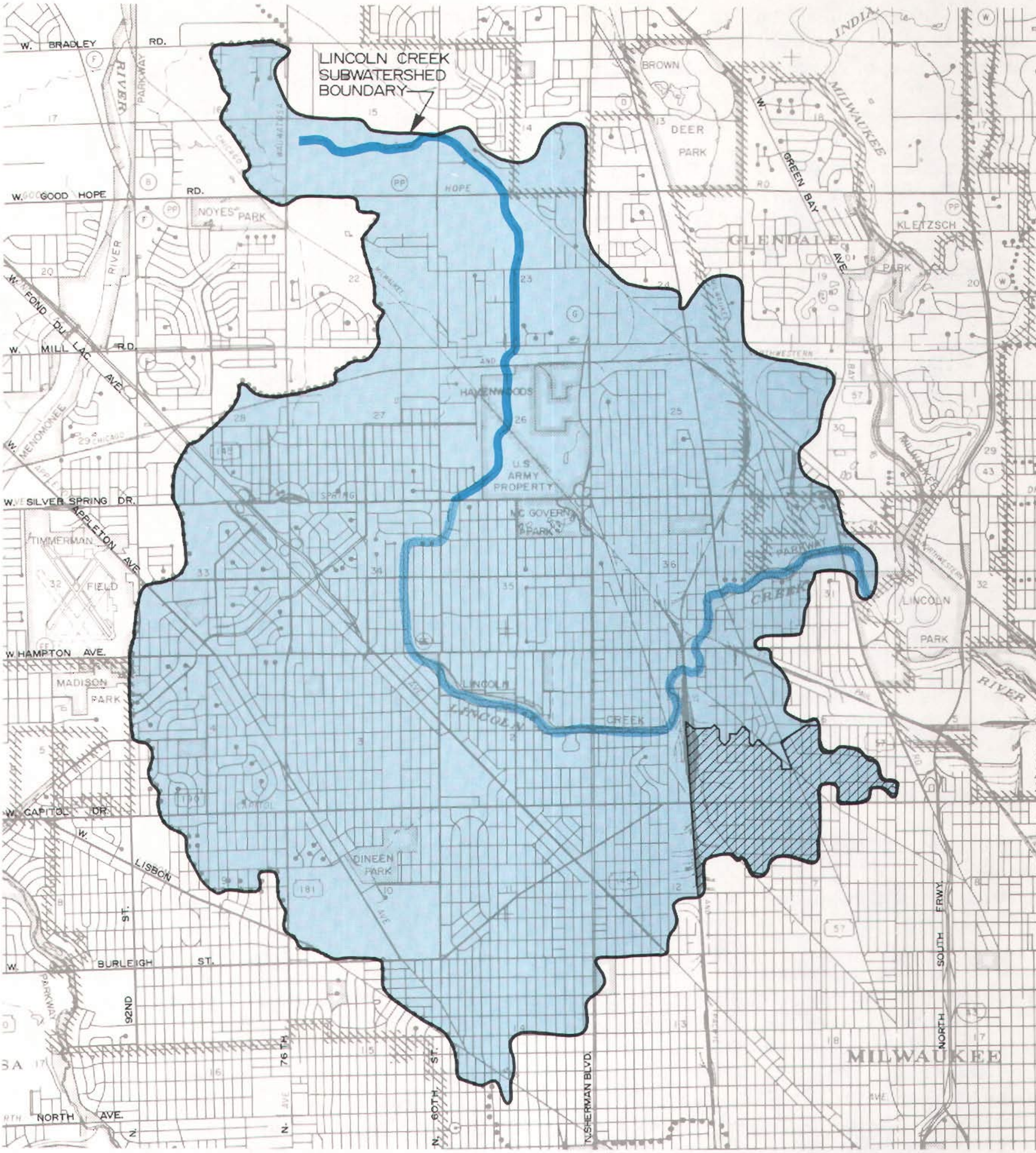
LOCATION OF THE LINCOLN CREEK SUBWATERSHED IN THE SOUTHEASTERN WISCONSIN REGION



Source: SEWRPC.

Map 2

THE LINCOLN CREEK SUBWATERSHED



LEGEND

SUBWATERSHED BOUNDARY

UPPER LINCOLN CREEK

LOWER LINCOLN CREEK

AREA TOPOGRAPHICALLY WITHIN LINCOLN CREEK SUBWATERSHED, BUT WITH STORM SEWERS TRIBUTARY TO A COMBINED SEWER OUTFALL DISCHARGING OUTSIDE THE SUBWATERSHED

Source: SEWRPC.

In the late 1960's, the U. S. Army declared approximately 238 acres of the site to be surplus and available through the General Services Administration to the local units of government in the area. The surplus area consisted of all that portion of the site lying generally north and east of the Wisconsin & Southern Railroad Company right-of-way--the former Chicago, Milwaukee, St. Paul, & Pacific (Milwaukee Road) Railroad right-of-way--which bisects the site (see Map 3). Subsequently, the City of Milwaukee took title to about 170 acres of the surplus land, with the balance of the land being divided between the Milwaukee Area Technical College (62 acres) and the Milwaukee County Park Commission (six acres). The latter parcel has been added by Milwaukee County to existing Schoenecker Park.

The U. S. Army has retained ownership of about 120 acres of the entire site, as shown on Map 3. About 40 of these acres lying west of Lincoln Creek have been designated by the U. S. Army as a natural area and wildlife preserve. The remaining 80 acres are currently used as a reserve training center.

In October 1973, a Disciplinary Barracks Advisory Task Force established by the City of Milwaukee made several recommendations concerning the future use of the surplus lands controlled by the City of Milwaukee, which, as noted above, totaled about 170 acres. The Task Force named the surplus lands controlled by the City of Milwaukee "Havenwoods." The major recommendations of the Task Force included:

- A site of not more than 25 acres should be set aside for housing for the elderly, with attendant convenience shopping facilities.

- The area along Lincoln Creek should be cleared and developed as a natural drainageway and environmental corridor.

- An environmental teaching and learning center should be established in conjunction with a community center facility.

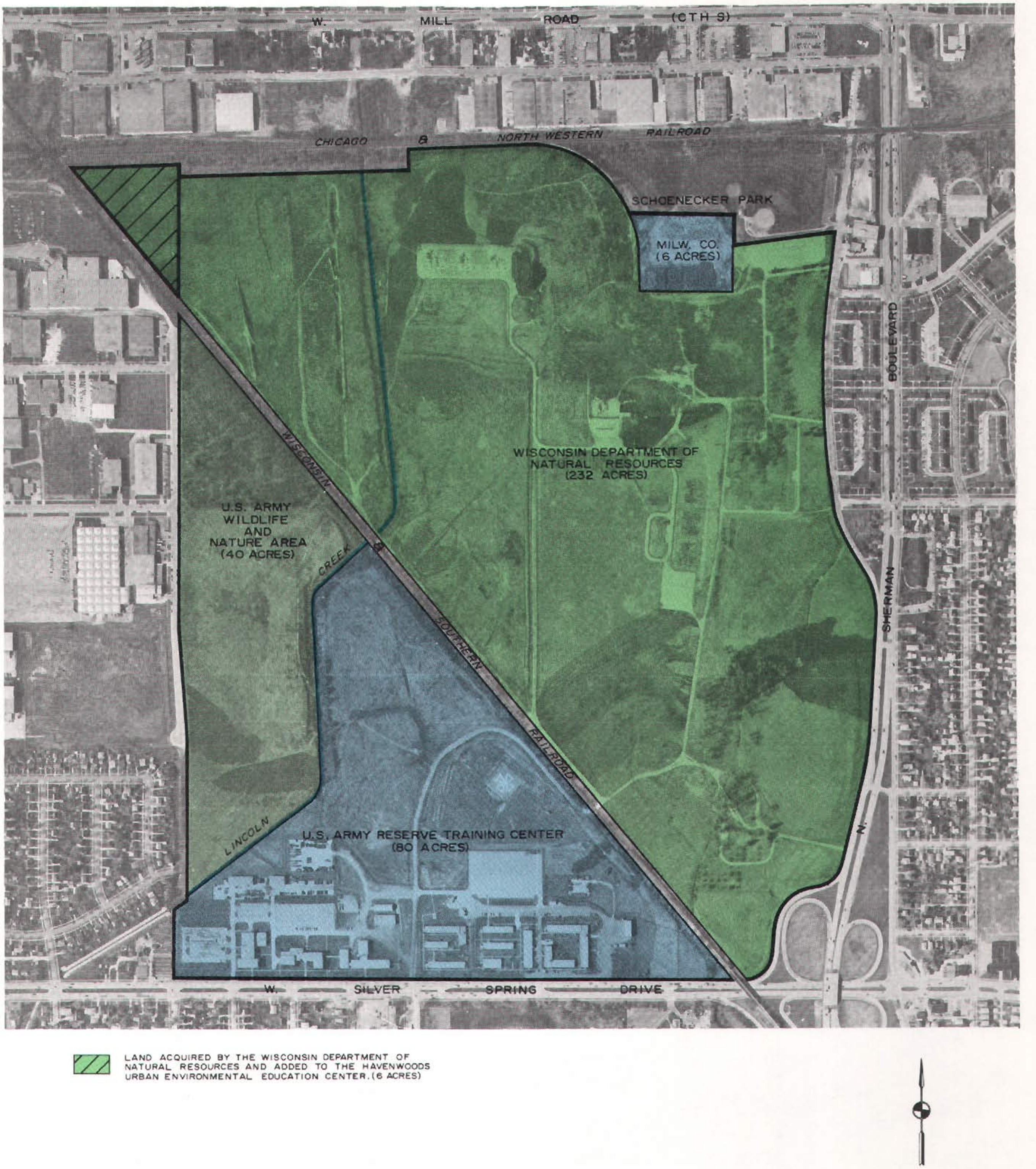
- Industrial land use should not be permitted on the site.

- The balance of the site should remain in open space and natural land uses.

In 1978, Acting Governor Martin J. Schreiber recommended that Havenwoods be established as the State's first urban natural area and wildlife preserve. The City of Milwaukee and the Natural Resources Board adopted separate, but similar, resolutions arranging for the transfer of approximately 232 acres of land belonging to the City of Milwaukee and lands held by the Milwaukee Area Technical College to the DNR. The DNR took full title to the land in February 1981. The DNR has also acquired approximately 6 acres at the northwest corner of the site making the total area of Havenwoods approximately 238 acres. The DNR subsequently prepared a master plan for the development of an urban environmental education center on this property. That plan was presented at a public hearing held by the DNR on July 7, 1981, and was subsequently adopted by the Department. Included within the master plan are two proposed wetland and floodwater detention basins. One such basin is to be located directly on Lincoln Creek. The second basin is to be located on the Havenwoods site but hydraulically isolated from the Creek.

Map 3

PRESENT OWNERSHIP OF LANDS FORMERLY COMPRISING
THE U. S. ARMY DISCIPLINARY BARRACKS SITE
IN THE LINCOLN CREEK SUBWATERSHED



Source: City of Milwaukee, Department of City Development; Wisconsin Department of Natural Resources, and SEWRPC.

These basins are intended to serve multiple purposes, including: 1) aesthetics, 2) improvement of plant and animal habitats, 3) education, 4) flood control (one basin), 5) water quality improvement, and 6) maintenance of natural characteristics on the site. As part of the study reported in this volume, the Commission has evaluated the merits of the proposed wetland basin on Lincoln Creek with respect to flood control for Lincoln Creek.

Chapter III

HISTORIC FLOOD EVENTS

INTRODUCTION

The collection, collation, and analysis of historic flood information--which includes measurements or observations of flood flows, stages, areas of inundation, and flood damage--is an important work element in the preparation of any flood control study. Such historic flood information is vital to this report for two reasons:

First, inasmuch as the flood flows, stages, and areas of inundation developed for this report were developed primarily through the application of hydrologic-hydraulic simulation techniques, sound engineering practice requires comparison between the results obtained with these techniques and available, reliable observations of actual floodland hydrologic-hydraulic behavior. Such comparisons permit adjustments to and refinements in the analytic work and, therefore, result in a more accurate representation of floodland hydrology and hydraulics.

Second, experience indicates that public memory of, and concern over, flood problems tends to diminish rapidly with the passage of time after a major flood event. Consequently, both public and private development decisions tend to be made without sound, definitive knowledge of actual flood events. An effective way to bring the seriousness of flood problems into proper perspective is to inventory and document historic flood information.

PROCEDURE FOR DATA COLLECTION

The inventory of historic flood events was made primarily by reviewing and analyzing rainfall records, streamflow data, and stage records. These data were provided from the files of the Milwaukee Metropolitan Sewerage District, the City of Milwaukee, and the Southeastern Wisconsin Regional Planning Commission. A field investigation was conducted of the entire Lincoln Creek channel, with particular emphasis on the areas that have experienced and may be expected to experience flooding and water-related damages.

MAJOR FLOOD EVENTS--MILWAUKEE RIVER

The Milwaukee River, of which Lincoln Creek is a tributary, has experienced flood stages in the City of Milwaukee during approximately one-half of the 68 years of record kept at the Estabrook Park stream gaging station, extending from 1914 through 1981. Floods of moderate severity occurred in 1959--equivalent to a 10-year recurrence interval flood--and in 1960, with the 1960 flood being slightly larger than the 1959 flood. The major floods of 1918 and 1924 were each nearly as severe as a 100-year recurrence interval event, both having a recurrence interval of about 77 years in the City of Milwaukee.

MAJOR FLOOD EVENTS--LINCOLN CREEK

Flooding, in various degrees, is a common occurrence adjacent to Lincoln Creek. Flooding along the Creek has increased proportionally to the conversion of land from open, rural use to urban use. Subsequently, channel improvements and bridge replacements have been made to accommodate the increased flows.

The Milwaukee River watershed as a whole, with a drainage area, including the Lincoln Creek subwatershed, of about 694 square miles, is most susceptible to the spring snowmelt type of flood event. In such an event, large volumes of runoff are produced in early spring when winter snow melts in a short period of time, and the entire drainage area contributes to the flow. This condition, coupled with watershedwide rainfall on frozen ground, usually generates the highest flood flows on large watersheds.

Lincoln Creek, on the other hand, is a relatively small and highly urbanized watershed, with a drainage area of only 19.26 square miles. Smaller watersheds such as that drained by Lincoln Creek are more susceptible to the higher intensity-shorter duration, summer-type rainstorms. This is borne out in the records of Lincoln Creek in that all of the most severe flood events have occurred at times other than during spring snowmelt events.

In recent years, the City of Milwaukee has kept records on the flood stages of Lincoln Creek. High-water marks were identified at bridge crossings after flood events, and elevations for these marks were determined by level surveys referenced to City of Milwaukee datum. The Milwaukee Metropolitan Sewerage District maintains crest-stage gages at eight bridges over Lincoln Creek. Flood crest elevations are collected at both the upstream and downstream sides of each bridge and are referenced to City of Milwaukee datum. In the period since 1960, the four largest events of record occurred in 1964, 1968, 1972, and 1973. The 1968 event was caused by a very short but intensive rainstorm and had about a five-year recurrence interval. The 1973 peak rate of discharge had a recurrence interval of about 40 years at N. 60th Street (River Mile 4.24) and of about 15 years at W. Hampton Avenue (River Mile 1.73). Peak stages and estimated discharges for the larger floods occurring on Lincoln Creek since 1960 are presented in Table 1. Selected observed flood stages are also plotted along with the 10-, 50-, and 100-year simulated flood profiles in Figure 7 of Chapter VI.

The major consequences of these runoff events have been flooding of roadways and underpasses, first-floor flooding of buildings, and basement flooding caused by sewer backup.

The City of Milwaukee Bureau of Engineers, Sewer Engineering Division, has documented flooding and water-related problems in the Lincoln Creek subwatershed. Over the 15-year period from 1960 through 1975, more than 1,300 separate flooding and water-related problems have been reported by property owners in the area. Problems include first-floor inundation, yard flooding, and basement flooding, with the most common complaint being basement flooding. The areas which experience these problems most frequently are outlined on Map 4.

Table 1

OBSERVED PEAK STAGES AND ESTIMATED PEAK DISCHARGES AND RECURRENCE INTERVALS FOR FLOODS OF 1964, 1968, 1972, AND 1973 ON LINCOLN CREEK

Location[a]	Date	Peak Stage[b] (feet NGVD[c])	Peak Estimated Discharge (cubic feet per second)	Approximate Recurrence Interval (years)
Green Bay Avenue (DSS)........	April 21, 1973	622.5	--	--
Green Bay Avenue (USS)........	April 14, 1973	622.5	--	--
W. Villard Avenue (USS).......	April 21, 1973	624.5	--	--
N. Teutonia Avenue (DSS)......	September 18, 1972	625.7	4,300	25
N. Teutonia Avenue (DSS)......	April 21, 1973	625.3	4,000	15
N. Teutonia Avenue (USS)......	April 21, 1973	630.1	--	--
W. Hampton Avenue (DSS).......	April 21, 1973	630.8	5,000	15
W. Hampton Avenue (USS).......	April 21, 1973	631.1	--	--
N. 32nd Street (USS)..........	April 21, 1973	637.6	--	--
N. 35th Street (DSS)..........	April 21, 1973	645.5	--	--
N. 35th Street (USS)..........	April 21, 1973	645.9	--	--
N. Sherman Boulevard (DSS)....	April 21, 1973	648.9	4,500	25
N. Sherman Boulevard (USS)....	April 21, 1973	650.0	--	--
N. 51st Street (USS)..........	April 21, 1973	652.1	--	--
N. 60th Street (DSS)..........	April 21, 1973	657.3	4,100	40
N. 60th Street (USS)..........	April 21, 1973	657.6	--	--
W. Hampton Avenue (USS).......	June 26, 1968	659.7	--	--
W. Villard Avenue (USS).......	June 26, 1968	662.4	--	--
W. Silver Spring Drive (USS)..	July 18, 1964	666.5	470	20
W. Mill Road (DSS)...........	April 21, 1973	687.5	--	--
W. Mill Road (USS)...........	April 21, 1973	687.5	--	--
W. Green Tree Road (USS)......	April 21, 1973	690.1	--	--
W. Good Hope Road (USS)........	June 26, 1968	696.3	--	--

[a]All flood stage records are at either the upstream side (USS) or downstream side (DSS) of bridges. The elevations listed as USS were high-water mark elevations determined by the City of Milwaukee Bureau of Sewer Engineering Division. The elevations listed as DSS were recorded on Milwaukee Metropolitan Sewerage District crest-stage gages.

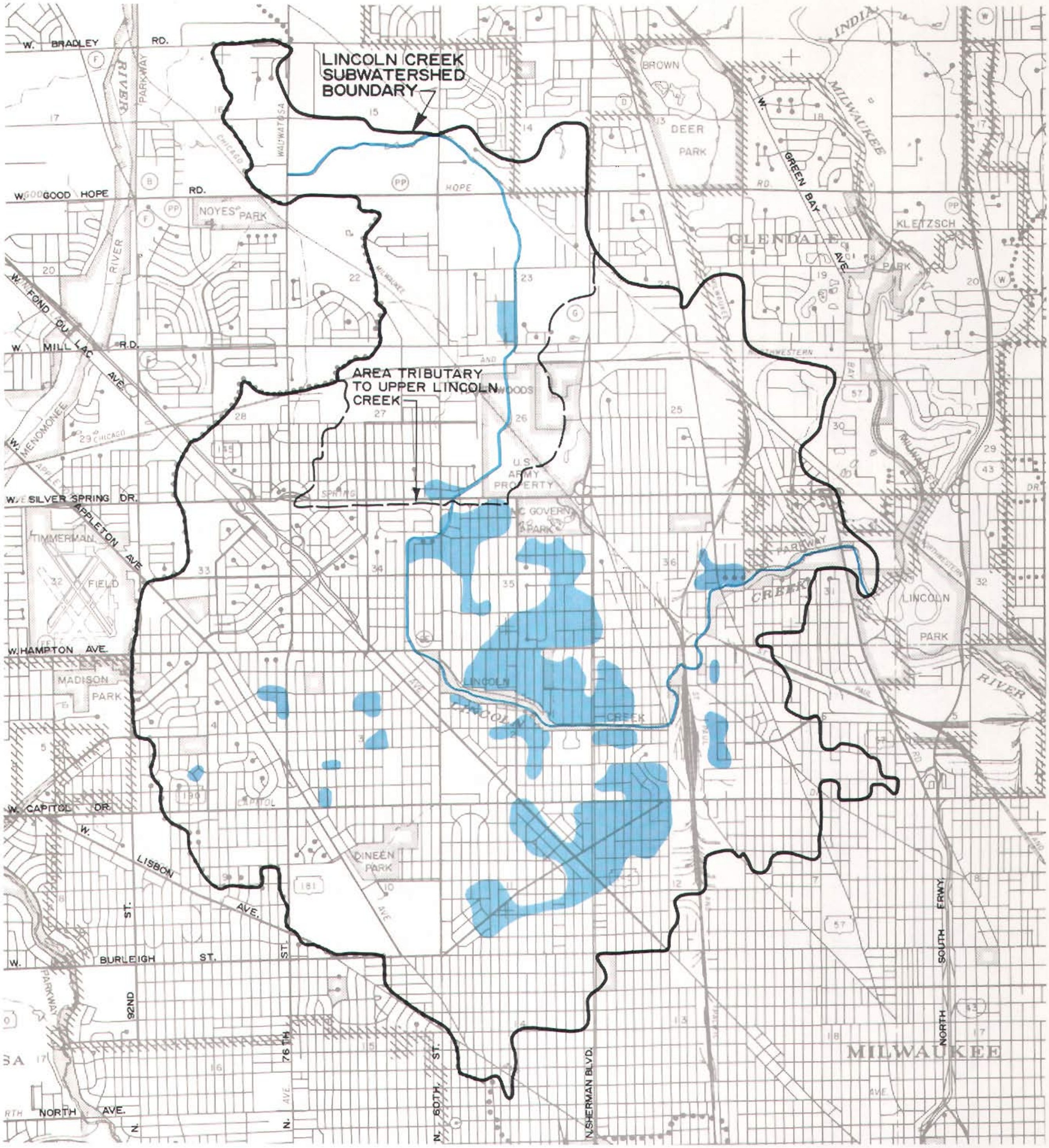
[b]The highest stages of record are presented at each bridge where such data have been collected.

[c]NGVD = National Geodetic Vertical Datum (mean sea level datum).

Source: City of Milwaukee, Milwaukee Metropolitan Sewerage District, and SEWRPC.

Map 4

HISTORIC FLOODING IN THE LINCOLN CREEK SUBWATERSHED: 1960-1975



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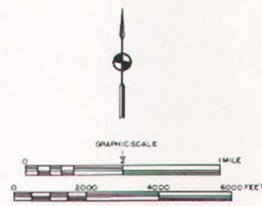

AREAS SUBJECTED TO PERIODIC FLOODING AND SURFACE WATER RELATED DAMAGES (INCLUDING BASEMENT FLOODING)

Source: City of Milwaukee Bureau of Engineers and SEWRPC.

SUMMARY

Based upon historic flood data, the Lincoln Creek subwatershed experiences minor flooding problems quite regularly, mostly in the form of basement flooding affecting many hundreds of residents. This type of flooding problem is particularly bothersome, involving great mental anguish as well as monetary damage and presenting a serious health hazard. Such flooding can be costly to eliminate or control.

Of greater consequence are the anticipated major flood events of 25-, 50-, and 100-year recurrence interval frequencies. A 100-year recurrence interval flood would cause costly first-floor flooding of hundreds of homes, businesses, and industries. As urban development continues in the upper watershed, flood stages in the downstream channel may be expected to continue to increase, with a related increase in the number of affected homes and industries. The existing and potential flood problems and attendant flood damages in the watershed are described further in Chapter VII of this report.

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Chapter IV

THE HYDROLOGIC-HYDRAULIC SYSTEM

INTRODUCTION

While the hydrologic and hydraulic characteristics of a watershed may be inventoried and described separately, as is done in this report, they must be analyzed together since they function in an interrelated manner within the watershed to determine the streamflow regimen. The computer modeling techniques used in this study to conduct an integrated analysis of watershed behavior are discussed in Chapter V of this report.

HYDROLOGY OF LINCOLN CREEK SUBWATERSHED

Precipitation

Precipitation within the subwatershed takes the form of rain, sleet, hail, and snow, and ranges from gentle showers of trace quantities, to brief, intense, and potentially destructive thunderstorms, to major rainfall-snowmelt events causing property damage. Monthly and annual total precipitation and snowfall data for the Milwaukee River watershed are presented in Table 2. The average annual total precipitation in the watershed, based on long-term records collected in the City of Milwaukee, is 30.3 inches.

Runoff

Because only limited streamflow data are available for the Lincoln Creek subwatershed, the eight pairs of crest gages owned and operated by the Milwaukee Metropolitan Sewerage District (MMSD) along the channel provide the only systematic flood data records. These records are of flood crest elevations only, with no associated peak flood discharges. The MMSD has collected such flood crest data on Lincoln Creek since 1967. The City of Milwaukee, Bureau of Engineers, has also collected high-water mark elevations at 17 sites along Lincoln Creek, with records extending back to 1960. Table 3 lists the locations and periods of record for the MMSD and City of Milwaukee flood stage data collection networks on Lincoln Creek. These stages were used to calculate the peak rates of discharge for the recorded peak stages, as described in Chapter V of this report. However, no records were available from which the annual runoff could be determined. Based upon the limited data available from the U. S. Geological Survey and a hydrologic analysis of the watershed, the average annual runoff was estimated at 16 inches per year.

Although Lincoln Creek is considered to be a perennial stream, the quantity of flow during summer months is negligible. Except during and after runoff events, the normal or low flow in the upper portion of the channel is estimated to be less than two cubic feet per second (cfs).

Table 2

MEAN MONTHLY AND ANNUAL PRECIPITATION AND TEMPERATURE DATA AT WEST BEND, MILWAUKEE, AND PORT WASHINGTON, WISCONSIN

Recording Station	January	February	March	April	May	June	July
West Bend[a]							
Precipitation (inches)....	1.69	1.32	2.02	2.53	2.98	3.90	3.45
Temperature (°F)..........	20.50	22.00	31.00	45.00	56.30	66.50	71.70
Milwaukee[b]							
Precipitation (inches)....	1.87	1.63	2.40	2.73	3.22	3.52	2.99
Temperature (°F)..........	20.40	22.40	31.60	43.60	53.60	63.60	69.50
Port Washington[c]							
Precipitation (inches)....	1.50	1.32	1.81	2.57	2.91	3.52	2.87
Temperature (°F)..........	18.50	21.60	32.20	42.10	51.60	61.70	67.80
Milwaukee River[d] Watershed Average Precipitation (inches)....	1.73	1.39	2.03	2.36	2.93	3.92	2.86

Recording Station	August	September	October	November	December	Annual
West Bend[a]						
Precipitation (inches)....	2.99	3.21	2.21	2.19	1.47	29.96
Temperature (°F)..........	70.10	61.90	51.00	36.20	24.20	46.40
Milwaukee[b]						
Precipitation (inches)....	2.76	3.10	2.28	2.04	1.75	30.29
Temperature (°F)..........	68.50	61.40	50.40	36.40	25.20	45.60
Port Washington[c]						
Precipitation (inches)....	2.88	3.00	2.11	2.01	1.46	27.96
Temperature (°F)..........	66.80	60.10	50.70	38.10	24.10	44.60
Milwaukee River[d] Watershed Average Precipitation (inches)....	2.97	3.33	2.07	2.25	1.51	29.35

[a] Fifty-five year continuous temperature and precipitation records (1914-1968).

[b] One hundred-fifteen year continuous precipitation record (1854-1968). Ninety-eight year continuous temperature record (1871-1968). Station moved from City of Milwaukee to General Mitchell Field airport in 1927.

[c] Seventy-four year continuous precipitation record (1895-1968). Eight-year continuous temperature record (1961-1968).

[d] 1931-1960 by Thiessen weighting.

Source: National Weather Service.

Hydrologic Soil Groups

In 1966 the U. S. Soil Conservation Service (SCS), under a cooperative agreement with the Southeastern Wisconsin Regional Planning Commission, completed a detailed soil survey of the entire seven-county Southeastern Wisconsin Region, including the Lincoln Creek subwatershed. With respect to watershed hydrology, the most significant interpretation provided of the soil survey data is the categorization of the soils into Hydrologic Soil Groups A, B, C, and D. In terms of runoff characteristics, these four soil groups vary from Group A soils, which generate relatively little runoff because of high infiltration capacity, high permeability, and good drainage, to Group D soils, which generate relatively large amounts of runoff because of very low infiltration capacity, low permeability, and poor drainage (see Table 4).

The impact of soil type on runoff characteristics is illustrated by the fact that if 4.0 inches of rainfall occur on grassland or meadow underlain by Hydrologic Soil Group B soils under average antecedent soil moisture conditions, only about 0.7 inch could be expected to run off directly to the surface drainage system; whereas, if the pasture were underlain by Hydrologic Soil Group D soils, about 1.9 inches--more than twice as much--could be expected to appear as direct runoff. Hydrologic soils group data, therefore, constituted an important input to the computer model used to simulate the hydrologic response of the subwatershed.

Soil types in the Hydrologic Soil Group C predominate in the Lincoln Creek subwatershed. The three most common soils are Mequon silt loam, Ozaukee silt loam, and Ashkum silt loam. The Mequon and Ozaukee soils are located primarily throughout the higher lands, while the Ashkum soil is found primarily in the lowlands along the drainageways of the subwatershed. These three predominant soils are very slowly permeable, and therefore have a high potential for producing runoff. In addition, a high water table is generally associated with the Ashkum silt loam.

Land Use

The nature and distribution of land uses--existing, projected, or planned--within a watershed constitute an important element in a hydrologic inventory, since both the volume and timing of direct runoff to the stream system are influenced by land use and by changes in land use. While the underlying hydrologic soil groups are an important determinant of hydrologic response, the type of land use superimposed on the soil group can significantly modify that response. This is particularly true when lands are converted from rural to urban uses, since such a conversion results in a large increase in impervious surface and, therefore, an increase in runoff volume and a decrease in runoff time. The existing (1975) land use pattern within the Lincoln Creek subwatershed is shown on Map 5.

As already noted, the Lincoln Creek subwatershed is covered primarily by soils in Hydrologic Soil Group C, which exhibits moderately high runoff volume. However, the hydrologic behavior of the subwatershed may be significantly and adversely affected by improperly planned urbanization. Consider, for example, grassland or meadow underlain by soils in Hydrologic Soil Group C, for which a 4.0-inch rainfall would produce only 1.5 inches of runoff. If the pasture

Table 3

FLOOD STAGE DATA COLLECTION FOR LINCOLN CREEK BY THE MILWAUKEE METROPOLITAN SEWERAGE DISTRICT AND THE CITY OF MILWAUKEE BUREAU OF ENGINEERS

Location	River Mile	Upstream Side	Downstream Side	Period of Record	Type of Record		Source of Record
					Crest-Stage Gage	High-Water Marks	
W. Green Bay Avenue	0.43	--	X	1968-69, 1972-73, 1975-81	X	--	Milwaukee Metropolitan Sewerage District
W. Green Bay Avenue	0.43	X	--	1977-78, 1981	X	--	Milwaukee Metropolitan Sewerage District
W. Green Bay Avenue	0.43	X	--	1960-67, 1969-78, 1981	X	--	City of Milwaukee, Bureau of Engineers
N. Villard Avenue	0.81	X	--	1960-78, 1981	X	--	City of Milwaukee, Bureau of Engineers
N. Teutonia Avenue[a]	1.30	--	X	1967-81	X	--	Milwaukee Metropolitan Sewerage District
N. Teutonia Avenue	1.30	X	--	1975-80	X	--	Milwaukee Metropolitan Sewerage District
N. Teutonia Avenue	1.30	X	--	1960-78, 1980-81	--	X	City of Milwaukee, Bureau of Engineers
W. Hampton Avenue[a]	1.73	--	X	1967-81	X	--	Milwaukee Metropolitan Sewerage District
W. Hampton Avenue	1.73	X	--	1975, 1977-81	X	--	Milwaukee Metropolitan Sewerage District
W. Hampton Avenue	1.73	X	--	1964-81	--	X	City of Milwaukee, Bureau of Engineers
N. 32nd Street	1.90	X	--	1960-81	--	X	City of Milwaukee, Bureau of Engineers
N. 33rd Street (extended)	--	X	--	1972-81	--	X	City of Milwaukee, Bureau of Engineers
N. 35th Street at W. Glendale Avenue[a]	--	X	--	1967-81	--	X	City of Milwaukee, Bureau of Engineers
N. 35th Street at W. Congress Street[a]	2.52	--	X	1967-81	X	--	Milwaukee Metropolitan Sewerage District
N. 35th Street at W. Congress Street[a]	2.52	X	--	1978	X	--	Milwaukee Metropolitan Sewerage District
N. 35th Street at W. Congress Street[a]	2.52	X	--	1965-73, 1976-79	--	X	City of Milwaukee, Bureau of Engineers
N. Sherman Boulevard[a]	3.03	--	X	1967-81	X	--	Milwaukee Metropolitan Sewerage District
N. Sherman Boulevard	3.03	X	--	1977-78, 1981	X	--	Milwaukee Metropolitan Sewerage District

Table 3 (continued)

Location	River Mile	Upstream Side	Downstream Side	Period of Record	Type of Record		Source of Record
					Crest-Stage Gage	High-Water Marks	
N. Sherman Boulevard	3.03	X	--	1965-67, 1969-81	--	X	City of Milwaukee, Bureau of Engineers
N. 51st Boulevard	3.59	X	--	1965-81	--	X	City of Milwaukee, Bureau of Engineers
N. 60th Street[a]	4.24	--	X	1967-81	X	--	Milwaukee Metropolitan Sewerage District
N. 60th Street	4.24	X	--	1977-78, 1980-81	X	--	Milwaukee Metropolitan Sewerage District
N. 60th Street	4.24	X	--	1960-72, 1974-81	--	X	City of Milwaukee, Bureau of Engineers
W. Hampton Avenue at N. 63rd Street[a]	4.41	X	--	1960, 1964-72, 1974-81	--	X	City of Milwaukee, Bureau of Engineers
W. Villard Avenue	4.92	X	--	1960-72, 1974-81	--	X	City of Milwaukee, Bureau of Engineers
W. Silver Spring Drive	5.65	--	X	1967-81[b]	X	--	Milwaukee Metropolitan Sewerage District
W. Silver Spring Drive	5.65	X	--	1975-81[c]	X	--	Milwaukee Metropolitan Sewerage District
W. Silver Spring Drive[a]	5.65	X	--	1960-67, 1969-72, 1974-78, 1980-81	--	X	City of Milwaukee, Bureau of Engineers
W. Mill Road	6.90	--	X	1970-77, 1979-81	X	--	Milwaukee Metropolitan Sewerage District
W. Mill Road	6.90	X	--	1975-77, 1980-81	X	--	Milwaukee Metropolitan Sewerage District
W. Mill Road	6.90	X	--	1964-69, 1972-78, 1980-81	--	X	City of Milwaukee, Bureau of Engineers
W. Green Tree Road	7.40	X	--	1964-67, 1972-74, 1977-78, 1980-81	--	X	City of Milwaukee, Bureau of Engineers
W. Good Hope Road	7.92	X	--	1965-68, 1977-78, 1980-81	--	X	City of Milwaukee, Bureau of Engineers

[a] Hydrologic model calibration site.

[b] Flood stages were recorded only in 1977, 1978, 1979, and 1981 because the crest stage gage was installed too high.

[c] Flood stages were recorded only in 1981 because the crest stage gage was installed too high.

Source: SEWRPC.

Table 4

RUNOFF CURVE NUMBERS FOR SELECTED LAND USES BY HYDROLOGIC SOIL GROUP[a]

Land Use Category	Hydrologic Soil Group			
	A	B	C	D
Cultivated Land[b]				
Without Conservation Treatment	72	81	88	91
With Conservation Treatment	62	71	78	81
Pasture or Range Land				
Poor Condition	68	79	86	89
Good Condition	39	61	74	80
Meadow				
Good Condition	30	58	71	78
Wood or Forest Land				
Thin Stand, Poor Cover, No Mulch	45	66	77	83
Good Cover[c]	25	55	70	77
Open Spaces, Lawns, Parks, Golf Courses, and Cemeteries				
Good Condition: Grass Cover on 75 Percent or More of the Area	39	61	74	80
Fair Condition: Grass Cover on 50 Percent to 75 Percent of the Area	49	69	79	84
Industrial Districts (72 percent impervious)	81	88	91	93
Residential[d] — Average Lot Size / Average Percent Impervious[e]				
1/8 acre or less / 65	77	85	90	92
1/4 acre / 38	61	75	83	87
1/3 acre / 30	57	72	81	86
1/2 acre / 25	54	70	80	85
1 acre / 20	51	68	79	84
Paved Parking Lots, Roofs, and Driveways[f]	98	98	98	98
Streets and Roads				
Paved with Curbs and Storm Sewers[f]	98	98	98	98
Gravel	76	85	89	91
Dirt	72	82	87	89

[a] Antecedent moisture condition II, and $I_a = 0.2S$.

[b] For a more detailed description of agricultural land use curve numbers, refer to Chapter 9 of National Engineering Handbook, Section 4, Hydrology, August 1972.

[c] Good cover is protected from grazing and litter and brush cover soil.

[d] Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street, with a minimum of roof water directed to lawns where additional infiltration could occur.

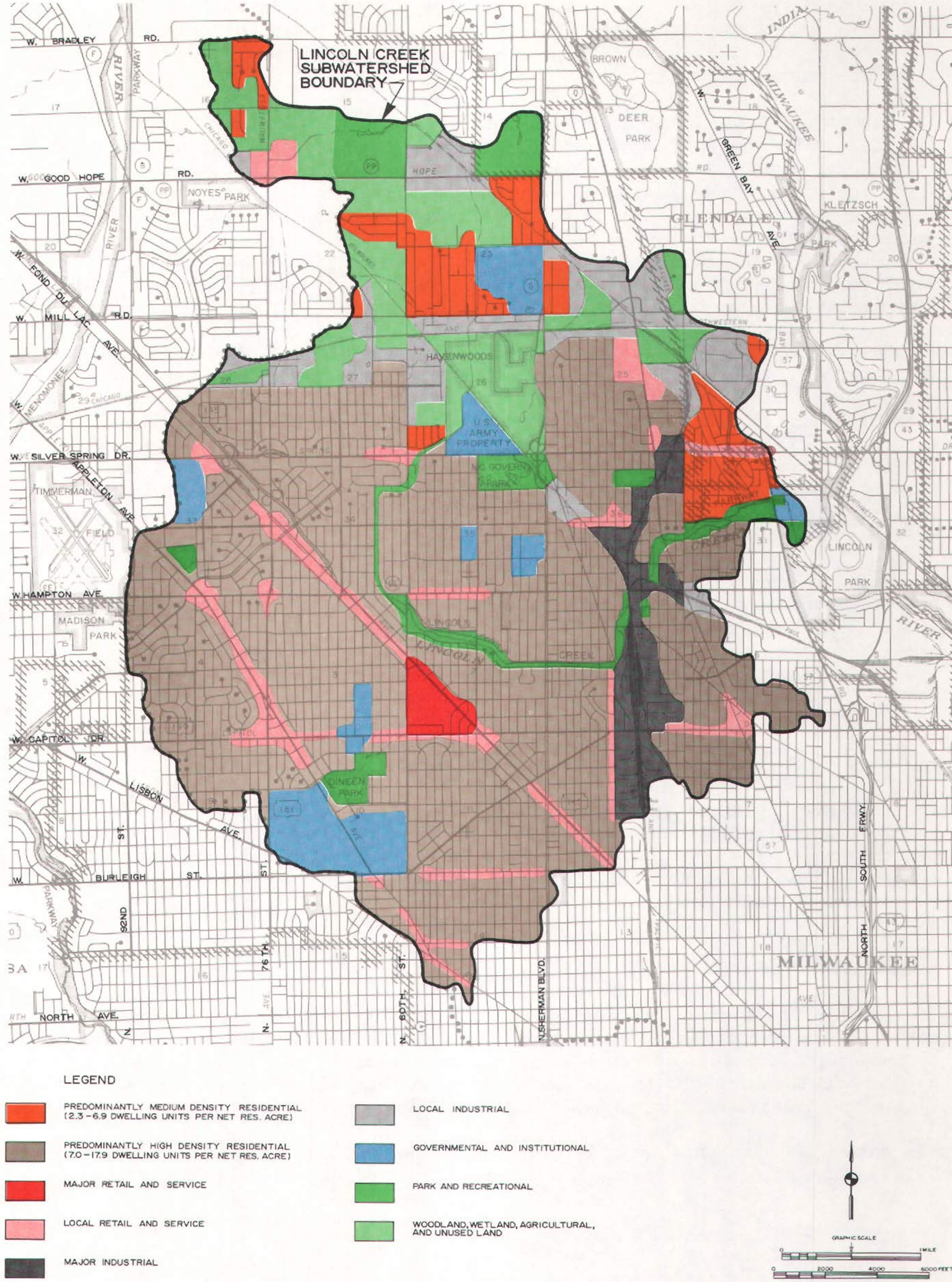
[e] The remaining pervious areas (lawn) are considered to be in good pasture condition for these curve numbers.

[f] In some warmer climates of the country a curve number of 95 may be used.

Source: U. S. Soil Conservation Service.

Map 5

GENERALIZED EXISTING LAND USE IN THE LINCOLN CREEK SUBWATERSHED: 1975



Source: SEWRPC.

were converted to a medium-density residential subdivision with a conventional storm sewer system, the 4.0-inch rainfall would result in approximately 2.6 inches of direct runoff volume--nearly twice as much--and the peak discharge rate would probably increase by several multiples because of the added effect of reduced runoff times.

A great majority of the soils in the subwatershed have been graded, excavated, filled, or in some way disturbed in the process of urban development. Disturbed and compacted soils are generally less permeable than natural soils. Also, the total amount of topsoil is usually decreased, sometimes by more than 50 percent, as urbanization takes place. As the amount of pervious surface decreases with development, the significance of soil types decreases with respect to effect on surface runoff. For example, if an entire site were developed for paved parking areas and buildings, the underlying soil would have minimal bearing on the runoff characteristics.

As already noted, the lower portion of the Lincoln Creek subwatershed--that is, the 15.17-square-mile area from about W. Silver Spring Drive to the confluence with the Milwaukee River--is almost completely developed for urban uses. No significant changes in land use are anticipated in this area in the future. Existing open spaces such as parks and cemeteries are expected to remain in their present use. A parkway system adjacent to the Creek has been developed along an approximately 4.3-mile reach of the stream from Lincoln Park to W. Cameron Avenue and from the Chicago, Milwaukee, St. Paul & Pacific Railroad to W. Hampton Avenue.

Land use is changing in the upper 4.09-square-mile area of the subwatershed. For the purposes of this report it is assumed that the upper watershed will be fully urbanized by the year 2000, with approximately 21 percent of the total area remaining in urban open space uses (see Map 6). The major thrust of the new development is industrial, commercial, and single-family and multiple-family residential. It is anticipated that existing open space uses such as parks, cemeteries, and golf courses will remain in the future.

The slopes of the land surface of the subwatershed vary from practically level to a maximum of 10 percent. The average slope is approximately 1.5 percent. The more sloping areas are located along the western boundary of the subwatershed. Practically all the lower portion of the subwatershed is served by storm sewers except the areas devoted to park and cemetery use. Storm sewers also serve all the developed areas in the upper part of the subwatershed, or about 50 percent of the upper area.

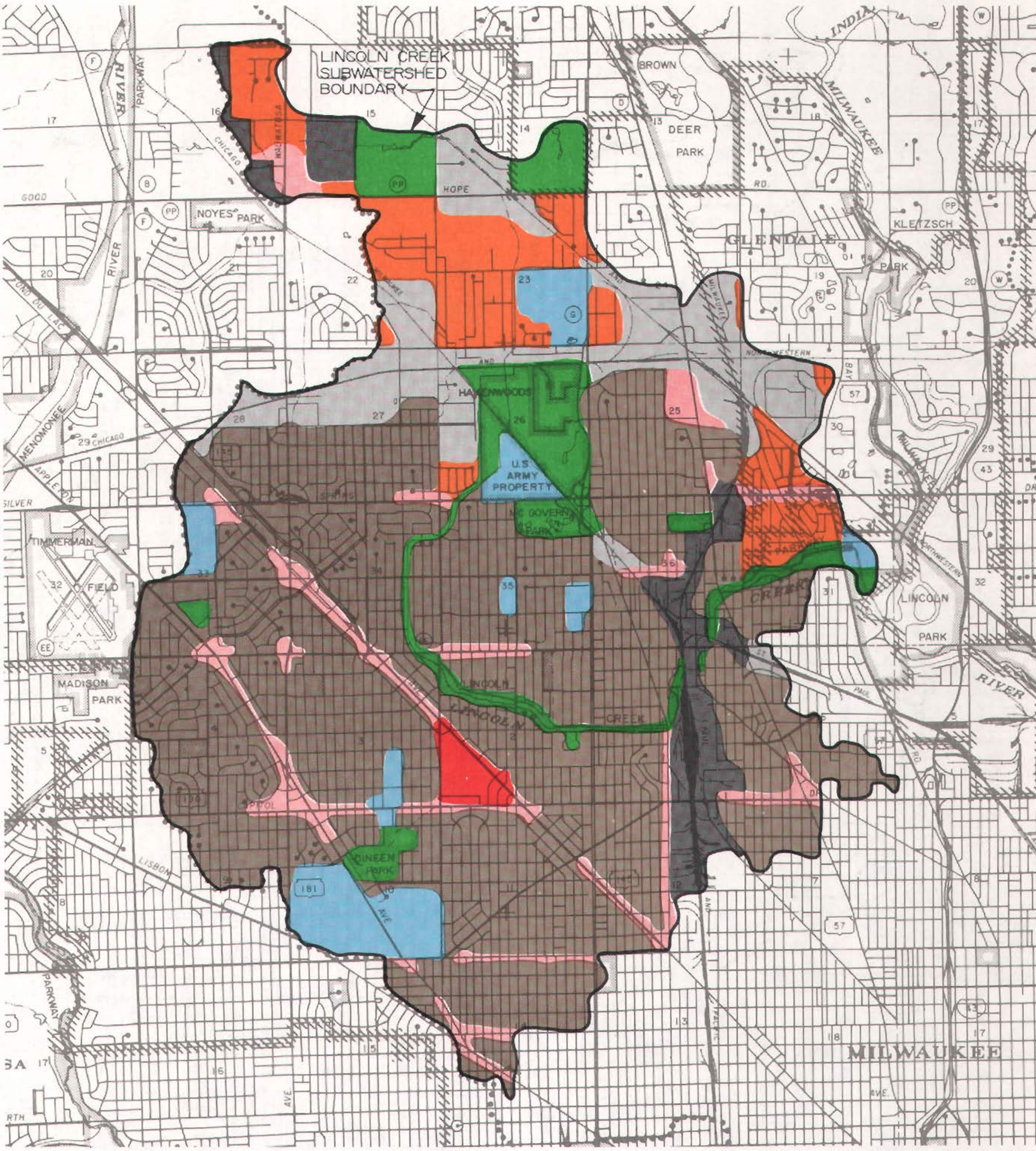
Subbasins

The Lincoln Creek subwatershed was divided into small hydrologic units called subbasins to permit an adequate representation of the subwatershed hydrology by the computer model used to compute flood discharges and stages. These subbasins are the areal units for which the subwatershed hydrologic characteristics were quantified prior to hydrologic modeling.

The entire subwatershed was divided into 18 subbasins--ranging in size from 0.32 square mile to 2.55 square miles--as shown on Map 7. Numerous factors in

Map 6

PLANNED LAND USE IN THE LINCOLN CREEK SUBWATERSHED: 2000



LEGEND

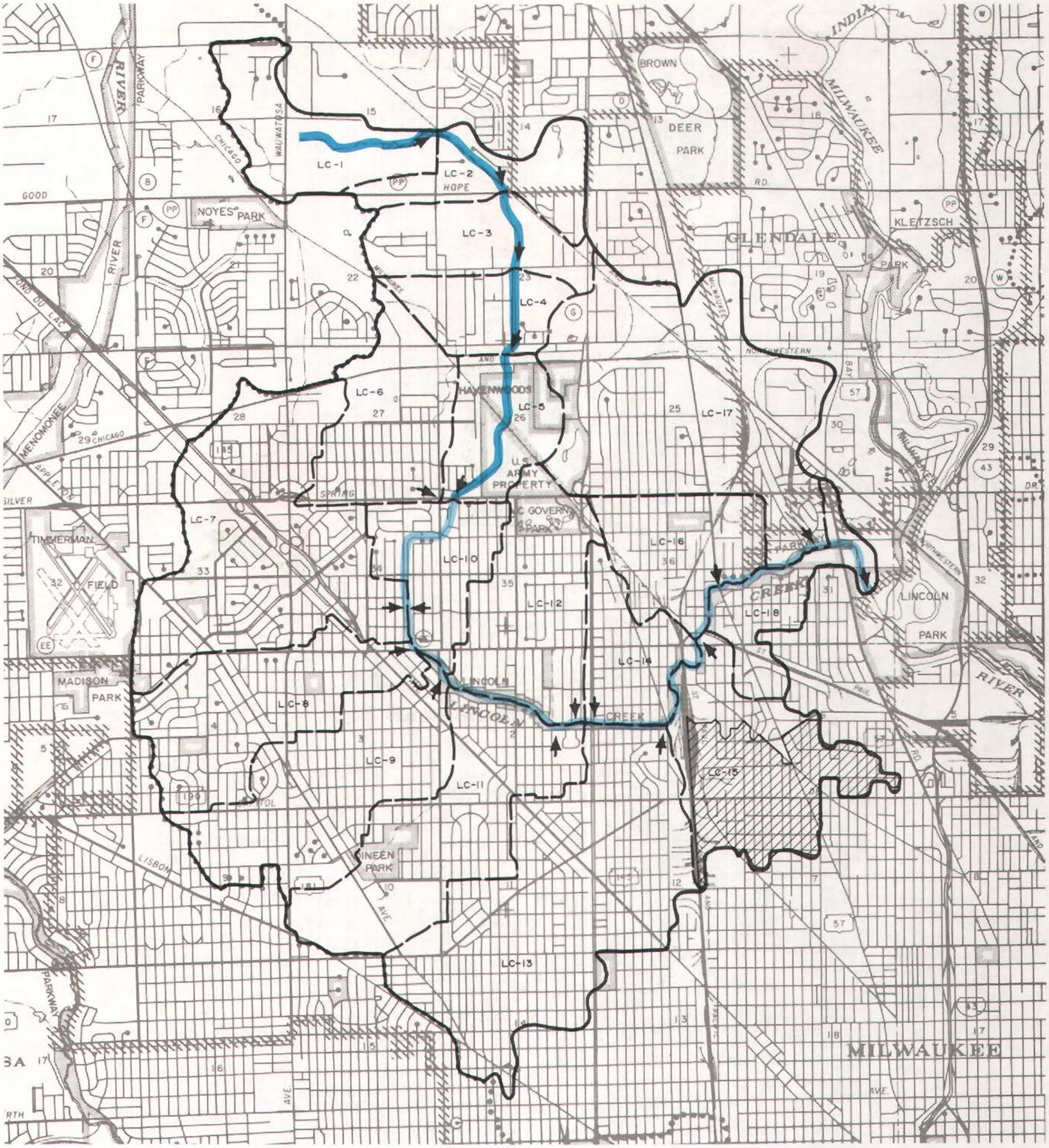
- PREDOMINANTLY MEDIUM DENSITY RESIDENTIAL (2.3 – 6.9 DWELLING UNITS PER NET RES. ACRE)
- PREDOMINANTLY HIGH DENSITY RESIDENTIAL (7.0 – 17.9 DWELLING UNITS PER NET RES. ACRE)
- MAJOR RETAIL AND SERVICE
- LOCAL RETAIL AND SERVICE
- MAJOR INDUSTRIAL
- LOCAL INDUSTRIAL
- GOVERNMENTAL AND INSTITUTIONAL
- PARK AND RECREATIONAL

GRAPHIC SCALE: 0 – 1 MILE; 0 – 2000 – 4000 – 6000 FEET

Source: SEWRPC.

Map 7

SUBBASINS IN THE LINCOLN CREEK SUBWATERSHED



LEGEND

SUBWATERSHED BOUNDARY

SUBBASIN BOUNDARY

SUBBASIN DISCHARGE LOCATION USED IN HYDROLOGIC MODEL

LC-13 SUBBASIN IDENTIFICATION CODE NUMBER

UPPER LINCOLN CREEK

LOWER LINCOLN CREEK

AREA TOPOGRAPHICALLY WITHIN LINCOLN CREEK SUBWATERSHED, BUT WITH STORM SEWERS TRIBUTARY TO A COMBINED SEWER OUTFALL DISCHARGING OUTSIDE THE SUBWATERSHED

GRAPHIC SCALE

0 1 MILE

0 2000 4000 6000 FEET

Source: SEWRPC.

addition to topographic considerations entered into the delineation of subbasins. The subbasins were delineated, for example, so as to define areas tributary to intermittent streams and drainageways and to major hydraulic structures such as dams and bridges.

Times of concentration were computed for each subbasin under 1975 and year 2000 planned conditions. These times of concentration constitute an important input to the computer model used to compute flood discharges and stages.

Runoff curve numbers--so named because they relate to rainfall-runoff curves or graphs--were determined for each subbasin under 1975 and year 2000 plan land use conditions using procedures established by the SCS. These curve numbers are listed for each subbasin in Table 5, and provide a measure of the proportion of rainfall that may be expected to be discharged as direct runoff from any given subbasin. The proportion of runoff that may be expected to occur increases with the runoff curve number, although the relationship is not necessarily linear. Hydrologic soil group characteristics and land use were the primary factors used to determine the runoff curve numbers, and the resulting numbers were entered directly into the watershed hydrologic-hydraulic model.

The upper portion of the Lincoln Creek subwatershed will be discussed separately from the lower portion since the upper portion is less highly urbanized. The upper subwatershed of 4.09 square miles was divided into six subbasins and five channel reaches for hydrologic simulation, as shown on Map 7. The refined subwatershed boundary delineated as a part of this study closely approximates the boundary shown in the Commission Milwaukee River watershed planning report.

The lower subwatershed of 16.07 square miles was divided into 12 subbasins and 12 reaches (see Map 7). Each subbasin was then field inspected, the field inspection being facilitated by the use of SEWRPC 1980 aerial photos. Runoff curve numbers (RCN) were assigned to each land use as determined from Technical Release 55 (TR-55) by the U. S. Soil Conservation Service (see Table 4). A weighted RCN representing existing conditions was then developed for each subbasin.

Future land uses to the year 2000 were then assigned to various parcels of land in each subbasin based upon City of Milwaukee zoning district maps and the regional land use plan (see Map 6). Using the procedure described above, a weighted RCN representing probable future conditions was also developed for each subbasin.

The time of concentration and the flow-through time were then established for each subbasin. Velocities of flow varied from 1.0 foot per second (fps) for overland flow to 10.0 fps in storm sewers. The average velocity in improved and partially lined concrete channels was assumed to approximate 6.0 fps.

HYDRAULICS OF THE LINCOLN CREEK SUBWATERSHED

The fall of the Lincoln Creek channel is 102 feet in a distance of 8.6 miles. The average fall is 17.3 feet per mile in the upper channel and 9.0 feet per mile in the lower channel. The channel of Lincoln Creek is in an essentially

Table 5

HYDROLOGIC AND HYDRAULIC DATA FOR THE LINCOLN CREEK SUBWATERSHED

Existing Conditions 1975 - Upper Lincoln Creek

Subbasin Identification[a]	Channel Length		Subbasin Area		Time of Concentration (minutes)	100-Year Design Rainfall Duration[b]		Runoff Curve Number
	Miles	Feet	Acres	Square Miles		Minutes	Hours	
1	--	--	506	0.79	33	180	3.0	80
2	0.60	3,150	371	0.58	22	240	4.0	81
3	0.53	2,800	422	0.66	16	60	1.0	80
4	0.61	3,200	320	0.50	21	240	4.0	82
5	1.16	6,100	390	0.61	22	240	4.0	81
6	--	--	602	0.94	23	60	1.0	86

Existing Conditions 1975 - Lower Lincoln Creek

Subbasin Identification[a]	Channel Length		Subbasin Area		Time of Concentration (minutes)	100-Year Design Rainfall Duration[b]		Runoff Curve Number
	Miles	Feet	Acres	Square Miles		Minutes	Hours	
7	--	--	1,370	2.14	33	60	1.0	88
8	--	--	794	1.24	36	60	1.0	88
9	0.27	1,400	915	1.43	40	60	1.0	89
10	1.21	6,400	410	0.64	14	60	1.0	88
11	--	--	960	1.50	32	60	1.0	85
12	1.00	5,300	698	1.09	22	180	3.0	86
13	0.57	3,000	1,632	2.55	46	180	3.0	88
14	--	--	346	0.54	12	180	3.0	88
15	0.80	4,200	781	0.32	6	180	3.0	89
16	1.16	6,150	486	0.76	14	180	3.0	89
17	--	--	1,549	2.42	45	240	4.0	87
18	0.51	2,700	346	0.54	10	240	4.0	87

Planned Land Use Conditions 2000, Existing Channels - Upper Lincoln Creek

Subbasin Identification[a]	Channel Length		Subbasin Area		Time of Concentration (minutes)	100-Year Design Rainfall Duration[b]		Runoff Curve Number
	Miles	Feet	Acres	Square Miles		Minutes	Hours	
1	--	--	506	0.79	33	180	3.0	84
2	0.60	3,150	371	0.58	19	240	4.0	82
3	0.53	2,800	422	0.66	16	60	1.0	84
4	0.61	3,200	320	0.50	14	240	4.0	83
5	1.16	6,100	390	0.61	18	240	4.0	85
6	--	--	602	0.94	20	60	1.0	88

Planned Land Use Conditions 2000, Existing Channels - Lower Lincoln Creek

Subbasin Identification[a]	Channel Length		Subbasin Area		Time of Concentration (minutes)	100-Year Design Rainfall Duration[b]		Runoff Curve Number
	Miles	Feet	Acres	Square Miles		Minutes	Hours	
7	--	--	1,370	2.14	33	60	1.0	88
8	--	--	794	1.24	36	60	1.0	88
9	0.27	1,400	915	1.43	40	60	1.0	89
10	1.21	6,400	410	0.64	14	60	1.0	88
11	--	--	960	1.50	32	60	1.0	85
12	1.00	5,300	698	1.09	22	180	3.0	86
13	0.57	3,000	1,632	2.55	46	180	3.0	88
14	--	--	346	0.54	12	180	3.0	88
15	0.80	4,200	781	0.32	6	180	3.0	89
16	1.16	6,150	486	0.76	23	180	3.0	89
17	--	--	1,549	2.42	45	240	4.0	87
18	0.51	2,700	346	0.54	10	240	4.0	87

[a] Number found on Map 2 in Chapter II of this report.

[b] Design storm which causes peak 100-year discharge in Lincoln Creek just downstream of subbasin outfall.

Source: SEWRPC.

natural and relatively undisturbed state for only a short distance from Teutonia Avenue (River Mile 1.30) to the confluence with the Milwaukee River. The remainder of the channel has been physically altered by deepening, straightening, lining with concrete or stone, and the construction of sills or drop spillways.

The channel has a concrete lining from N. Teutonia Avenue (River Mile 1.30) to N. 32nd Street (River Mile 1.90), and from W. Hampton Avenue (River Mile 4.41) to the sheet piling drop spillway (River Mile 5.79) located north of W. Silver Spring Drive. The channel is unlined from N. 32nd Street (River Mile 1.90) to W. Hampton Avenue (River Mile 4.41) but has masonry and rock walls from N. 32nd Street to N. 37th Street (River Mile 2.64). The channel is unimproved from the sheet piling spillway north of W. Silver Spring Drive (River Mile 5.79) to W. Mill Road (River Mile 6.90). From W. Mill Road to N. 60th Street (River Mile 8.55), the channel cross-section has been improved but not lined. In the area west of N. 60th Street, the watercourse consists of a series of 11 man-made ponds through Brynwood Country Club, then continuing southwesterly in an improved channel to N. 76th Street. The remainder of the Creek upstream is enclosed in storm sewer.

Cross-Sections

The width, slope, and flow resistance of the channel and its floodplains, particularly the latter, are important hydraulic elements of a river inasmuch as they are the primary determinants of the stage at which a given flood discharge will occur.

In the upper subwatershed channel, cross-sections were surveyed by the Milwaukee Metropolitan Sewerage District. In addition, a large-scale, two-foot contour interval map based on aerial photography taken in 1980 was utilized to develop stream valley cross-sections on the U. S. Army property and in Havenwoods (River Mile 5.80 to River Mile 6.73). In the lower subwatershed, cross-sections were surveyed in 1979 by the U. S. Geological Survey (USGS) for use in the federal flood insurance study of the City of Milwaukee. These cross-sections, along with channel and floodplain Manning roughness coefficients determined by field inspection by the USGS in the lower subwatershed and by SEWRPC in the upper subwatershed, were used as input to the flood flow simulation model.

Bridges and Culverts

Depending on the size of the waterway opening and the characteristics of the approaches, bridges and culverts can be important determinants of the hydraulics of a watershed. Constrictions caused by inadequately sized bridges and culverts can result in large backwater effects and thereby create a floodland area upstream of the structure that is significantly larger than that which would exist in the absence of the inadequately sized bridge or culvert.

There are 36 road bridges, pedestrian bridges, railroad bridges, and culverts along Lincoln Creek. In addition, the Creek flows over three small sills and three drop spillways or dams. These hydraulic structures are listed in Table 6.

Table 6

EXISTING HYDRAULIC STRUCTURES IN THE LINCOLN CREEK SUBWATERSHED

Structure Identification		Structure Type			Hydraulically Significant[a]		Hydrologically Significant[b]	
River Mile Station	Name	Bridge	Culvert	Dam	Yes	No	Yes	No
0.43	N. Green Bay Avenue (STH 57)	X	--	--	X	--	--	X
0.81	W. Villard Avenue	X	--	--	X	--	--	X
0.93	Pedestrian Bridge	X	--	--	--	X	--	X
1.30	N. Teutonia Avenue	X	--	--	X	--	--	X
1.53	W. Cameron Avenue	X	--	--	X	--	--	X
1.65	Chicago, Milwaukee, St. Paul & Pacific Railroad	X	--	--	X	--	--	X
1.73	W. Hampton Avenue	X	--	--	X	--	--	X
1.90	N. 32nd Street	X	--	--	X	--	--	X
2.01	Chicago, Milwaukee, St. Paul & Pacific Railroad	X	--	--	X	--	X	--
2.15	Sill	--	--	X	--	X	--	X
2.20	W. Glendale Avenue	X	--	--	X	--	--	X
2.52	N. 35th Street	X	--	--	X	--	--	X
2.64	N. 37th Street	X	--	--	X	--	X	--
2.82	Pedestrian Bridges	X	--	--	--	X	--	X
3.03	N. Sherman Boulevard	X	--	--	X	--	X	--
3.13	Sill	--	--	X	--	X	--	X
3.34	Sill	--	--	X	--	X	--	X
3.48	Pedestrian Bridge	X	--	--	--	X	--	X
3.59	N. 51st Street	X	--	--	X	--	--	X
3.80	Pedestrian Bridge	X	--	--	--	X	--	X
4.24	N. 60th Street	X	--	--	X	--	--	X
4.41	W. Hampton Avenue (CTH EE)	X	--	--	X	--	--	X
4.56	Pedestrian Bridge	X	--	--	--	X	--	X
4.92	W. Villard Avenue	--	X	--	X	--	--	X
5.37	N. 60th Street and W. Custer Avenue	--	X	--	X	--	--	X
5.51	Pedestrian Bridge	X	--	--	--	X	--	X
5.65	W. Silver Spring Drive	--	X	--	X	--	--	X
5.79	Steel Drop Spillway	--	--	X	X	--	--	X
6.06	Private Road	--	X	--	X	--	--	X
6.28	Wisconsin & Southern Railroad	--	X	--	X	--	X	--
6.29	Private Road	--	X	--	X	--	--	X
6.67	Pedestrian Bridge	X	--	--	--	X	--	X
6.73	Chicago & North Western Railway	--	X	--	X	--	X	--
6.82	W. Woolworth Avenue	--	X	--	X	--	--	X
6.86	N. 51st Street	--	X	--	X	--	--	X
6.90	W. Mill Road (CTH S)	--	X	--	X	--	--	X
7.40	W. Green Tree Road	--	X	--	X	--	X	--
7.92	W. Good Hope Road, Chicago & North Western Railway, and Concrete Drop Spillway	--	X	X	X	--	--	X
8.49	Chicago & North Western Railway	--	X	--	X	--	--	X
8.55	N. 60th Street	--	X	--	X	--	X	--
8.58	Concrete Drop Spillway	--	--	X	--	X	--	X

[a] *Hydraulically Significant—A hydraulically significant structure is a structure such as a culvert, bridge, or dam across a stream which increases the 100-year recurrence interval flood stage immediately upstream from the structure by 0.1 foot or more over the flood stage which would occur if the structure did not exist.*

[b] *Hydrologically Significant—A condition occurring when a hydraulic structure in a stream functions in effect like a flood control structure by causing significant storage of flood waters upstream and thereby significantly reducing peak flood flows and stages downstream.*

Source: SEWRPC.

Data on waterway opening size, roadway profile, and channel bottom elevation were obtained for the hydraulically significant bridges and culverts by the USGS and the MMSD, and were used as input to the hydrologic-hydraulic computer model used to compute flood discharges and stages.

Natural Floodplains

The Lincoln Creek channel has been straightened, reshaped, or modified in some manner for almost all of its nine-mile length. The series of small ponds in Brynwood Country Club--part of the Upper Lincoln Creek watercourse--approximates a natural floodplain condition, although this area also has been altered by the construction of the ponds.

The Lower Lincoln Creek channel from W. Hampton Avenue (River Mile 4.41) to N. Green Bay Avenue (River Mile 0.43) has been developed, and the floodplain adjacent to the Creek modified within the Lincoln Creek Parkway. This area performs the function of conveying floodwaters greater than can be accommodated by the channel itself. In this area, however, the parkway cannot contain the 100-year flood in some reaches under existing conditions.

Because of the development that has taken place in the original floodplains and the modifications that have been made to the Lincoln Creek channel, little open floodplain exists for the storage and conveyance of flood flows along Lower Lincoln Creek.

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Chapter V

THE HYDROLOGIC-HYDRAULIC MODEL

INTRODUCTION

In order to accomplish the objectives of the flood control study of Lincoln Creek in a technically sound manner, it was necessary to be able to quantitatively test and evaluate the performance of alternative flood control plans under existing and probable future land use activities. A digital computer model capable of simulating the watershed hydrologic-hydraulic system was selected as the analytical technique for such plan test and evaluation.

DESCRIPTION OF THE MODEL

The hydrologic-hydraulic simulation model used in the flood control study of Lincoln Creek consists of two submodels--that is, two computer programs operated in sequence, as illustrated in Figure 1. The first, or hydraulic, submodel[1] was used to determine the hydraulic characteristics of the drainage system of the Lincoln Creek subwatershed. These characteristics, along with hydrologic data describing the land surface and the rainfall event to be modeled, provided the input for the second, or hydrologic, submodel,[2] the primary function of which was to convert design rainfall events into 10-, 50-, and 100-year recurrence interval discharges for Lincoln Creek under existing 1975 and plan year 2000 land use conditions. The hydraulic submodel was applied a second time, using peak discharges obtained from the hydrologic submodel to obtain 10-, 50-, and 100-year flood stages under existing channel conditions and existing 1975 and plan year 2000 land use conditions. Both submodels were also used in the quantitative test and evaluation of alternative flood control plans.

MODEL INPUT

Inputs to the two submodels developed under and taken from the inventory of the subwatershed hydrologic-hydraulic system were described in general in Chapter IV of this report. More specific descriptions of some of the input data are provided in this chapter.

Hydraulic Submodel

As indicated previously, input to the hydraulic submodel consisted, in part, of pertinent data on hydraulic structures and stream valley cross-sections,

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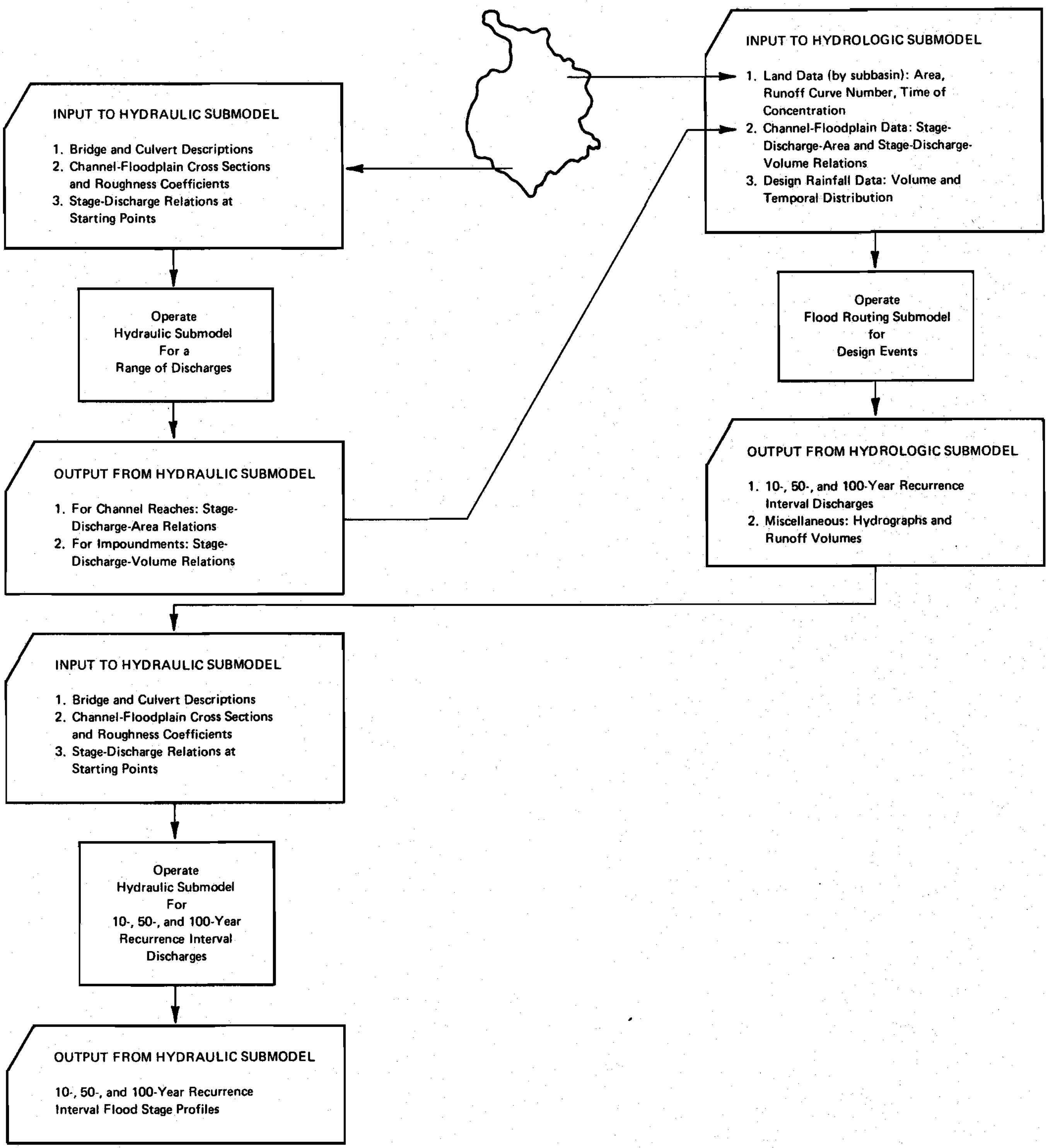
[1]U. S. Army Corps of Engineers, Hydrologic Engineering Center, "HEC-2, Water Surface Profiles," Computer Program 723-X6-L202A, February 1972.

[2]U. S. Department of Agriculture, Soil Conservation Service--Engineering Division, "Computer Program for Project Formulation-Hydrology," Technical Release No. 20, May 1965.

Figure 1

HYDROLOGIC-HYDRAULIC MODEL OF THE LINCOLN CREEK SUBWATERSHED



Source: SEWRPC.

along with appropriate Manning roughness coefficients for the main channel and floodway of Lincoln Creek. Flood stages along Lower Lincoln Creek were computed using the floodway developed by the U. S. Geological Survey under the federal flood insurance study for the City of Milwaukee and subsequently approved by the Wisconsin Department of Natural Resources. This floodway adequately represents conveyance conditions for the existing channel and floodplain. For Upper Lincoln Creek, flood stages were computed using the existing channel and floodplain. The floodways for the existing channels under plan year 2000 land use conditions for Upper and Lower Lincoln Creek are shown on Map 15 in Chapter IX of this report, along with the associated 100-year recurrence interval floodplain.

Hydrologic Submodel

Also as indicated previously, hydrologic submodel inputs consisted of runoff curve numbers and times of concentration for each subbasin shown on Map 7 in Chapter IV of this report. Stream valley cross-sections were provided for channel routing, and stage-storage-discharge relationships were provided for hydrologically significant structures for reservoir routing of flood flows. Potential hydrologically significant structures were initially identified by the hydraulic submodel and verified as hydrologically significant or insignificant by the hydrologic submodel. Seven structures were verified as hydrologically significant and are so identified in Table 6 in Chapter IV.

The design storms selected for simulation of the 10-, 50-, and 100-year flood discharges were taken from equations developed by the Commission.[3] The rainfall distribution utilized for each design storm was the median distribution of a first-quartile storm as developed by F A. Huff.[4] The duration of the design storm was determined for a given recurrence interval by simulating the peak discharge at a given location for a range of storm durations. The storm duration and associated rainfall volume which produced the largest peak discharge at a given location for a given recurrence interval was selected as the design storm for that location. This analysis was conducted for both existing and planned conditions at 24 locations on the main stem of Lincoln Creek.

HYDROLOGIC MODEL CALIBRATION

In order to assure the validity of the simulation model applications, the flood discharges simulated by any hydrologic model should be checked for accuracy against observed flood discharge data. Although such data were not available for Lincoln Creek, up to 22 years of high-water mark data were available for 17 locations on the channel from the City of Milwaukee Bureau of Engineers; and up to 15 years of crest-stage gage data for eight locations on the channel were available from the Milwaukee Metropolitan Sewerage District (MMSD). Data on the locations and periods of record involved are presented in Table 3 in Chapter IV of this report.

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[3]See "Development of Equations for Rainfall Intensity--Duration-Frequency Relationship," SEWRPC Technical Record, Vol. 3, No. 5, March 1973.

[4]F. A. Huff, "Time Distribution of Rainfall in Heavy Storms," Water Resources Research, Vol. 3, No. 4, 1967, pp. 1007-1019.

To convert the available actual flood stage data to estimates of flood discharges, five hydraulically favorable sites on Lincoln Creek were selected from among those sites for which flood-stage records were available. Crest-stage gages generally provide more dependable and more accurate stage data than do high-water marks. Consequently, crest-stage gage sites were utilized where possible. Four of the sites selected were crest-stage gaging stations. These stations were located at N. Teutonia Avenue (River Mile 1.30), W. Hampton Avenue (River Mile 1.73), N. Sherman Boulevard (River Mile 3.03), and N. 60th Street (River Mile 4.24). The fifth site concerned was located at W. Silver Spring Drive (River Mile 5.65), where 22 years of high-water-mark records have been collected. The four crest-stage gage records selected were all collected at the downstream side of each of the four bridges, where hydraulic conditions were such that accurate discharge estimates could be made. Crest-stage records at the upstream side of these bridges are less useful for making discharge estimates because the crest-stage gages either are in the drawdown zone or are subject to variable backwater effects owing to debris accumulation on the upstream side of the bridge.

The MMSD operates two crest-stage gages, one near each end of the culvert at W. Silver Spring Drive. However, both gages are mounted so high above Lincoln Creek that flood stages very seldom reach the gages. Therefore, it was necessary to utilize the 22-year, high-water-mark record collected at the upstream side of the culvert for estimation of flood discharges at this location.

The hydraulic submodel was utilized to determine stage-discharge relationships at the four selected crest-stage gage sites. The hydraulic submodel in conjunction with a culvert flow simulation model developed by the U. S. Geological Survey[5] was used to simulate the stage-discharge relationship at the upstream side of W. Silver Spring Drive. The stage-discharge relationships developed at these five sites were combined with the flood stage records to generate annual peak flood discharges. To augment the crest-stage gage records, high-water-mark records were also used where both types of record were available to extend the data base.

The series of estimated annual peak discharges at each of the five flood stage record sites was subjected to a log Pearson Type III frequency analysis. Figures 2 through 6 indicate the resultant flood frequency curves and the annual peak flood discharges to which the curves were fitted. These curves were developed so that discharges simulated by the hydrologic submodel for the 10-, 50-, and 100-year floods could be evaluated for accuracy against the curves based on observed flood data.

Initial simulations by the hydrologic submodel yielded 10-, 50-, and 100-year flood discharges which were somewhat low compared with the observed data at the calibration sites at W. Silver Spring Drive and N. 60th Street (River Mile 4.24). Consequently, runoff curve numbers were increased slightly for all subbasins in the entire Lincoln Creek subwatershed. The results of this refined simulation are shown along with the observed flood frequency curves in

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[5]Howard Matthai, Harold E. Stull, and Jacob Davidian, "Preparation of Input Data for Automatic Computation of Stage-Discharge Relations at Culverts," U. S. Geological Survey Technique of Water Resources Investigations, Book 7, (unpublished).

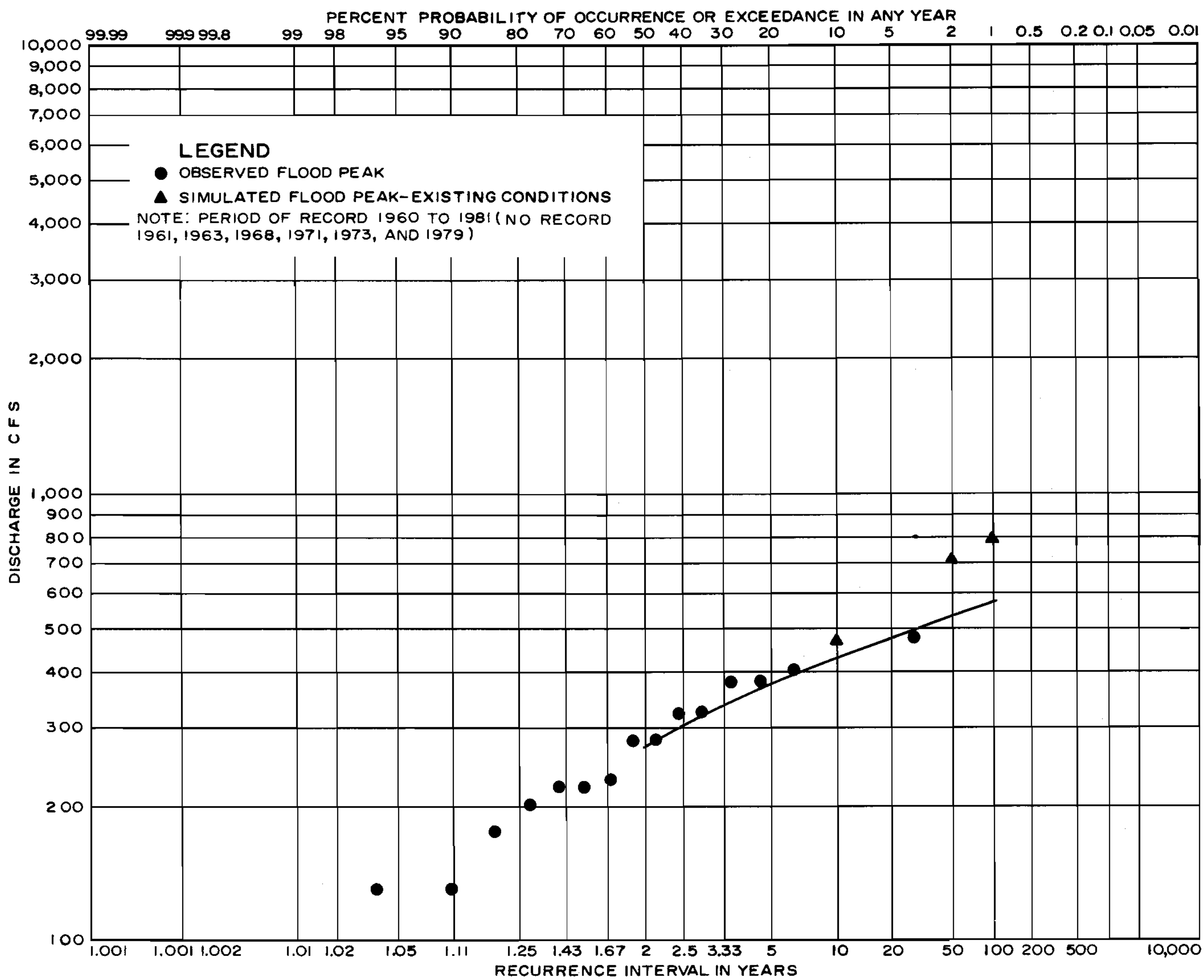
Figures 2 through 6. As these figures indicate, relatively good comparisons between observed and simulated flood flows were found at four of the five calibration sites. The observed and simulated flows did not correspond well at N. Teutonia Avenue, as indicated in Figure 6, with the simulated flows being considerably higher than the observed flows.

In an attempt to resolve the discrepancy between the observed and simulated results at N. Teutonia Avenue, the hydrologic model was subjected to a sensitivity analysis by simulating flows for a range in times of concentration for subbasins tributary to Lincoln Creek near this calibration site. These simulations did not provide significant reductions in flows at N. Teutonia Avenue. In a further attempt to resolve the discrepancy, the entire Lincoln Creek subwatershed was simulated for a range in times of concentration for each subbasin. Simulated flows still did not change much, indicating that the hydrologic submodel for Lincoln Creek is not very sensitive to time of concentration. The stage-discharge relationship developed for the crest-stage gage at the downstream side of N. Teutonia Avenue was checked in a further attempt to resolve the discrepancy, and no justification for changing this relationship was found. Flood flows simulated at W. Hampton Avenue--0.43 mile upstream of N. Teutonia Avenue, where a relatively good model calibration was achieved--were compared with the flows simulated at N. Teutonia Avenue. The 10-, 50-, and 100-year simulated flows at both locations were similar in magnitude, which suggests that the N. Teutonia Avenue simulated flows are not too high, there being no significant floodplain storage area between the two sites. Based on the foregoing analysis, it was concluded that the simulated flood flows at N. Teutonia Avenue are reasonable, and either that the flood-stage records collected at the crest-stage gage are not indicative of the actual stage of Lincoln Creek owing to high velocities at the gage intake, or that hydraulic conditions near the downstream side of the bridge are such that the hydraulic submodel is not calculating stages accurately enough to adequately calibrate the crest-stage gage for flow.

Following calibration of the hydrologic submodel for existing channel conditions and year 1975 land use conditions, flood flows were simulated for design year 2000 plan land use conditions and for a number of alternative channel and floodwater storage conditions. The results thereof are described in subsequent chapters of this report.

Figure 2

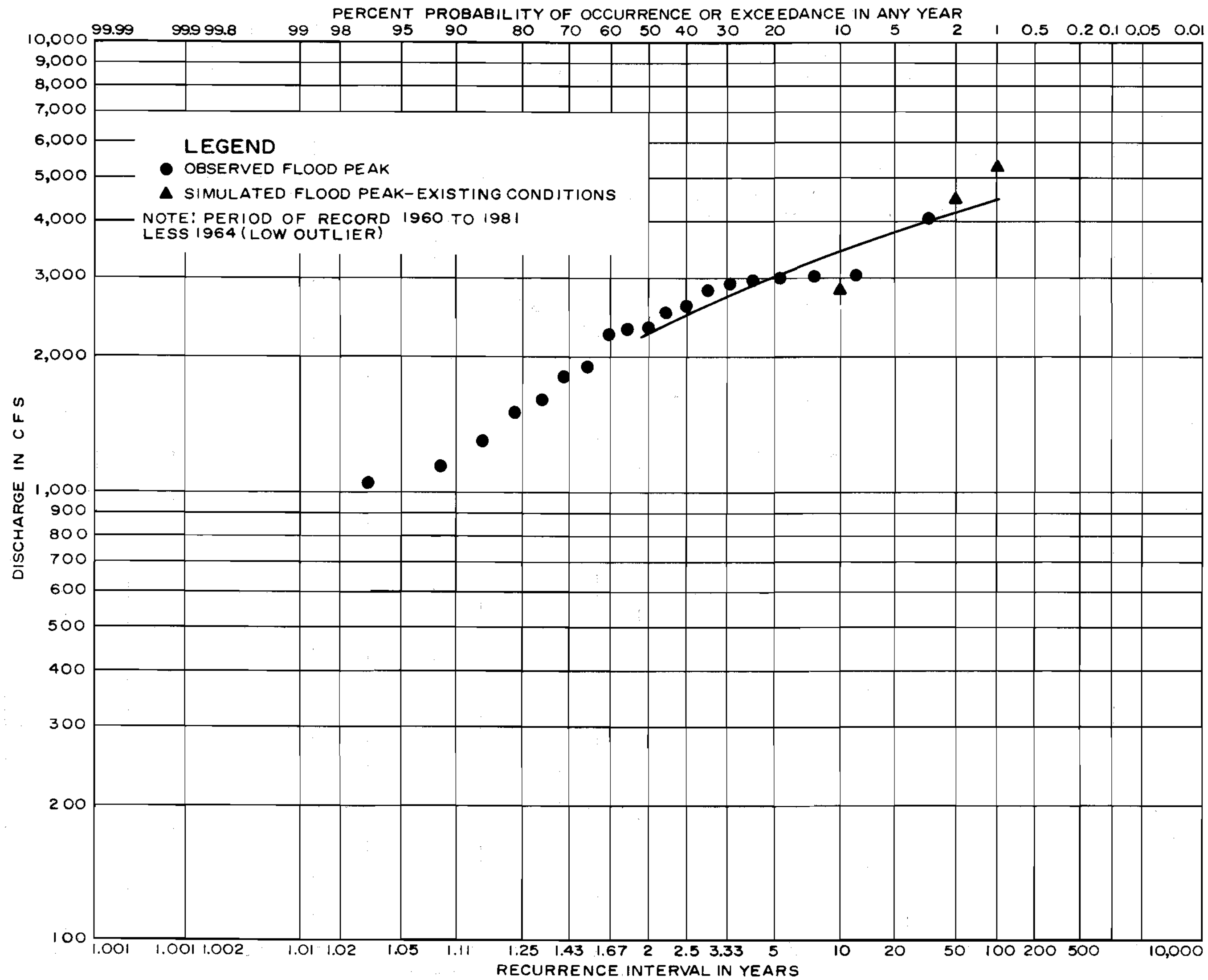
COMPARISON OF OBSERVED FLOOD FREQUENCY CURVE WITH FLOOD DISCHARGES SIMULATED BY THE HYDROLOGIC SUBMODEL FOR LINCOLN CREEK AT THE UPSTREAM SIDE OF W. SILVER SPRING DRIVE (RIVER MILE 5.65)



Source: SEWRPC.

Figure 3

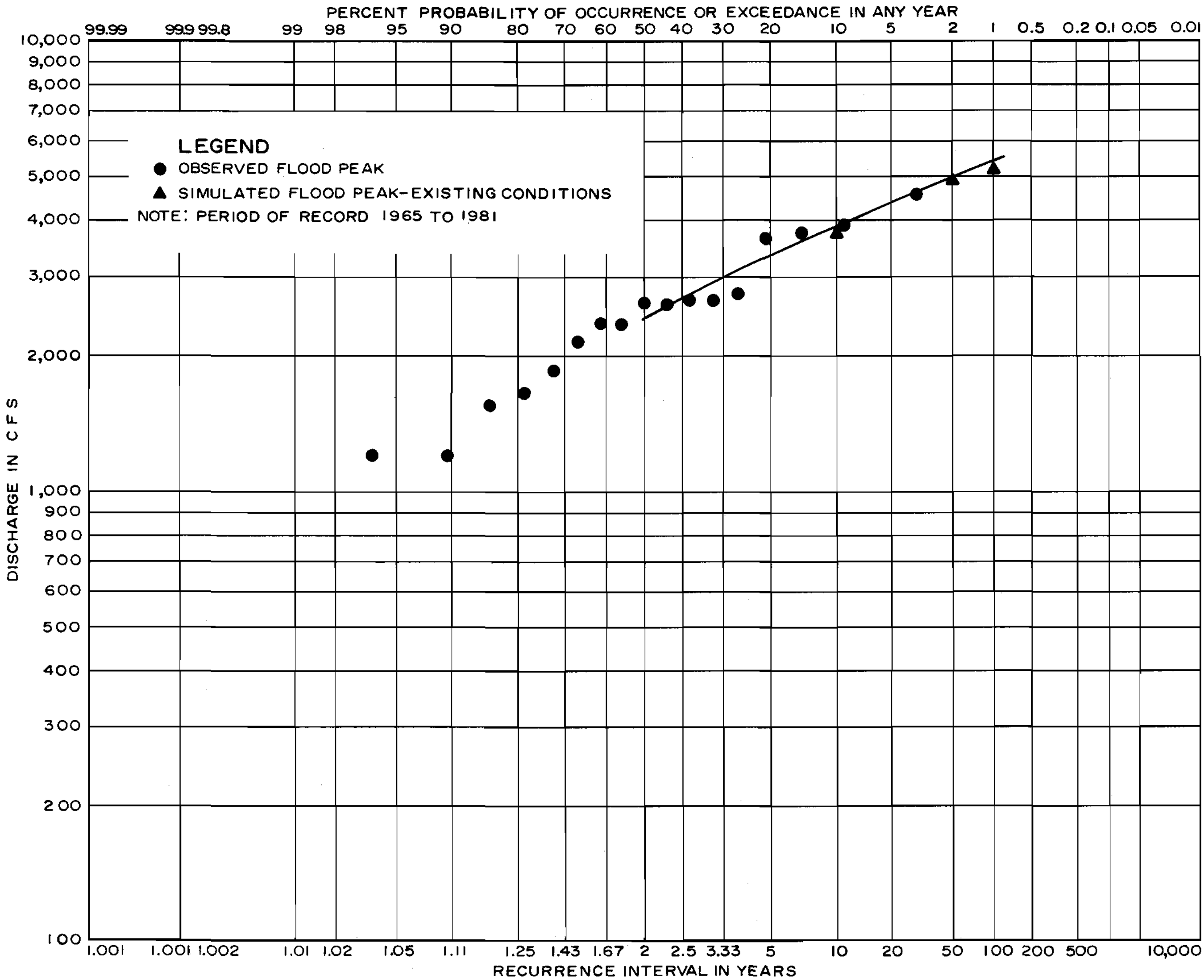
COMPARISON OF OBSERVED FLOOD FREQUENCY CURVE WITH FLOOD DISCHARGES SIMULATED BY THE HYDROLOGIC SUBMODEL FOR LINCOLN CREEK AT N. 60TH STREET (RIVER MILE 4.24)



Source: SEWRPC.

Figure 4

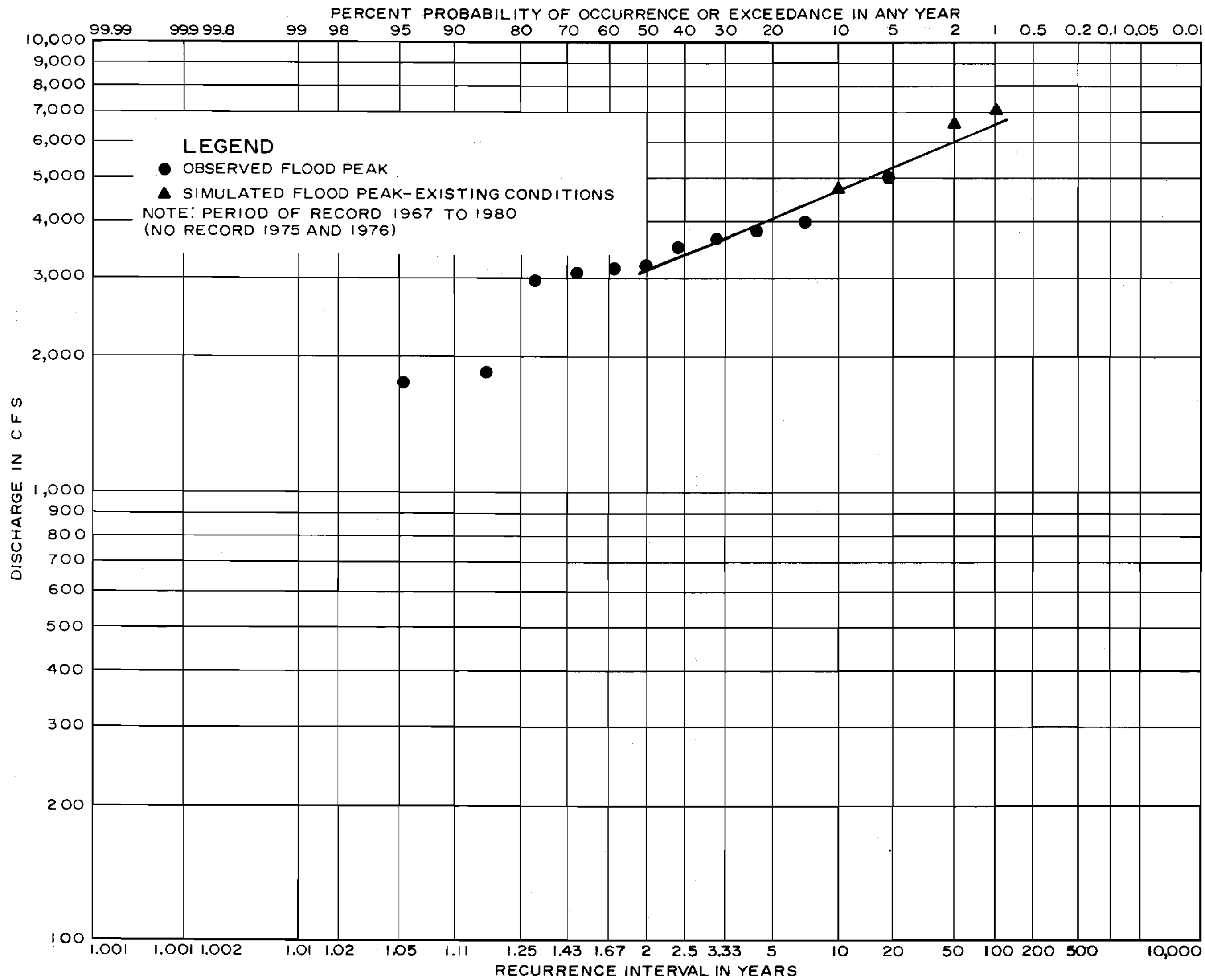
COMPARISON OF OBSERVED FLOOD FREQUENCY CURVE WITH FLOOD DISCHARGES SIMULATED BY THE HYDROLOGIC SUBMODEL FOR LINCOLN CREEK AT N. SHERMAN BOULEVARD (RIVER MILE 3.03)



Source: SEWRPC.

Figure 5

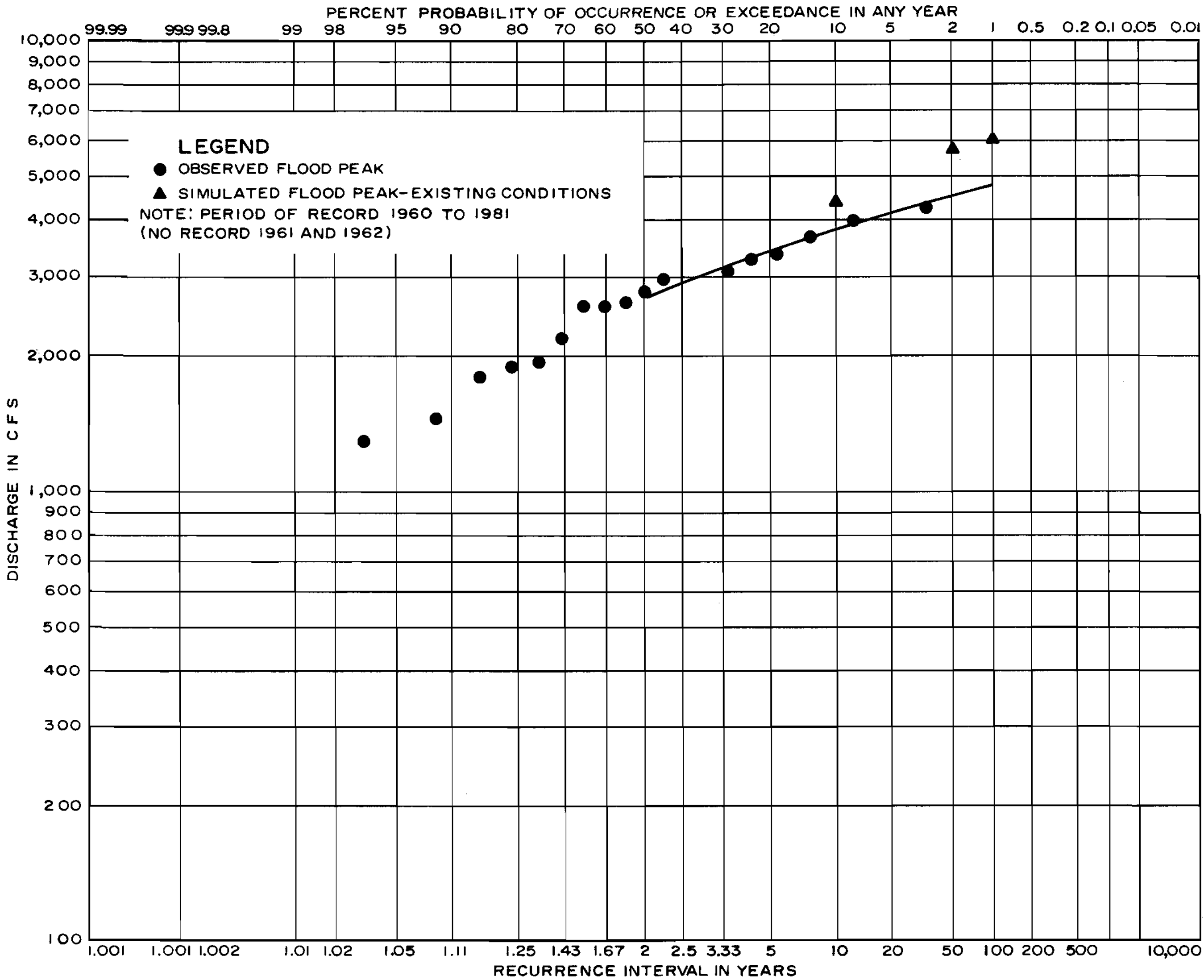
COMPARISON OF OBSERVED FLOOD FREQUENCY CURVE WITH FLOOD DISCHARGES SIMULATED BY THE HYDROLOGIC SUBMODEL FOR LINCOLN CREEK AT W. HAMPTON AVENUE (RIVER MILE 1.73)



Source: SEWRPC.

Figure 6

COMPARISON OF OBSERVED FLOOD FREQUENCY CURVE WITH FLOOD DISCHARGES SIMULATED BY THE HYDROLOGIC SUBMODEL FOR LINCOLN CREEK AT N. TEUTONIA AVENUE (RIVER MILE 1.30)



Source: *SEWRPC.*

Chapter VI

FLOOD DISCHARGES AND STAGES

INTRODUCTION

The hydrologic-hydraulic simulation model described in Chapter V of this report was used in the computation of discharges and stages for the 10-, 50-, and 100-year recurrence interval flood events on Lincoln Creek under existing channel conditions and under both existing year 1975 and year 2000 plan land use conditions. The sound development and management of water resources requires consideration of future as well as existing land uses which affect water resources in general and flood problems in particular. Accordingly, flood events were first simulated under existing land use and channel conditions in order to determine the existing flood characteristics of Lincoln Creek, and to establish a point of reference for the evaluation of the results of the simulation of stream system performance under design year 2000 land use conditions.

The lower subwatershed is essentially fully developed for urban use. Consequently, land use in the lower subwatershed is not expected to change significantly by the year 2000. Because of the development now taking place in the remaining, developable, open areas of the upper subwatershed, it is anticipated that most of the upper subwatershed will be urbanized by the year 2000. Therefore, peak discharges and stages in the upper subwatershed may be expected to change significantly under the effects of these land use changes. Peak discharges and stages under existing channel conditions in Lower Lincoln Creek are not expected to change significantly for the 100-year recurrence interval flood. However, significant increases are likely for the more frequent, smaller magnitude events.

The estimated peak flood discharges under existing and year 2000 land use conditions and under existing channel conditions are set forth in Table 7. These discharges are significantly different from those set forth in the federal flood insurance study (FIS) for Lincoln Creek and in the first edition of this report prepared in 1977. These differences are the result of the significant refinements which were incorporated into the application of the hydrologic-hydraulic simulation model since the completion of that initial study and the federal FIS. These refinements were of two types. First, more detailed topographic data in the form of field-surveyed channel and floodplain cross-sections became available for Lower Lincoln Creek as a result of work conducted by the U. S. Geological Survey (USGS) in 1979. Similarly, such data became available for Upper Lincoln Creek as a result of work conducted by the Milwaukee Metropolitan Sewerage District (MMSD) in 1981. The cross-sections surveyed by the USGS were used in the preparation of the federal FIS. The FIS, however, did not include a detailed study of Upper Lincoln Creek. The additional topographic data for Upper Lincoln Creek were obtained by the MMSD at the request of the Commission specifically for use in the preparation of this report. The refined topographic data were utilized in the refined application of the hydrologic-hydraulic simulation model for Lincoln Creek, specifically in channel flood-routing.

Table 7

FLOOD DISCHARGES FOR LINCOLN CREEK FOR EXISTING AND YEAR 2000 LAND USE CONDITIONS FOR EXISTING CHANNELS

Location	River Mile	Peak Flood Discharge (cubic feet per second)					
		Existing Land Use, Existing Storage, and Existing Channel Conditions			Planned Land Use, Existing Storage, and Existing Channel Conditions		
		10-Year	50-Year	100-Year	10-Year	50-Year	100-Year
Mouth at Milwaukee River	0.00	5,310	7,350	7,980	5,410	7,370	7,970
N. Green Bay Avenue	0.43	5,310	7,350	7,980	5,410	7,370	7,970
W. Villard Avenue	0.81	4,640	6,120	6,510	4,740	6,120	6,510
Pedestrian Bridge	0.93	4,640	6,120	6,510	4,740	6,120	6,510
N. Teutonia Avenue	1.30	4,640	6,120	6,510	4,740	6,120	6,510
W. Cameron Avenue	1.53	4,480	5,840	6,160	4,580	5,840	6,160
Chicago, Milwaukee, St. Paul & Pacific Railroad	1.65	4,480	5,840	6,160	4,580	5,840	6,160
W. Hampton Avenue	1.73	4,480	5,840	6,160	4,580	5,840	6,160
N. 32nd Street	1.90	4,480	5,840	6,160	4,580	5,840	6,160
Chicago, Milwaukee, St. Paul & Pacific Railroad	2.01	4,480	5,840	6,160	4,580	5,840	6,160
Glendale Avenue	2.20	4,480	5,840	6,160	4,580	5,840	6,160
N. 35th Street	2.52	3,640	4,510	4,600	3,730	4,530	4,600
N. 37th Street	2.64						
Downstream Side		3,640	4,510	4,600	3,730	4,530	4,600
Upstream Side		3,730	4,900	5,160	3,880	4,960	5,240
N. Sherman Boulevard	3.03						
Downstream Side		3,720	4,730	4,990	3,870	4,790	5,060
Upstream Side		4,500	7,070	8,020	4,810	7,440	8,480
N. 51st Street	3.59	3,670	5,860	6,760	4,020	6,290	7,340
Pedestrian Bridge	3.80	3,670	5,860	6,760	4,020	6,290	7,340
N. 58th Street (extended)	4.16	3,670	5,860	6,760	4,020	6,290	7,340
N. 60th Street	4.24	2,840	4,570	5,290	3,190	5,000	5,860
W. Hampton Avenue	4.41	2,840	4,570	5,290	3,190	5,000	5,860
Pedestrian Bridge	4.56	2,150	3,480	4,040	2,490	3,910	4,590
W. Villard Avenue	4.92	830	1,400	1,680	1,130	1,820	2,160
N. 60th Street	5.37	830	1,400	1,680	1,130	1,820	2,160
W. Silver Spring Drive	5.65						
Downstream Side		830	1,400	1,680	1,130	1,820	2,160
Upstream Side		470	710	790	530	770	840
Drop Structure	5.79	470	710	790	530	770	840
U. S. Army Bridge	6.06	440	670	740	500	720	780
Wisconsin & Southern Railroad	6.28	400	600	660	440	640	690
Havenwoods Bridge	6.29	400	600	660	440	640	690
Chicago & North Western Railway	6.73						
Downstream Side		420	610	660	460	640	700
Upstream Side		610	1,070	1,290	800	1,370	1,640
W. Woolworth Avenue	6.82	490	870	1,040	660	1,110	1,330
N. 51st Street	6.86	490	870	1,040	660	1,110	1,330
W. Mill Road	6.90	490	870	1,040	660	1,110	1,330
W. Greentree Road	7.40						
Downstream Side		370	660	790	510	850	1,020
Upstream Side		240	350	390	260	380	400
W. Good Hope Road (structure outlet)	7.92	320	500	560	340	540	630
Chicago & North Western Railway (structure inlet)	7.97	180	250	280	210	290	310
Chicago & North Western Railway	8.49	180	250	280	210	290	310
N. 60th Street	8.55						
Downstream Side		180	250	280	210	290	310
Upstream Side		260	470	550	350	590	700

Source: SEWRPC.

The second major refinement made in the application of the hydrologic-hydraulic simulation model for Lincoln Creek included the incorporation of floodwater storage data on seven hydrologically significant structures, identification of which was made possible in part by the availability of the more detailed topographic data already noted, and in part by analysis of the historic flood stage records collected by the MMSD and the City of Milwaukee, as discussed in Chapter V. A comparison of the flood flows used in the federal FIS and in this study at selected locations along Lincoln Creek is presented in Table 8 for existing land use and channel conditions. In Lower Lincoln Creek, flood flows for the 100-year recurrence interval flood, for example, are about 30 percent lower just below N. Sherman Boulevard than those used in the FIS, and about 15 percent lower at N. Green Bay Avenue. The FIS did not address Upper Lincoln Creek. The superseded flows presented in Table 8 for that reach were taken from the first edition of this report.

FLOOD STAGE PROFILES

Flood stage profiles were determined for the 10-, 50-, and 100-year recurrence interval runoff events under existing land use and channel conditions and under future land use conditions. These profiles, which encompass the full 8.6-mile-long reach of Lincoln Creek studied, constitute a graphic representation of the flood stages along Lincoln Creek under the specified recurrence interval flood discharges. In addition to providing an overall representation of flood stages relative to familiar points of reference such as the channel bottom and bridge deck surfaces, the profiles, because they are continuous, permit the determination of flood stages at any point along the stream channel. For reference, observed historic flood stages are also shown on the flood profiles. The flood profiles are shown in Figures 7 and 8.

In most locations, the flood profiles are somewhat lower than those provided in the federal FIS. While the same topographic data were used in the application of the hydrologic-hydraulic simulation model, the model application utilized the revised, and generally lower, flood discharges described above. Upper Lincoln Creek was not studied in the federal FIS, but had been studied more generally during preparation of the first edition of this report completed in 1977. The cross-sections as surveyed by the MMSD and the revised flood discharges were used in the application of the hydrologic-hydraulic simulation model for Upper Lincoln Creek. The resulting flood stages are significantly lower than those calculated for and presented in the first edition of this report. A comparison of these two sets of 100-year recurrence interval flood stages is presented for selected locations along Lincoln Creek in Table 9 for existing land use and channel conditions. The superseded stages for Lower Lincoln Creek were taken from the FIS, and those for Upper Lincoln Creek were taken from the first edition of this report. Table 10 presents summary hydrologic-hydraulic flood data for Lincoln Creek at all the hydraulic structures in the study reach, and identifies structures recommended for replacement. Map 8 illustrates the difference between the 100-year recurrence interval floodplain for Lincoln Creek as determined under the federal FIS and as determined through the more refined study on which this report is based.

Table 8

COMPARISON OF SUPERSEDED AND REVISED FLOOD DISCHARGES FOR LINCOLN CREEK FOR EXISTING LAND USE AND CHANNEL CONDITIONS

Location	Peak Flood Discharge (cubic feet per second)					
	Revised			Superseded[a]		
	10-Year	50-Year	100-Year	10-Year	50-Year	100-Year
N. 60th Street............	180	250	280	150	340	430
W. Mill Road..............	490	870	1,040	700	1,080	1,270
W. Silver Spring Drive						
Upstream Side...........	470	710	790	910	1,400	1,650
Downstream Side.........	830	1,400	1,680	1,410	2,190	2,410
N. 60th Street............	830	1,400	1,680	1,410	2,190	2,410
N. Sherman Boulevard						
Upstream Side...........	4,500	7,070	8,020	4,500	6,935	7,425
Downstream Side.........	3,720	4,730	4,990	4,500	6,935	7,425
N. 37th Street						
Upstream Side...........	3,730	4,900	5,160	4,500	6,935	7,425
Downstream Side.........	3,640	4,510	4,600	4,500	6,935	7,425
N. Teutonia Avenue........	4,640	6,120	6,510	5,020	7,620	8,170
N. Green Bay Avenue.......	5,310	7,350	7,980	5,720	8,820	9,525

[a] Discharges as used in the federal flood insurance study for the City of Milwaukee for Lower Lincoln Creek downstream of W. Silver Spring Drive, and as presented in the first edition of this report for Upper Lincoln Creek upstream of W. Silver Spring Drive.

Source: Federal Flood Insurance Study and SEWRPC.

Figure 7

FLOOD STAGE PROFILES FOR LINCOLN CREEK UNDER EXISTING LAND USE AND CHANNEL CONDITIONS: 1975

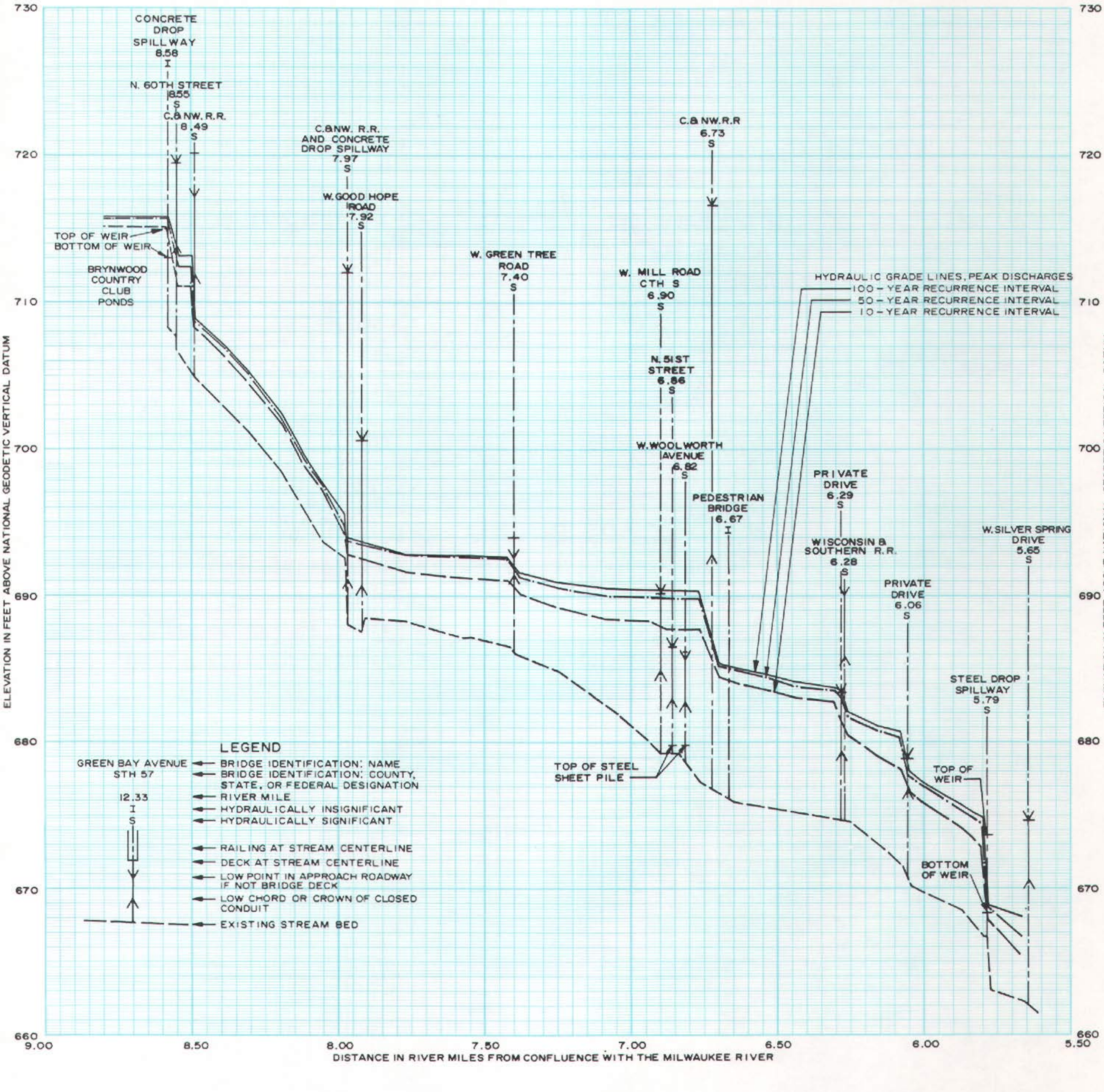


Figure 7 (continued)

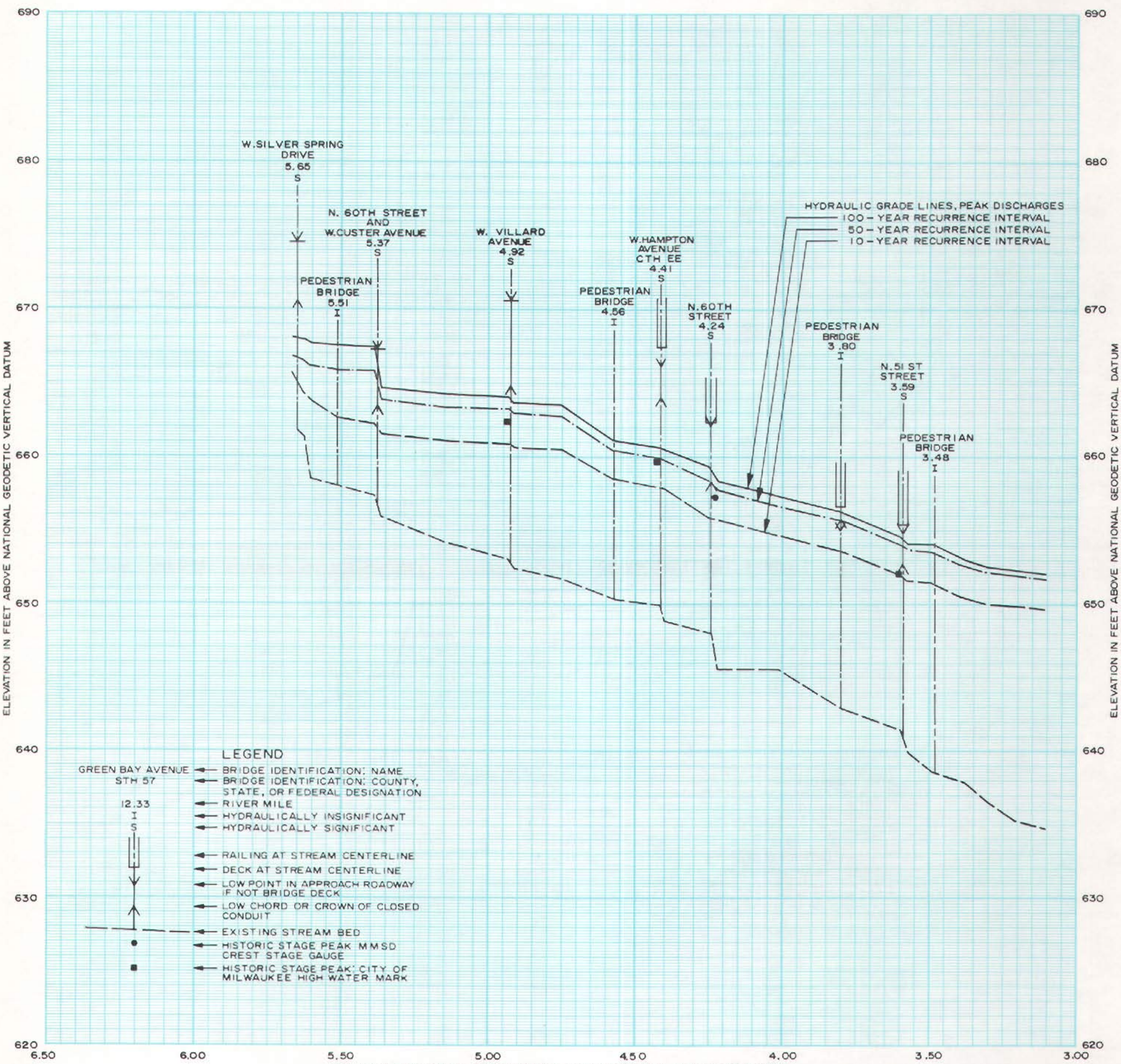
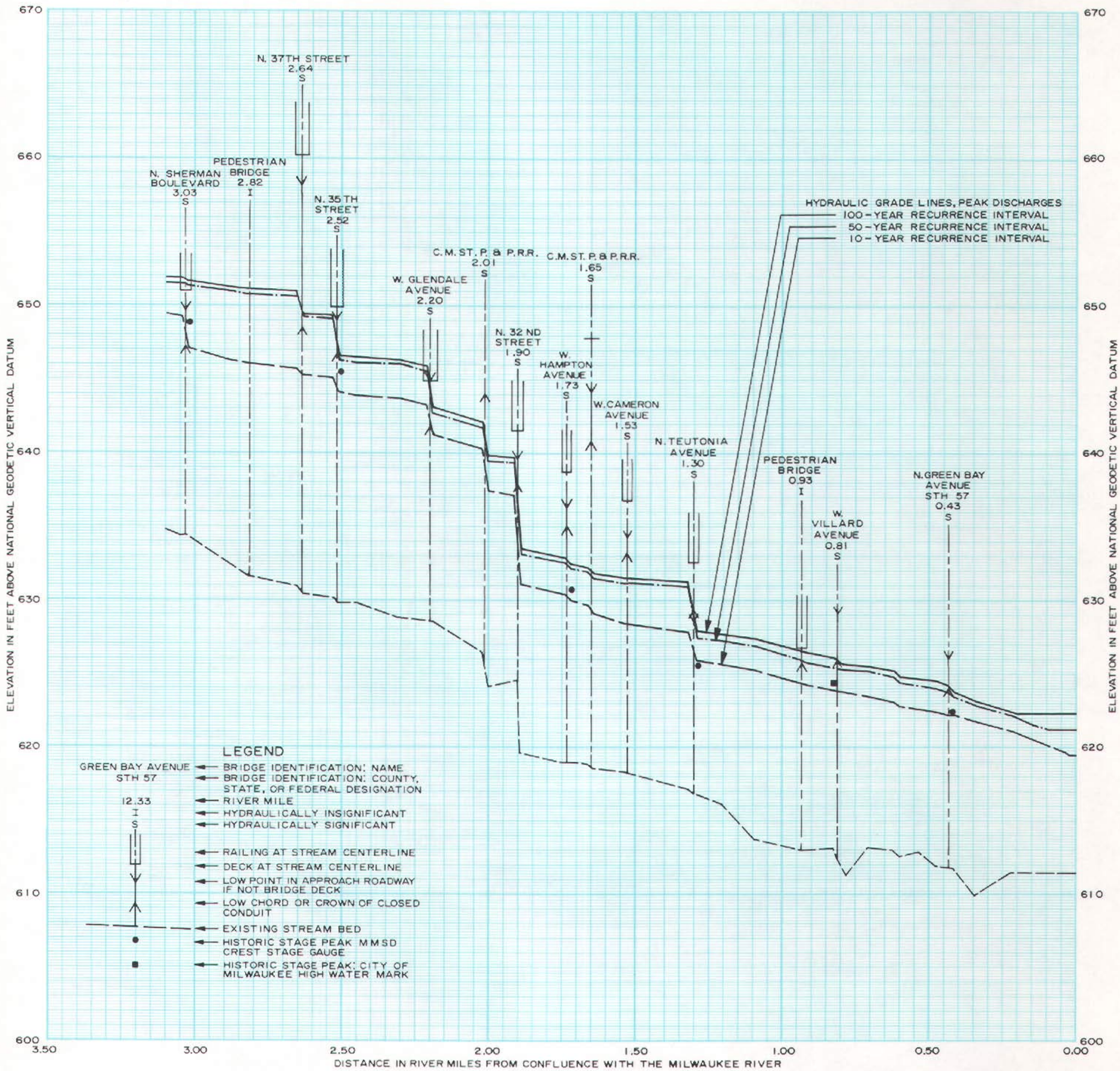


Figure 7 (continued)



Source: SEWRPC.

Figure 8

FLOOD STAGE PROFILES FOR LINCOLN CREEK UNDER PLANNED LAND USE: 2000 AND EXISTING CHANNEL CONDITIONS: 1975

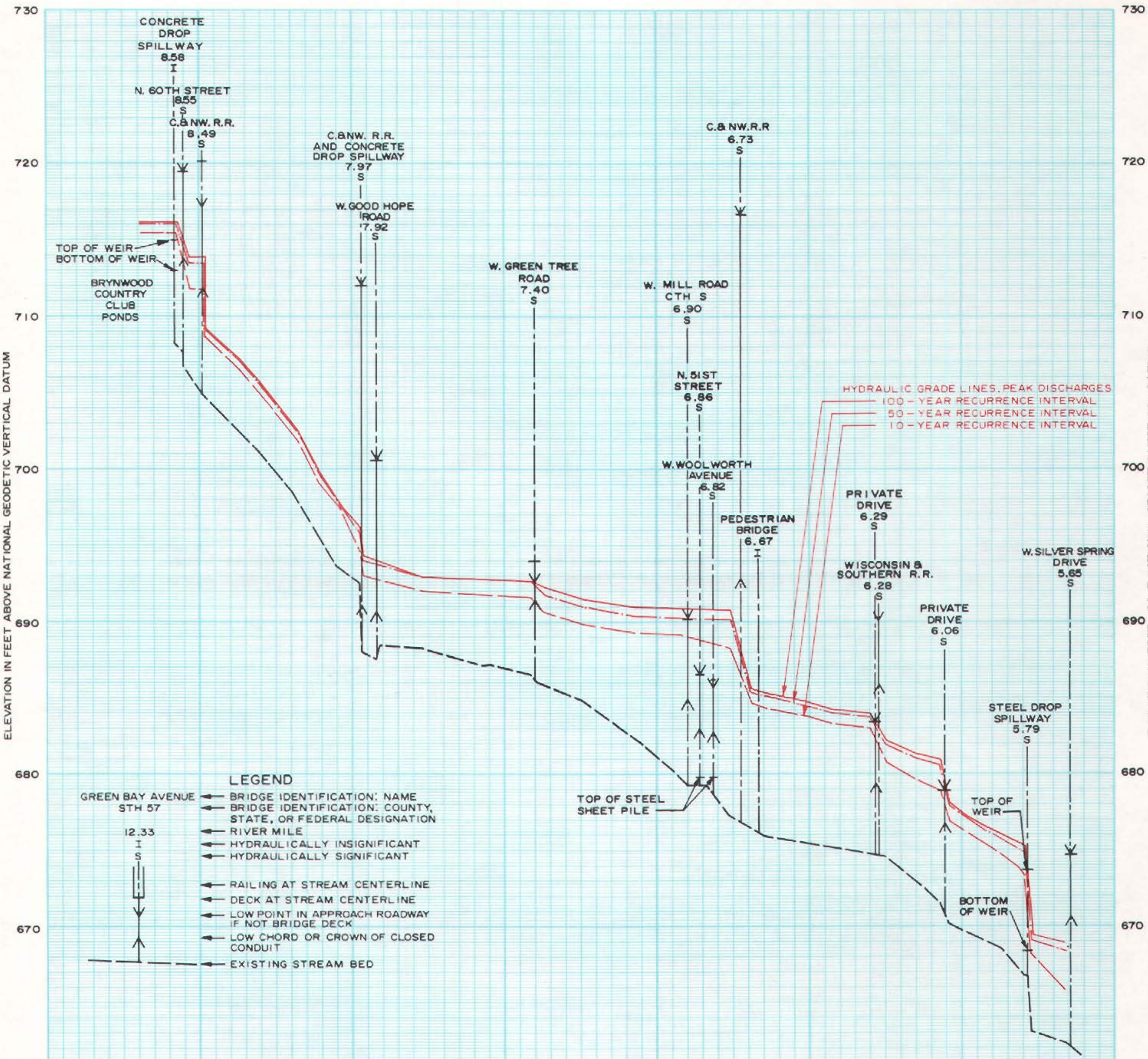
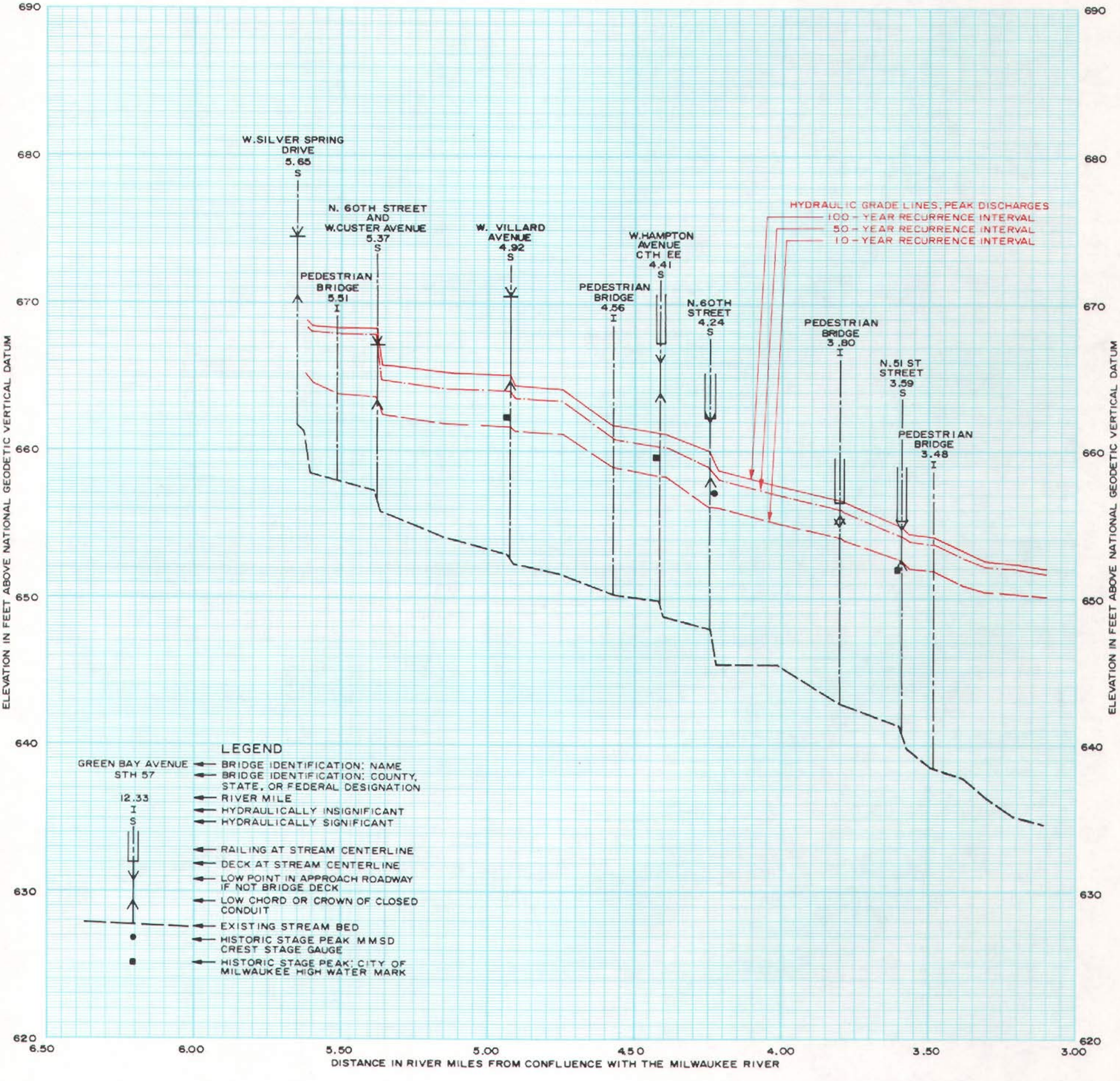


Figure 8 (continued)



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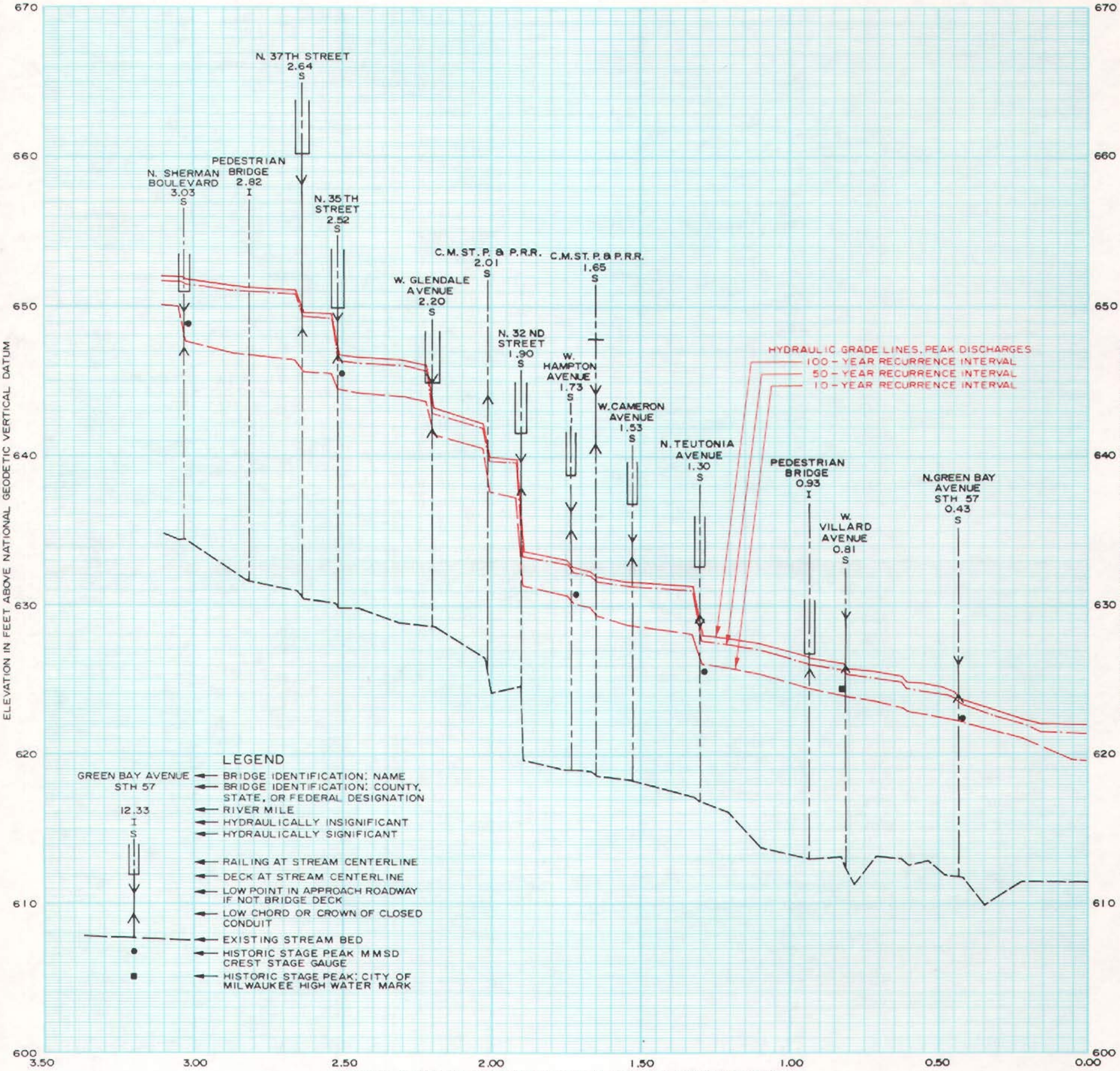


Source: SEWRPC.

Table 9

COMPARISON OF SUPERSEDED AND REVISED FLOOD STAGES FOR LINCOLN CREEK FOR EXISTING LAND USE AND CHANNEL CONDITIONS

River Mile	Structure Name or Location	100-Year	
		Revised	Superseded[a]
0.42	--	623.7	624.5
0.43	N. Green Bay Avenue	--	--
0.71	--	625.5	626.7
0.81	W. Villard Avenue	--	--
0.92	--	626.5	627.9
0.93	Pedestrian Bridge	--	--
1.20	--	627.8	629.1
1.30	Teutonia Avenue	--	--
1.32	--	631.3	632.2
1.53	Cameron Avenue	--	--
1.64	--	631.9	633.2
1.65	Chicago, Milwaukee, St. Paul & Pacific Railroad	--	--
1.72	--	632.6	634.5
1.73	Hampton Avenue	--	--
1.89	--	633.6	635.4
1.90	N. 32nd Street	--	--
2.00	--	639.9	640.8
2.01	Chicago, Milwaukee, St. Paul & Pacific Railroad	--	--
2.19	--	643.2	645.4
2.20	W. Glendale Avenue	--	--
2.30	--	646.4	647.7
2.52	N. 35th Street	--	--
2.63	--	649.5	650.4
2.64	N. 37th Street	--	--
2.82	--	651.3	653.5
3.02	--	651.8	653.8
3.03	N. Sherman Boulevard	--	--
3.11	--	652.0	654.4
3.39	--	653.0	654.7
3.59	N. 51st Street	--	--
3.60	--	654.6	655.3
3.79	Pedestrian Bridge	--	--
4.02	--	657.3	657.5
4.24	N. 60th Street	--	--
4.40	--	660.5	660.0
4.41	W. Hampton Avenue	--	--
4.57	--	661.1	661.3
4.92	W. Villard Avenue	--	--
5.14	--	664.2	664.8
5.37	W. Custer Avenue	--	--
5.51	--	667.5	668.4
5.65	W. Silver Spring Drive	--	--
5.78	--	669.0	670.2
5.79	Steel Drop Spillway	--	--
6.06	Private Road	--	--
6.08	--	680.8	685.4
6.28	Wisconsin & Southern Railroad	--	--
6.29	Private Road	--	--
6.31	--	683.8	688.3
6.73	Chicago & North Western Railway	--	--
6.77	--	690.4	694.5
6.82	Woolworth Avenue	--	--
6.86	N. 51st Street	--	--
6.90	W. Mill Road	--	--
6.94	--	690.5	694.5
7.40	W. Green Tree Road	--	--
7.42	--	692.7	695.5

[a] Flood stages as presented in the federal flood insurance study for the City of Milwaukee for Lower Lincoln Creek downstream of W. Silver Spring Drive, and as presented in the first edition of this report for Upper Lincoln Creek upstream of W. Silver Spring Drive.

Source: Federal Flood Insurance Study and SEWRPC.

Table 10

SUMMARY OF HYDROLOGIC-HYDRAULIC FLOOD DATA FOR HYDRAULIC STRUCTURES ON LINCOLN CREEK FOR THE YEAR 2000 PLAN LAND USE AND EXISTING CHANNEL CONDITIONS

Structure Identification			10-Year Recurrence Interval Flood				
Name	River Mile	Structure Type[a]	Instantaneous Peak Discharge (cubic feet per second)	Upstream Stage (feet above mean sea level)	Downstream Stage (feet above mean sea level)	Headloss[b] (feet)	Road Inundated
N. Green Bay Avenue	0.43	1	5,410	622.3	622.2	0.1	No
W. Villard Avenue	0.81	1	4,740	624.0	623.9	0.1	No
N. Teutonia Avenue	1.30	1	4,740	628.1	626.1	2.0	No
W. Cameron Avenue	1.53	1	4,580	628.8	628.8	--	No
Chicago, Milwaukee, St. Paul & Pacific Railroad	1.65	1	4,580	629.9	629.3	0.6	No
W. Hampton Avenue	1.73	1	4,580	630.6	630.2	0.4	No
N. 32nd Street	1.90	1	4,580	637.2	631.3	5.9[c]	No
Chicago, Milwaukee, St. Paul & Pacific Railroad	2.01	1	4,580	640.5	637.6	2.9	No
W. Glendale Avenue	2.20	1	4,580	643.6	641.4	2.2	No
N. 35th Street	2.52	1	3,730	645.5	644.4	1.1	No
N. 37th Street	2.64	1	3,730	646.4	645.6	0.8	No
N. Sherman Boulevard	3.03	1	3,870	650.0	647.6	2.4	Yes
N. 51st Street	3.59	1	4,020	652.6	652.0	0.6	No
N. 60th Street	4.24	1	3,190	656.2	656.1	0.1	No
W. Hampton Avenue	4.41	1	3,190	658.2	658.2	--	No
W. Villard Avenue	4.92	2	1,130	661.6	661.3	0.3	No
N. 60th Street and W. Custer Avenue	5.37	2	1,130	663.6	662.4	1.2	No
W. Silver Spring Drive	5.65	2	530	665.9	665.2	0.7	No
Steel Drop Spillway	5.79	3	530	673.4	668.4	--	--
Private Road	6.06	2	500	679.0	677.0	2.0	Yes
Wisconsin & Southern Railroad	6.28	2	440	681.9	680.9	1.0	No
Private Road	6.29	2	440	683.1	681.9	1.2	Yes
Chicago & North Western Railway	6.73	2	460	688.3	684.8	3.5	No
W. Woolworth Avenue	6.82	2	660	688.3	688.3	--	Yes
N. 51st Street	6.86	2	660	688.3	688.3	--	Yes
W. Mill Road	6.90	2	660	689.2	688.3	0.9	No
W. Green Tree Road	7.40	2	260	691.6	690.7	0.9	No
W. Good Hope Road, Chicago & North Western Railway, and Concrete Drop Spillway	7.92	2,3	210	694.6	692.7	1.9	No
Chicago & North Western Railway	8.49	2	210	711.7	707.9	3.8	No
N. 60th Street	8.55	2	210	713.1	711.7	1.4	No

Table 10 (continued)

Structure Identification			50-Year Recurrence Interval Flood				
Name	River Mile	Structure Type[a]	Instantaneous Peak Discharge (cubic feet per second)	Upstream Stage (feet above mean sea level)	Downstream Stage (feet above mean sea level)	Headloss[b] (feet)	Road Inundated
N. Green Bay Avenue...............	0.43	1	7,370	623.8	623.4	0.4	No
W. Villard Avenue................	0.81	1	6,120	625.7	625.3	0.4	No
N. Teutonia Avenue...............	1.30	1	6,120	631.0	627.6	3.4	Yes
W. Cameron Avenue................	1.53	1	5,840	631.4	631.4	--	No
Chicago, Milwaukee, St. Paul & Pacific Railroad..............	1.65	1	5,840	632.0	631.6	0.4	No
W. Hampton Avenue................	1.73	1	5,840	632.7	632.2	0.5	No
N. 32nd Street...................	1.90	1	5,840	639.5	633.2	6.3[c]	Yes
Chicago, Milwaukee, St. Paul & Pacific Railroad	2.01	1	5,840	641.8	639.8	2.0	No
W. Glendale Avenue	2.20	1	5,840	645.7	642.8	2.9	Yes
N. 35th Street	2.52	1	4,530	649.2	646.4	2.8	Yes
N. 37th Street	2.64	1	4,530	650.8	649.3	1.5	No
N. Sherman Boulevard	3.03	1	4,790	651.7	651.4	0.3	Yes
N. 51st Street...................	3.59	1	6,290	654.3	653.8	0.5	Yes
N. 60th Street...................	4.24	1	5,000	658.8	658.0	0.8	No
W. Hampton Avenue................	4.41	1	5,000	660.2	660.2	--	No
W. Villard Avenue................	4.92	2	1,820	664.0	663.5	0.5	No
N. 60th Street and W. Custer Avenue................	5.37	2	1,820	667.8	664.7	3.1	Yes
W. Silver Spring Drive...........	5.65	2	770	668.5	668.3	0.2	No
Steel Drop Spillway..............	5.79	3	770	674.9	669.3	--	--
Private Road.....................	6.06	2	720	680.7	678.0	2.7	Yes
Wisconsin & Southern Railroad.....	6.28	2	640	683.4	682.0	1.4	No
Private Road.....................	6.29	2	640	683.8	683.4	0.4	Yes
Chicago & North Western Railway ..	6.73	2	640	690.2	685.4	4.8	No
W. Woolworth Avenue..............	6.82	2	1,110	690.2	690.2	--	Yes
N. 51st Street...................	6.86	2	1,110	690.2	690.2	--	Yes
W. Mill Road.....................	6.90	2	1,110	690.3	690.2	0.1	Yes
W. Green Tree Road...............	7.40	2	380	692.7	691.8	0.9	Yes
W. Good Hope Road, Chicago & North Western Railway, and Concrete Drop Spillway.......	7.92	2,3	290	695.8	693.6	2.2	No
Chicago & North Western Railway...	8.49	2	290	713.4	708.4	5.0	No
N. 60th Street...................	8.55	2	290	715.0	713.4	1.6	No

Table 10 (continued)

Structure Identification			100-Year Recurrence Interval Flood				
Name	River Mile	Structure Type[a]	Instantaneous Peak Discharge (cubic feet per second)	Upstream Stage (feet above mean sea level)	Downstream Stage (feet above mean sea level)	Headloss[b] (feet)	Road Inundated
N. Green Bay Avenue	0.43	1	7,970	624.2	623.7	0.5	No
W. Villard Avenue	0.81	1	6,510	626.1	625.7	0.4	No
N. Teutonia Avenue	1.30	1	6,510	631.3	628.0	3.3	Yes
W. Cameron Avenue	1.53	1	6,160	631.6	631.6	--	No
Chicago, Milwaukee, St. Paul & Pacific Railroad	1.65	1	6,160	632.3	631.9	0.4	No
W. Hampton Avenue	1.73	1	6,160	633.0	632.6	0.4	No
N. 32nd Street	1.90	1	6,160	639.8	633.6	6.2[c]	Yes
Chicago, Milwaukee, St. Paul & Pacific Railroad	2.01	1	6,160	642.2	640.1	2.1	No
W. Glendale Avenue	2.20	1	6,160	646.0	643.2	2.8	Yes
N. 35th Street	2.52	1	4,600	649.4	646.7	2.7	Yes
N. 37th Street	2.64	1	4,600	651.1	649.5	1.6	No
N. Sherman Boulevard	3.03	1	5,060	652.0	651.8	0.2	Yes
N. 51st Street	3.59	1	7,340	654.9	654.3	0.6	Yes
N. 60th Street	4.24	1	5,860	660.0	658.6	1.4	No
W. Hampton Avenue	4.41	1	5,860	661.1	661.1	--	No
W. Villard Avenue	4.92	2	2,160	665.1	664.3	0.8	No
N. 60th Street and W. Custer Avenue	5.37	2	2,160	668.3	665.8	2.5	Yes
W. Silver Spring Drive	5.65	2	840	669.0	668.8	0.2	No
Steel Drop Spillway	5.79	3	840	675.4	669.7	--	--
Private Road	6.06	2	780	681.0	678.2	2.8	Yes
Wisconsin & Southern Railroad	6.28	2	690	683.8	682.3	1.5	No
Private Road	6.29	2	690	684.0	683.8	0.2	Yes
Chicago & North Western Railway	6.73	2	700	690.8	685.6	5.2	No
W. Woolworth Avenue	6.82	2	1,330	690.8	690.8	--	Yes
N. 51st Street	6.86	2	1,330	690.8	690.8	--	Yes
W. Mill Road	6.90	2	1,330	690.9	690.8	0.1	Yes
W. Green Tree Road	7.40	2	400	692.7	692.3	0.4	Yes
W. Good Hope Road, Chicago & North Western Railway, and Concrete Drop Spillway	7.92	2,3	310	696.3	693.9	2.4	No
Chicago & North Western Railway	8.49	2	310	713.8	708.5	5.3	No
N. 60th Street	8.55	2	310	715.7	713.8	1.9	No

[a]Structure codes are as follows: 1 - bridge; 2 - culvert; 3 - sill, drop structure, or weir.

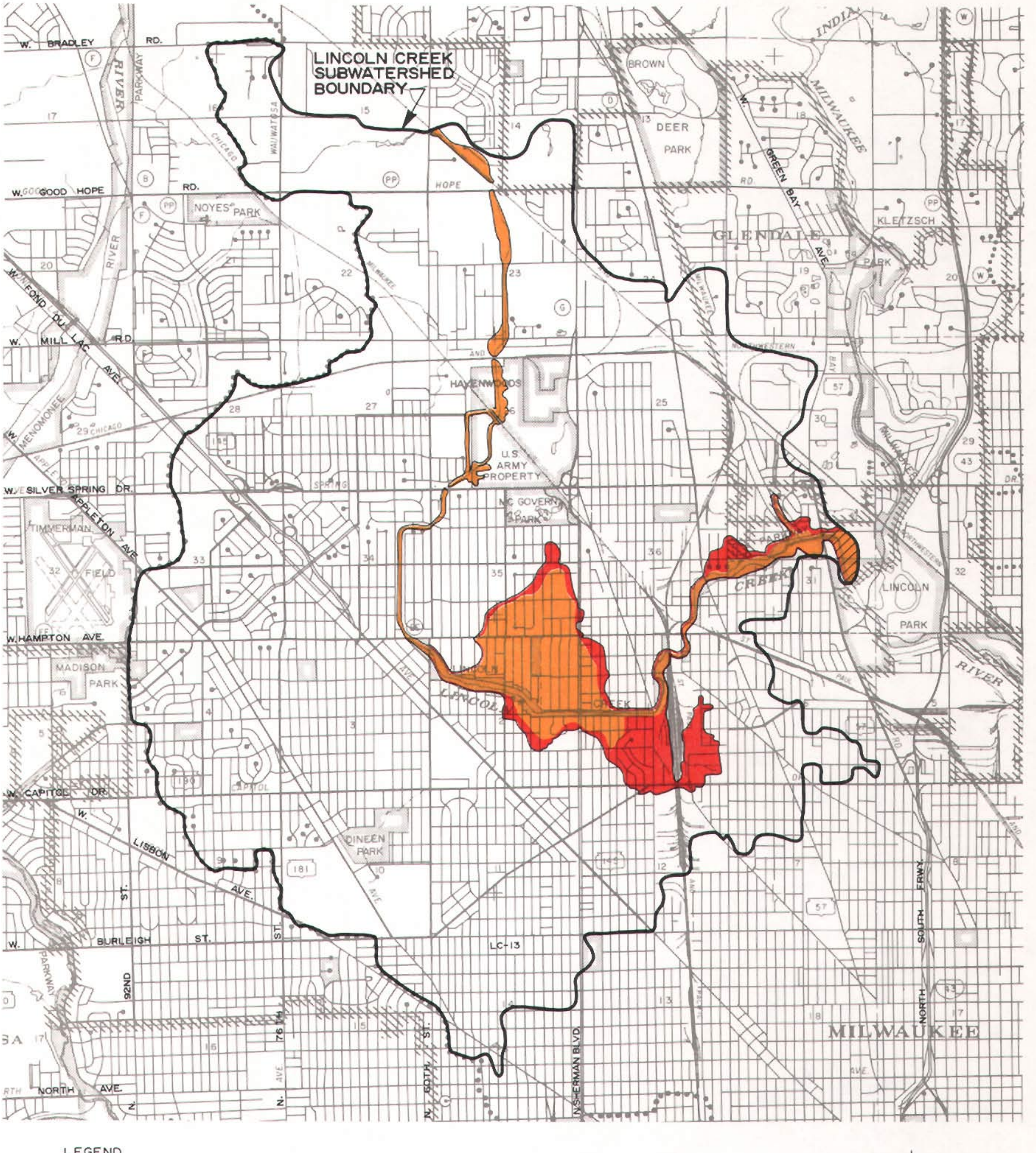
[b]Headloss is defined as the change in stage from the upstream side of the hydraulic structure to the downstream side.

[c]There is a change in streambed elevation of approximately five feet from the upstream to the downstream side of the N. 32nd Street bridge caused by a drop structure at this location.

Source: SEWRPC.

Map 8

COMPARISON OF REVISED 100-YEAR RECURRENCE INTERVAL FLOODPLAIN WITH FLOOD INSURANCE STUDY FLOODPLAIN FOR LINCOLN CREEK IN THE CITY OF MILWAUKEE



LEGEND

REVISED 100-YEAR FLOODPLAIN BOUNDARY FOR EXISTING CHANNELS AND YEAR 2000 LAND USE

FLOOD INSURANCE STUDY 100-YEAR FLOODPLAIN BOUNDARY FOR EXISTING CHANNELS AND YEAR 1975 LAND USE

AREA SUBJECT TO FLOODING FROM BOTH LINCOLN CREEK AND THE MILWAUKEE RIVER. DAMAGES FOR THIS REACH NOT INCLUDED IN THE ECONOMIC STUDY

Source: SEWRPC.

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Chapter VII

FLOOD PROBLEMS AND DAMAGES

INTRODUCTION

One useful way to quantify the relative effect of land use changes on flood problems is to compare average annual flood damages to structures and their contents under various land use patterns. Average annual flood damages are a measure of land use influences, since such damages reflect the full range of flood severity--in this case, the 10- through 100-year recurrence interval flood events.

Flood damages and other damages attributable to high water levels in the channel were assessed for both the upper and lower portions of Lincoln Creek. These damages included flooding of buildings and lawns, sewer backup into basements, and flooding of public streets and highways.

These damages are considered direct losses, as monetary expenditures are necessary to restore the flood-damaged property. Indirect damages such as the cost of flood-fighting, the loss of wages and sales, evacuation and relocation, and transportation detours were excluded in this analysis. Depreciation losses and intangible losses were also excluded, thereby making the estimate of flood damages quite conservative.

The damages computed for the individual flood events were then integrated to obtain monetary flood damages on an average annual basis. While experience has indicated that the monetary flood damage totals computed by these procedures accurately approximate actual flood damage costs, they are, as already noted, quite conservative; that is, they may be expected to be somewhat lower than actual damage costs inasmuch as they pertain only to principal structures and their contents, and do not reflect damage to public property and post-flood cleanup and other costs incurred by local units of government.

BASEMENT FLOODING

Basement flooding due to sewer backup has historically been a serious problem in certain areas of the Lincoln Creek subwatershed. In most instances, basement flooding has been caused by the surcharging of separate sanitary sewers primarily due to the excessive amounts of clear water entering these sewers.

Although this portion of the City of Milwaukee has separate sanitary and storm sewer systems, there are means by which significant amounts of storm water and snowmelt runoff--clear water--find access to the sanitary sewer system and ultimately, through the surcharging of the sewers, to the basements of structures scattered throughout the developed urban areas of the subwatershed. Storm water and snowmelt runoff commonly gain access to sanitary sewer systems via vent holes and other openings in sanitary sewer system manhole covers, via roof and street drains connected directly to the sanitary sewers, and via sanitary sewer bypasses to storm sewers and to Lincoln Creek. Clear water may also enter sanitary sewer systems by indirect routes such as infiltration from the land surface through the ground and into cracks and other openings in the sanitary sewers, and infiltration into structure foundation drains which are, in turn, connected to the sanitary sewer system, as was common practice in the past.

This report does not directly address the resolution of the basement flooding problem in the subwatershed as caused by sanitary sewer backup. A separate program administered by the City Engineer addresses this problem. However, to the extent that overland flooding from Lincoln Creek contributes to the surcharge of sanitary sewers, the flood control recommendations made in this report will abate the indirect basement flooding problem.

DAMAGE ANALYSIS PROCEDURE

The elevation of the floodwaters was determined from the water surface profiles prepared under the study as explained in Chapter VI. These elevations were determined for the 10-, 50-, and 100-year recurrence interval flood events under existing channel conditions, and under both existing land use and plan design year 2000 land use conditions. This information provides a basis for determining the costs of flooding, should a decision be made to retain the channel in its present condition. All proposed alternative plans were then compared to this "do nothing" alternative.

Areas inundated by flood flows were delineated on Commission 1980 1" = 400' scale ratioed and rectified aerial photographs. A determination was then made of the number of buildings flooded and the approximate depth to which they could be expected to be inundated based upon topographic data collected by the U. S. Geological Survey and upon street grade elevations determined by the City of Milwaukee.

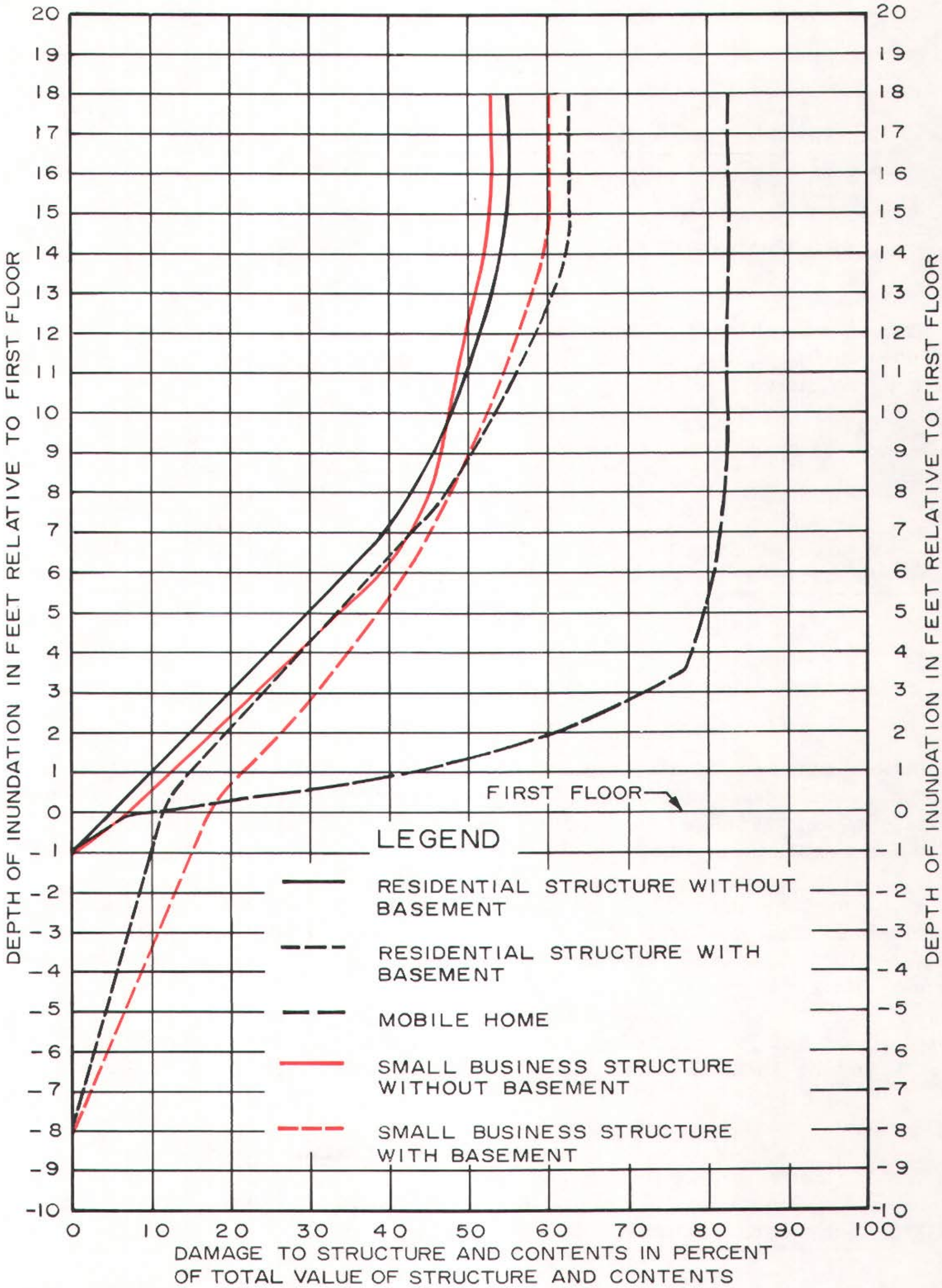
Costs of flooding were then estimated using damage cost curves prepared by the Commission (see Figure 9). These curves were used to estimate flooding costs entailing residential, industrial, and commercial buildings, and residential basement flooding caused by sewer backup and by flow through basement windows and seepage through basement walls. The dollar amount of flooding is based upon the depth of inundation and the assessed valuation of the building. Damages to building contents were included. All dollar amounts were expressed in terms of 1980 dollars.

An example of the method used to estimate the flooding cost of a single-family residence with basement is as follows:

Assessed value of home....................	$30,000
Less value of lot.........................	7,000
Net value of home.........................	23,000
Value of contents (30 percent)...........	6,900
Net value of home and contents...........	29,900
Percent loss for two-foot inundation above first-floor level from damage curves................	17.5
Total estimated flood loss	$ 5,232

Figure 9

DEPTH-DAMAGE CURVES FOR SELECTED STRUCTURES



Source: Federal Insurance Administration and SEWRPC.

Flooding, as indicated herein, includes basement flooding, yard inundation, and flooding above the first-floor level. The total number of existing residences that may be expected to experience direct flooding in the Upper Lincoln Creek subwatershed is as follows:

Flood Event Recurrence Interval	Number of Existing Homes Flooded: Existing Land Use Conditions	Number of Existing Homes Flooded: Year 2000 Land Use Conditions
100-Year	15	16
50-Year	15	15
10-Year	7	8

The number of existing industrial and commercial properties that may be expected to experience direct flooding in the Upper Lincoln Creek subwatershed is as follows:

Flood Event Recurrence Interval	Number of Existing Industries and Businesses Flooded: Existing Land Use Conditions	Number of Existing Industries and Businesses Flooded: Year 2000 Land Use Conditions
100-Year	6	9
50-Year	5	6
10-Year	2	5

Many homes and some industrial and commercial properties in addition to the residences and industrial and commercial properties listed above may be expected to experience indirect flood damages through sewer backup during a 100-year recurrence interval flood event.

The total average annual flood losses--damages--for the Upper Lincoln Creek subwatershed from N. 76th Street to W. Silver Spring Drive are estimated at $17,900 under existing land use conditions, and $32,300 under year 2000 land use conditions.

The total number of existing residences that may be expected to experience direct flooding in the Lower Lincoln Creek subwatershed is as follows:

Flood Event Recurrence Interval	Number of Existing Homes Flooded: Existing Land Use Conditions	Number of Existing Homes Flooded: Year 2000 Land Use Conditions
100-Year	1,450	1,595
50-Year	897	1,110
10-Year	77	114

The total number of existing industrial and commercial properties that may be expected to experience direct flooding in the Lower Lincoln Creek subwatershed is as follows:

Flood Event Recurrence Interval	Number of Existing Industries and Businesses Flooded: Existing Land Use Conditions	Number of Existing Industries and Businesses Flooded: Year 2000 Land Use Conditions
100-Year	23	26
50-Year	14	17
10-Year	1	3

Many additional homes and some industrial and commercial properties in addition to the residences and industrial and commercial properties listed above may be expected to experience indirect flood damages through sewer backup during a 100-year recurrence interval flood event.

The total average annual flood losses--damages--for the Lower Lincoln Creek subwatershed from W. Silver Spring Drive to its confluence with the Milwaukee River are estimated at $600,000 under existing land use conditions, and $805,000 under year 2000 land use conditions. It should be noted that an estimated $156,000 and $188,000, respectively, of the total annual flood damages under existing and year 2000 land use conditions are associated with a small area located in the extreme lower reaches of the subwatershed which would experience flood damages of about the same magnitude from Milwaukee River floods. The recommendations in this report would not abate these damages. The Milwaukee River watershed study recommended that all existing homes and other major structures located in the floodplains of the Milwaukee River watershed that are not subject to first-floor inundation by the 100-year recurrence interval flood and that lie outside the floodway be floodproofed as a condition of continued occupancy of the floodplains. Thus, those houses located in the area of the Lincoln Creek subwatershed subjected to flooding from the Milwaukee River main stem that would be flooded above the first-floor elevation should be elevated or removed.

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Chapter VIII

ALTERNATIVE FLOOD CONTROL PLANS

INTRODUCTION

In an effort to identify the best means of abating the flood problems of the Lincoln Creek subwatershed, the Commission examined five distinctly different flood control alternatives for the upper subwatershed, including a "no action" alternative, and four different alternatives for the lower subwatershed, also including a "no action" alternative. These alternatives were selected so as to encompass a range of practically available structural and nonstructural flood control measures. Each of the alternatives was first analyzed--consistent with good water resources planning procedures--in sufficient detail to determine if it was technically feasible--that is, not only physically capable of implementation, but also capable of achieving a significant reduction in flood damages. Capital and operation and maintenance costs were then developed for the technically feasible alternatives to a level of detail needed to make economic comparisons between such alternatives.

UPPER LINCOLN CREEK SUBWATERSHED

Five alternative plans were considered for alleviating flood damages in the upper portion of the Lincoln Creek subwatershed, as listed below:

Alternative Plan 1--No Action
Alternative Plan 2--Limited Channelization
Alternative Plan 3--Floodwater Storage
Alternative Plan 4--Diking
Alternative Plan 5--Structure Floodproofing, Elevation, and Removal

Each alternative plan is discussed in the following sections, which include a description of each plan, a review of its technical feasibility, and, as necessary, a determination of its economic viability.

Alternative Plan 1--No Action

One alternative course of action to alleviate the flood problems of the Upper Lincoln Creek subwatershed is to do nothing--that is, to recognize the inevitability of extensive flooding but to decide not to mount a collective, coordinated program to abate the flood damages. Under future land use and existing stream channel conditions, the average annual flood damages in the subwatershed would approximate $32,300. Under existing land use and stream channel conditions, there is a 10 percent chance each year of flood damage to about eight residences and five businesses or industries located in the 10-year recurrence interval floodplain. In addition, flooded basements may be expected in many homes located outside but directly adjacent to the floodplain. There are no monetary benefits associated with this alternative, and the average annual cost would be equivalent to the average annual flood damage cost of $32,300. A brief description of this alternative and its attendant economic costs is provided in Table 11.

Table 11

COST ESTIMATES FOR FLOOD CONTROL ALTERNATIVES FOR THE LINCOLN CREEK SUBWATERSHED

Upper Lincoln Creek, Interest Rate = 6 Percent, 50-Year Period of Economic Analysis

Flood Control Alternative		Costs (dollars)					Benefit-Cost Analysis			
			Annual							
Number	Description	Capital	Amortized Capital	Operation and Maintenance	Other	Total	Annual Benefits (dollars)	Annual Benefits Minus Annual Costs (dollars)	Benefit-Cost Ratio	Economic Ratio Greater Than One
1	No Action.....................	--	--	--	32,300	32,300	--	-32,300	--	No
2	Limited Channelization........	329,600	20,800	500	--	21,300	32,300	11,000	1.52	Yes
3	Floodwater Storage............	523,000	32,900	1,100	--	34,000	32,300	- 1,700	0.95	No
4	Diking........................	404,000	25,500	700	--	26,200	32,300	6,100	1.23	Yes
5	Structure Floodproofing, Elevation, and Removal.......	407,000	25,800	--	--	25,800	32,300	6,500	1.25	Yes

Lower Lincoln Creek, Interest Rate = 6 Percent, 50-Year Period of Economic Analysis

Flood Control Alternative		Costs (dollars)					Benefit-Cost Analysis			
			Annual							
Number	Description	Capital	Amortized Capital	Operation and Maintenance	Other	Total	Annual Benefits (dollars)	Annual Benefits Minus Annual Costs (dollars)	Benefit-Cost Ratio	Economic Ratio Greater Than One
1	No Action.....................	--	--	--	617,000	617,000	--	-617,000	--	No
2	Major Channelization..........	9,591,600	604,000	6,000	--	610,000	617,000	7,000	1.01	Yes
3	Diking and Pumping............	12,115,600	763,000	14,000	--	777,000	617,000	-160,000	0.79	No
4	Structure Floodproofing, Elevation, and Removal.......	20,229,000	1,283,000	--	--	1,283,000	617,000	-666,000	0.48	No

Table 11 (continued)

Upper Lincoln Creek, Interest Rate = 10 Percent, 50-Year Period of Economic Analysis											
Flood Control Alternative		Costs (dollars)					Benefit-Cost Analysis				
			Annual								
Number	Description	Capital	Amortized Capital	Operation and Maintenance	Other	Total	Annual Benefits (dollars)	Annual Benefits Minus Annual Costs (dollars)	Benefit-Cost Ratio	Economic Ratio Greater Than One
1	No Action....................	--	--	--	32,300	32,300	--	-32,300	--	No
2	Limited Channelization.......	329,600	33,000	500	--	33,500	32,300	- 1,200	0.96	No
3	Floodwater Storage...........	523,000	52,300	1,100	--	53,400	32,300	-21,100	0.60	No
4	Diking......................	404,000	40,400	700	--	41,100	32,300	- 8,800	0.78	No
5	Structure Floodproofing, Elevation, and Removal......	407,000	40,700	--	--	40,700	32,300	- 8,400	0.79	No

Lower Lincoln Creek, Interest Rate = 10 Percent, 50-Year Period of Economic Analysis										
Flood Control Alternative		Costs (dollars)					Benefit-Cost Analysis			
			Annual							
Number	Description	Capital	Amortized Capital	Operation and Maintenance	Other	Total	Annual Benefits (dollars)	Annual Benefits Minus Annual Costs (dollars)	Benefit-Cost Ratio	Economic Ratio Greater Than One
1	No Action....................	--	--	--	617,000	617,000	--	- 617,000	--	No
2	Major Channelization.........	9,591,600	959,000	6,000	--	965,000	617,000	- 348,000	0.64	No
3	Diking and Pumping...........	12,115,600	1,212,000	14,000	--	1,226,000	617,000	- 609,000	0.50	No
4	Structure Floodproofing, Elevation, and Removal......	20,229,000	2,022,900	--	--	2,022,900	617,000	-1,405,900	0.30	No

Source: SEWRPC.

It is highly unlikely that a "no action" course should, or indeed can, be followed completely within this subwatershed, since it will become necessary to replace deteriorating culverts and bridges from time to time. If a particular deteriorated channel structure was known to constitute a severe restriction to flow, it should and probably would be replaced with a new structure having a larger waterway opening. Further, as flood flows and damages increased, demands from the residents of the flood-prone areas would very likely precipitate some collective action toward correcting the problems. Therefore, this alternative, although technically feasible, is probably not practical. It does, however, offer a basis for comparison for the other alternatives considered.

Alternative Plan 2--Limited Channelization

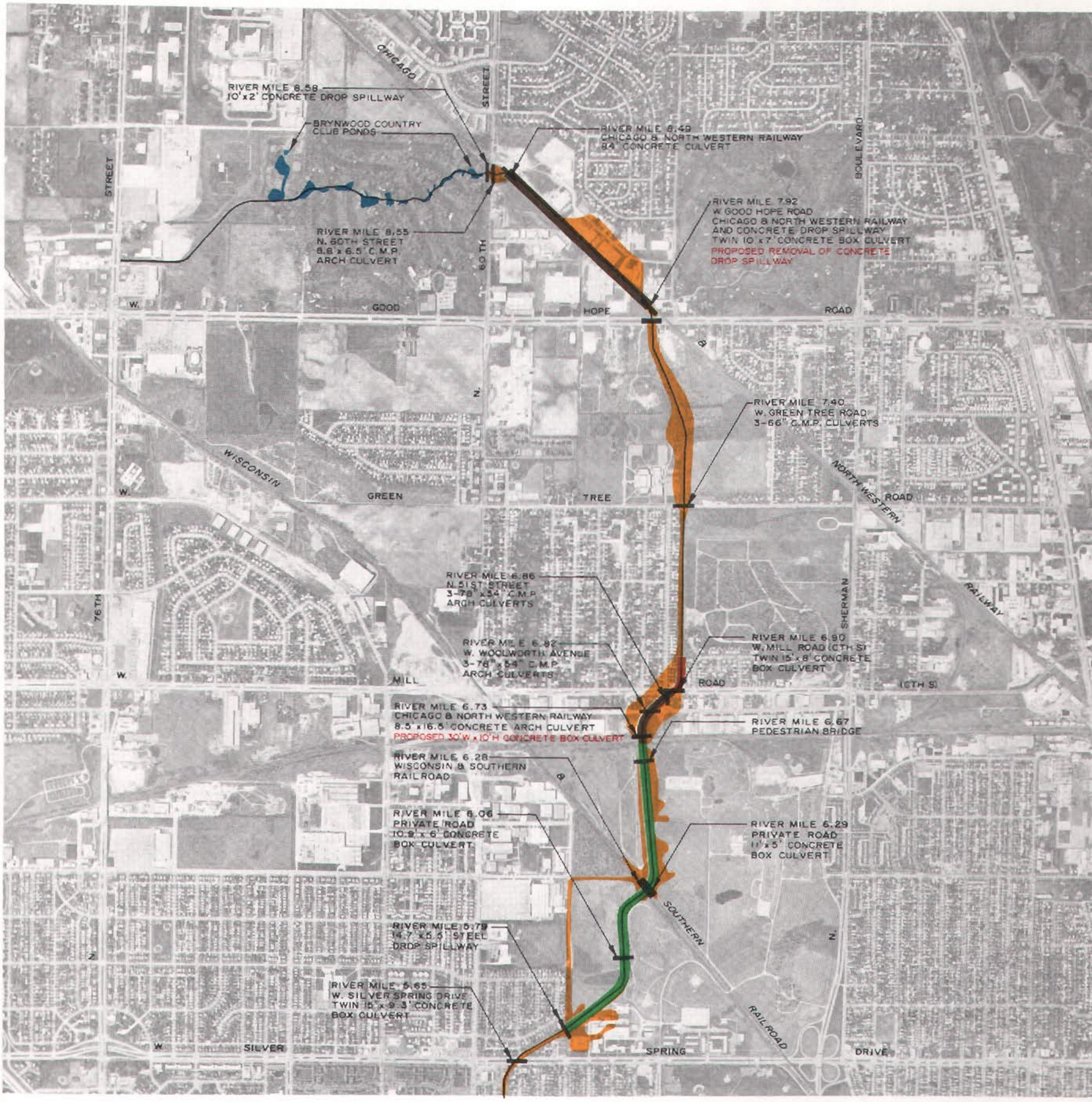
In highly urbanized areas channelization normally includes some or all of the following: channel straightening, a significant lowering of the channel profile, channel widening, placement of a concrete invert and sidewalls, and reconstruction or modification of selected bridges. These modifications yield a lower, hydraulically more efficient channel, the intended effect of which is to produce significantly lower flood stages in the channelized reach and upstream therefrom. While channelization can be an effective means of reducing flood damages, the intangible, but nevertheless real, aesthetic and ecological costs may be high. Moreover, care must be taken to assure that the channel improvements do not increase downstream peak flood discharges and stages and, thereby, aggravate downstream flood problems.

This alternative course of action for the resolution of the flood problems of the Upper Lincoln Creek subwatershed, shown on Map 9, would require cleaning and debrushing or other actions which would result in improved hydraulic efficiency of the channel reaches extending from the steel drop structure (River Mile 5.79) to the Chicago & North Western Railway (River Mile 6.73). The channel from approximately River Mile 6.69 to W. Woolworth Avenue (River Mile 6.82) would be gradually widened from a channel bottom width of approximately 15 feet at River Mile 6.69 to a channel bottom width of approximately 30 feet at W. Woolworth Avenue. The steel sheet piling on the upstream and downstream sides of W. Woolworth Avenue would be removed and the channel lowered to the existing culvert invert elevation. The lower channel invert would be continued upstream through N. 51st Street (River Mile 6.86) and W. Mill Road (River Mile 6.90), and would then be sloped to intersect the existing channel invert upstream of W. Mill Road. A total of approximately 80 feet of earthen diking would be required along the banks on the upstream side of the W. Mill Road structure. The dikes would have a maximum height of two feet and would contain the 100-year recurrence interval flood flows within the channel and prevent weir flow over W. Mill Road.

This alternative would also involve lowering the channel profile from the upstream side of the existing double-celled culvert under W. Good Hope Road and the Chicago & North Western Railway (River Mile 7.97) upstream to River Mile 8.40. The existing channel bottom would be lowered a maximum of about four feet at River Mile 7.97. The depth of excavation would gradually decrease until the existing channel profile was intersected at River Mile 8.40. In addition, the channel for the entire reach from River Mile 7.97 upstream to

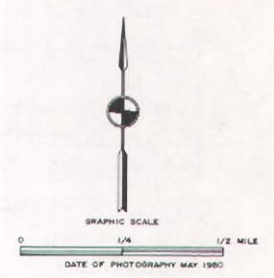
Map 9

ALTERNATIVE PLAN 2: LIMITED CHANNELIZATION IN THE UPPER LINCOLN CREEK SUBWATERSHED



LEGEND

- APPROXIMATE EXISTING CHANNEL CENTERLINE
- PROPOSED CHANNEL DEEPENING
- PROPOSED CHANNEL CLEANING AND DEBRUSHING
- PROPOSED EARTHEN DIKE
- 100-YEAR RECURRENCE INTERVAL FLOODPLAIN PLANNED LAND USE, EXISTING CHANNEL CONDITIONS



Source: SEWRPC.

the Chicago & North Western Railway culvert (River Mile 8.49) would be enlarged to a bottom width of approximately 16 feet, with channel side slopes varying from one on three to one on two, and would then be revegetated. This channel cross-section and grade change would be adequate to accommodate the 100-year recurrence interval flood flow with two feet of freeboard through the developed portion of the reach. As part of the channelization, the concrete drop structure at the entrance to the W. Good Hope Road-Chicago & North Western Railway structure (River Mile 7.97) would be removed.

Measures for providing adequate hydraulic capacity in Upper Lincoln Creek in addition to channelization include the removal of the existing 8.5 foot wide-by-16.5 foot high concrete arch culvert under the Chicago & North Western Railway (River Mile 6.73) and replacement with a 30 foot wide-by-10 foot high concrete box culvert. This culvert or one of equivalent capacity would accommodate the design flow with no appreciable headloss through the culvert.

Implementation of this alternative would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The average annual benefits of this alternative would approximate $32,300. The total capital cost of this plan would be $329,600. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $20,800. Operating and maintenance costs are estimated at $500 per year, bringing the total average annual cost to $21,300.

The ratio of the average annual benefit to the total average annual cost is 1.52, and the annual benefits exceed the annual costs by $11,000. Pertinent data on this alternative are presented in Table 11, which also presents data based on a 10 percent rate of return.

Alternative Plan 3--Floodwater Storage

The provision of floodwater storage to reduce peak flood discharges and stages entails the construction of flood detention reservoirs at strategic locations along a watercourse, or the utilization of existing natural floodplain storage areas by use of a restricted or controlled outlet. The function of a detention reservoir is to accept flood discharges from the upstream tributary watershed area, allowing the runoff to accumulate and temporarily raise the water level in the reservoir. An outlet structure, or spillway, releases the excess runoff from the detention reservoir at a predetermined, controlled or restricted rate. The rate of outflow is intended to be significantly lower than the inflow, thereby reducing peak discharges and flooding damages downstream from the detention site. Properly located and designed, detention reservoirs can significantly reduce peak flood discharges. The process of mathematically analyzing the inflow, outflow, and storage against time for a reservoir is known as flood-routing.

Flood detention reservoirs may be designed to be either "wet" or "dry"--that is, to contain or not contain a permanent pool of water after the runoff event is over. The advantage of "wet" detention reservoirs in general is that they may be designed for multiple uses such as wildlife ponds, water supply for fire protection, low streamflow augmentation, a variety of water-based recreational uses, and sediment retention. Multiple-use reservoirs must be very carefully planned and designed so that the various uses are fully compatible and the flood detention benefits are not impaired. "Dry" detention reservoirs are single purpose, less costly to construct, and more easily maintained.

The storage alternative for the Upper Lincoln Creek subwatershed, shown on Map 10, would provide for the construction of two detention reservoirs. One detention reservoir would be on a 16-acre site located between W. Good Hope Road and W. Green Tree Road. The proposed detention reservoir would be developed as a "dry" reservoir unless further studies and the expressed desires of local citizens indicate that the value to be derived from a multiple-purpose reservoir would warrant its construction. The reservoir dam would be constructed across the existing channel about 50 feet north of W. Green Tree Road, and would have an average height of about seven feet. The structure would be an earthen dam with an outlet spillway, which would consist of one four-foot diameter concrete pipe. A levee would be constructed along the eastern and northern boundaries of the Daniel Webster Junior High School property west of Lincoln Creek. The levee would extend from the dam upstream approximately 800 feet, and then westward an additional 700 feet to contain floodwaters in the reservoir without flooding the school property. The reservoir would have a maximum storage capacity of 84 acre-feet, and would serve to reduce the 100-year recurrence interval flood below W. Green Tree Road from 1,020 cubic feet per second (cfs) to 900 cfs.

There are 11 ponds on the Brynwood Country Club grounds, located immediately west of N. 60th Street. The ponds and adjacent floodlands would remain in their present condition and use. A new earthen dam and control spillway would be constructed at the outlet of the lowest pond to more effectively reduce flood discharges from the series of 11 ponds and increase floodwater storage. The outlet spillway would consist of a four-foot-diameter concrete pipe. This series of reservoirs would have a storage capacity of 48 acre-feet, and would serve to reduce the 100-year recurrence interval flood below N. 60th Street from 310 cfs to 190 cfs. It should be noted that the existing structures at W. Green Tree Road and N. 60th Street are hydrologically significant and reduce flows significantly.

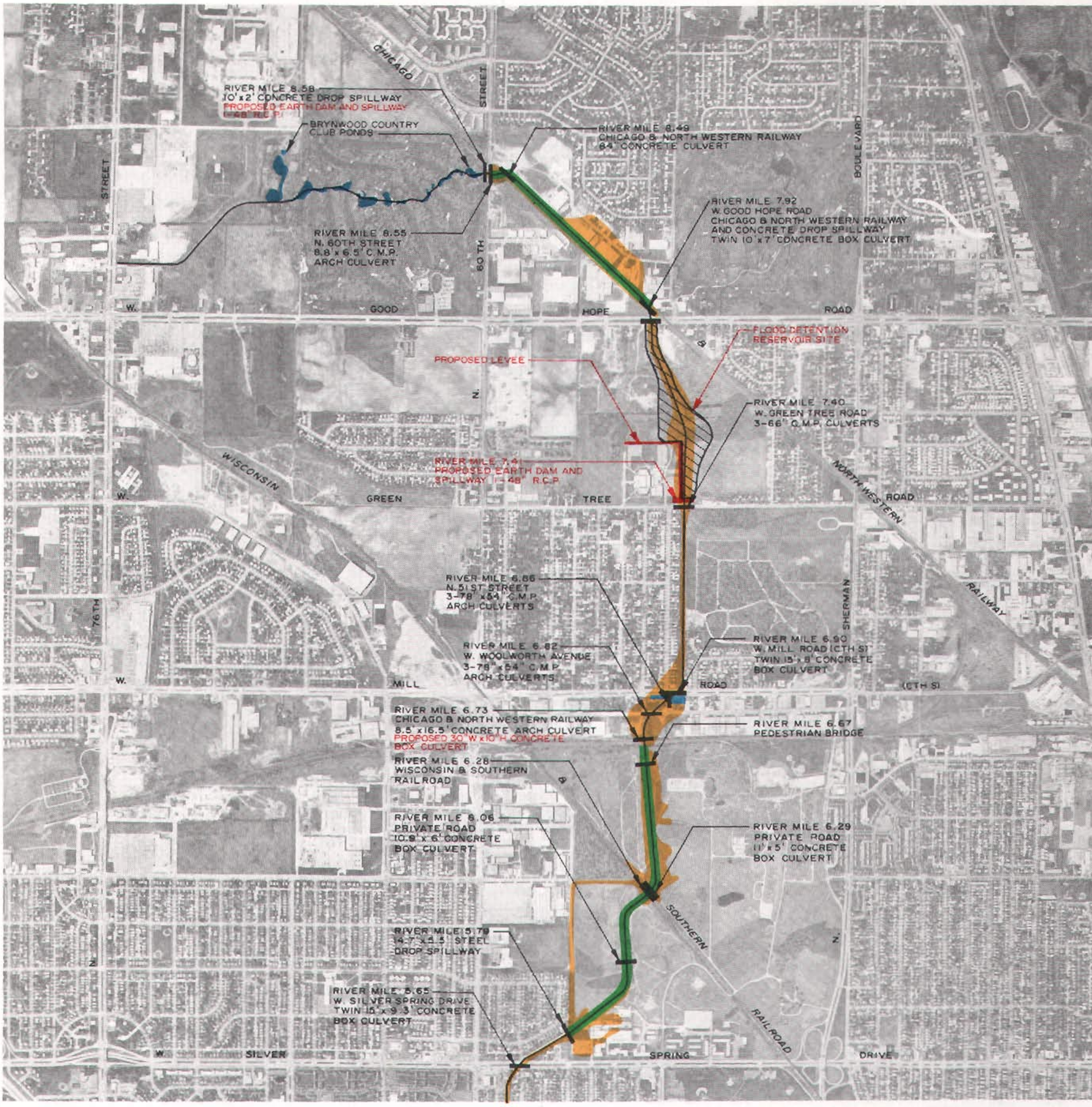
In addition to the proposed storage, cleaning and debrushing or other actions which would result in improved hydraulic efficiency would be required in the Lincoln Creek channel reaches extending from the steel drop structure (River Mile 5.79) to the Chicago & North Western Railway (River Mile 6.73) and between W. Good Hope Road and N. 60th Street to enhance the hydraulic capacity.

Also, in order to provide adequate hydraulic capacity, it would be necessary to remove the existing 8.5 foot wide-by-16.5 foot high concrete arch culvert under the Chicago & North Western Railway tracks (River Mile 6.73), and to replace it with a 30 foot wide-by-10 foot high concrete box culvert. This culvert, or one of equivalent capacity, would accommodate the design flow with no appreciable headloss through the culvert.

This alternative would also require the floodproofing of seven structures between W. Woolworth Avenue (River Mile 6.82) and W. Mill Road (River Mile 6.90). Implementation of this alternative would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The average annual benefits of this alternative would approximate $32,300. The

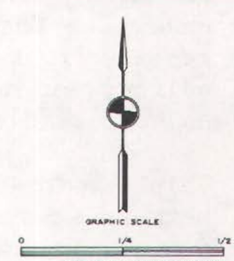
Map 10

ALTERNATIVE PLAN 3: FLOOD STORAGE IN THE UPPER LINCOLN CREEK SUBWATERSHED



LEGEND

- APPROXIMATE EXISTING CHANNEL CENTERLINE
- PROPOSED CHANNEL CLEANING AND DEBRUSHING
- PROPOSED STRUCTURE FLOODPROOFING
- 100-YEAR RECURRENCE INTERVAL FLOODPLAIN - PLANNED LAND USE, EXISTING CHANNEL CONDITIONS



Source: SEWRPC.

total capital cost of this plan, including land costs, would be $523,000. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $32,900. Operation and maintenance costs are estimated at $1,100 per year, bringing the total average annual cost to $34,000.

The ratio of the average annual benefit to the total average annual cost is 0.95, and the annual costs exceed the annual benefits by $1,700. Pertinent data on this alternative are presented in Table 11.

As part of the analyses conducted under this alternative, an analysis was made of the floodwater storage potential of a site in Havenwoods immediately upstream of the Wisconsin & Southern Railroad. The Wisconsin & Southern structure causes a moderate amount of floodwater storage because of its relatively small hydraulic capacity. No significant flood control benefit would be realized by providing additional floodwater storage at this site because flood damages between the site and W. Silver Spring Drive are minor for both existing and future land use conditions, and flood flows in the heavily urbanized reach downstream of W. Silver Spring Drive would not be significantly reduced by the provision of additional floodwater storage at the Havenwoods site.

Alternative Plan 4--Diking

Dikes constitute a practical structural flood control alternative for riverine areas in which flooding is primarily attributable to overbank flow. In such situations, dikes may be constructed between the river and the flood-prone areas so as to act as a physical barrier to the rising floodwaters, thereby preventing overbank flow into the urbanized portions of the floodlands. Dike installation usually requires supplemental facilities to intercept storm water runoff flowing toward the river from protected urban areas behind the dikes, and to temporarily store such runoff or pump it over the dikes into the diked stream channel. Dikes may be constructed of a number of materials, including concrete, steel sheet piling, and compacted earth. Earthen dikes are the least costly but require a considerable amount of land area adjacent to the channel to accommodate the side slopes and top width of the dike. Concrete and steel sheet piling dikes are applicable in more confined areas.

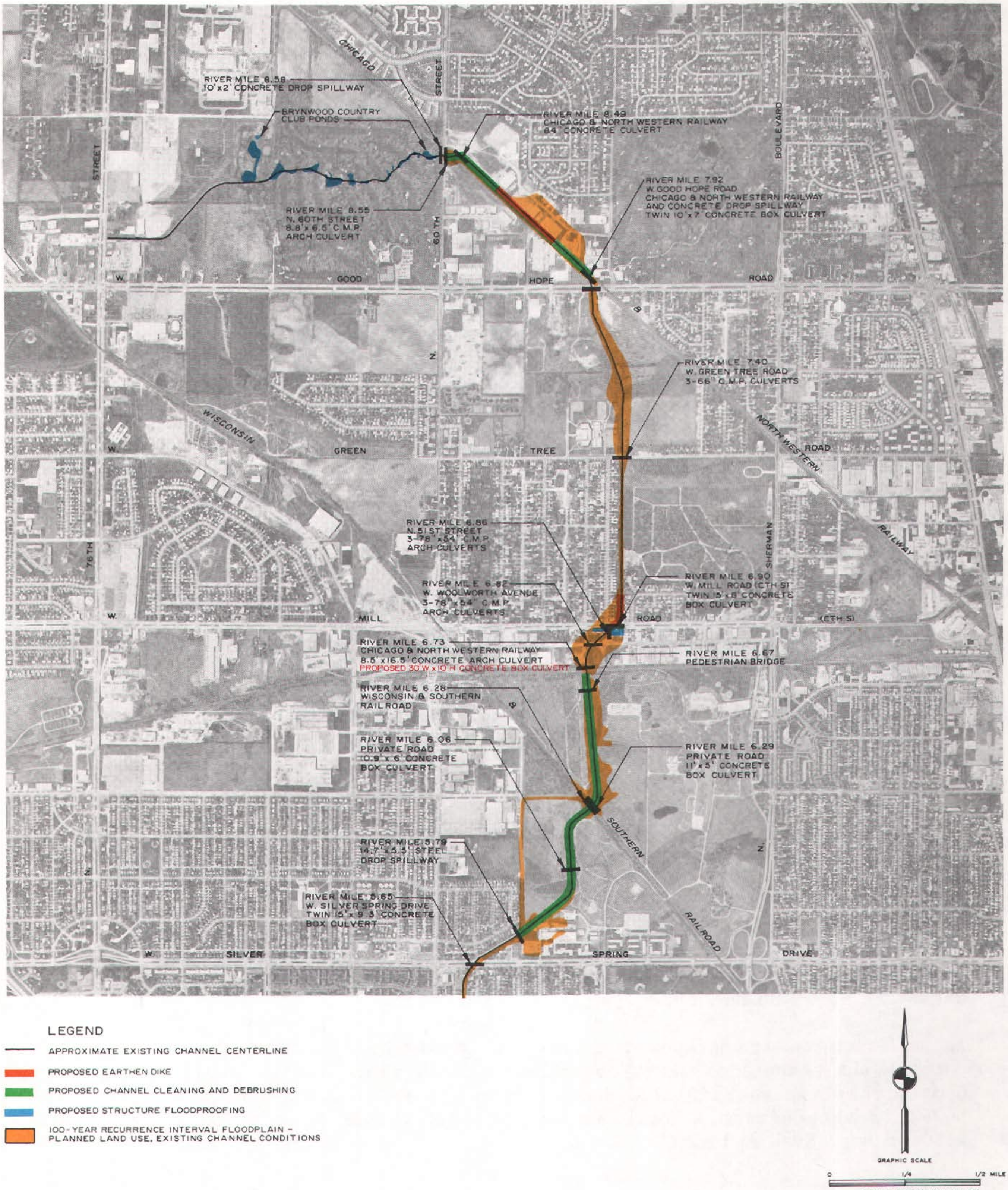
In the diking alternative plan, floodwaters would be confined between dikes on both sides of the channel at elevations higher than the existing adjacent land areas.

In the Upper Lincoln Creek subwatershed, 1,200 feet of earthen dike would be required to alleviate flood damages. The earthen dikes would average three feet in height above the existing bank elevations. The locations of these dikes are shown on Map 11.

In addition to the proposed diking, it would be necessary to clean out and debrush the channel or carry out other actions which would result in improved hydraulic efficiency in the channel from the steel drop structure (River Mile 5.79) to the Chicago & North Western Railway (River Mile 6.73), and between W. Good Hope Road and N. 60th Street.

Map 11

ALTERNATIVE PLAN 4: LOCATION OF PROPOSED DIKES IN THE UPPER LINCOLN CREEK SUBWATERSHED



Source: SEWRPC.

Also, in order to provide adequate hydraulic capacity it would be necessary to remove the existing 8.5 foot wide-by-16.5 foot high concrete arch culvert under the Chicago & North Western railroad tracks (River Mile 6.73), and to replace it with a 30 foot wide-by-10 foot high concrete box culvert. This culvert, or one of equivalent capacity, would accommodate the design flood with no appreciable headloss through the culvert. This alternative would also require the floodproofing of seven structures between W. Woolworth Avenue (River Mile 6.82) and W. Mill Road (River Mile 6.90).

Implementation of this alternative would essentially eliminate all damages attendant to floods up to and including the 100-year recurrence interval event. Therefore, the average annual benefits of this alternative would approximate $32,300. The total capital cost of this plan would be $404,000. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $25,500. Operating and maintenance costs are estimated at $700 per year, bringing the total average annual cost to $26,200.

The ratio of the average annual benefit to the total average annual cost is 1.23, and the annual benefits exceed the annual costs by $6,100. Pertinent data on this alternative are presented in Table 11.

Alternative Plan 5--Structure Floodproofing, Elevation, and Removal

It is possible and generally practicable for property owners, as individuals, to make certain structural adjustments to existing private properties in order to significantly reduce potential flood damages. These structural measures applied to buildings and their contents are known as "floodproofing." Selection of the specific floodproofing elements to be applied to a particular structure depends upon the features of the individual structure, such as the kind of structural material, age of the structure, substructure conditions, nature of the exposure to floodwaters, height of the water table, sewerage facilities, and uses demanded of the structure. Extensive floodproofing should be applied only under the guidance of a registered engineer who has carefully inspected the building and its contents and has evaluated the flood threat.

High residential flood damages can result from unwise uses of basements or from impractical designs of floodland homes. Use of basements or of the lower levels of "split level" homes located in floodlands as bedrooms, kitchens, or living rooms can result in high flood damages. Particularly severe residential flood damages can be caused by fuel oil storage tanks floating loose from their anchorage, rupturing, and spilling oil over the contents and interior of homes.

During periods of overland flooding and accompanying high water tables, basements situated in floodlands on permeable soils are particularly susceptible to flooding by seepage through walls. Experience has shown that basements can be severely flooded by seepage within a period of only a few hours. Where structures are sound and hydrostatic pressure from groundwater is low, basements may be floodproofed against seepage by sealing outside walls with asphaltic or certain quick-setting hydraulic compounds. In many instances, however, it is not practical to exclude all seepage water and it becomes necessary to provide and operate a sump pump. As a safeguard against power failure, homeowners can install an auxiliary gasoline-fueled pump or generator. As a principle, all homes constructed in floodlands where the water table is high should have basement walls sealed and should be equipped with a sump pit and a sump pump that is actuated automatically as waters rise.

Because of flat topography, high water tables, and potential storm water leakage into manholes, homes located in floodland areas often experience flood damage from the backup of sanitary sewage and floodwaters through a basement floor drain connected to the sanitary sewerage system. A number of relatively inexpensive standard devices can be installed in sewer lines to prevent such reverse flow of water. These include standard backwater valves, horizontal swing check valves, and closed-end pipes threaded into floor drains. It is important to note that, in order for these devices to accomplish flood damage relief, the house sewer and floor drain must be of adequate strength to resist the hydrostatic pressure without rupturing and thus introducing floodwaters.

Under certain conditions of rapidly rising floodwaters, more flood-damage prevention may be accomplished by allowing a basement to flood than by trying to exclude the inflow of floodwater through sewer lines or in other ways. Severe damage can be caused by the differential pressure between floodwaters and empty basements. Basement floors can be uplifted by hydrostatic pressure. Basement floors, walls, and floor drains should not be floodproofed without careful consideration of the probable forces which the structure must withstand.

In the case of residential structures in the primary flood hazard area--that is, located within the design floodplain boundary--floodproofing was assumed to be feasible if the design flood stage was below the first-floor elevation. Most frame structures are difficult to floodproof above the first-floor level. There may be exceptions where particularly sturdy structures such as well-constructed masonry and brick buildings could be floodproofed above the first-floor level. Below the first-floor level, overland flow can sometimes be excluded by the installation of seal-tight, wire-reinforced glass on all basement windows, or by replacing such windows with glass block, concrete block, or brick, and depending entirely on artificial light and mechanical ventilation for light and air in the basement area. Additional information on floodproofing is contained in a number of publications, two of which were prepared by the U. S. Army Corps of Engineers[1] and the Illinois Department of Transportation.[2]

Structure elevation was considered feasible for residential structures with basements if the estimated cost of elevating the structure was less than the estimated structure removal cost. Structures to be elevated were assumed to be raised to an elevation two feet higher than the 100-year recurrence interval

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[1]U. S. Army Corps of Engineers, Flood-Proofing Regulations, Office of the Chief of Engineers, U. S. Army, Washington, D. C., report, EP 1165 2 314, June 1972, 79 pp.

[2]Illinois Department of Transportation, Protecting Your House from Flood Damage, Division of Water Resources, Bureau of Local Assistance, Series 3B report, January 1980, 26 pp.

flood stage to provide adequate freeboard. For aesthetic reasons, structure elevation was limited to four feet. Structures which would have to be elevated more than four feet were considered for removal.

Floodproofing was assumed to be feasible for all nonresidential structures within the primary flood hazard area provided the flood stage was not more than seven feet above the first floor, with the floodproofing cost for stages above the first floor being a function of the depth of water over the first floor. With respect to structures located in the secondary flood hazard area--that is, outside but immediately adjacent to the 100-year recurrence interval floodlands where the potential for sewer backup into basements exists--floodproofing would be applied to those structures with basement floors below the elevation of the design flood stage. However, for the purpose of analysis of alternative flood control measures in this report, damages due to flooding caused by backup through cross-connections between sanitary and storm sewers were not considered because the City of Milwaukee plans to eliminate sanitary sewer crossovers to storm sewers in not only the Lincoln Creek subwatershed, but elsewhere in the City, thus alleviating to a great extent, although not totally, the problem of basement flooding.

Secondary flooding has been demonstrated to be an important consideration in the study area. However, the secondary flooding problem was not given separate consideration because it was possible to develop flood control measures to eliminate both primary and secondary flood damage that were both technically and economically feasible when considering only flood damages due to overland or direct flooding.

A structure floodproofing, elevation, and removal alternative flood control plan was analyzed to determine if such a structure-by-structure approach would be a technically feasible and economically viable solution to the flood problem in the Upper Lincoln Creek subwatershed. For the purpose of this analysis, the 100-year recurrence interval flood stage under plan year 2000 conditions was used to estimate the number of flood-prone structures to be floodproofed, elevated, or removed and the approximate costs involved.

The analysis indicated that 25 structures may be expected to be located in the primary flood hazard area. Of these 25 structures, 14 would have to be elevated, 11 would have to be floodproofed, and none would have to be removed under this alternative.

Implementation of this alternative would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. Therefore, the average annual benefit of this alternative would approximate $32,300. The total capital costs of this plan would be $407,000. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $25,800.

The ratio of the average annual benefit to the total average annual cost is 1.25, and the annual benefits exceed the annual cost by $6,500. Pertinent data on this alternative are presented in Table 11.

Storm Sewer Outlet Considerations

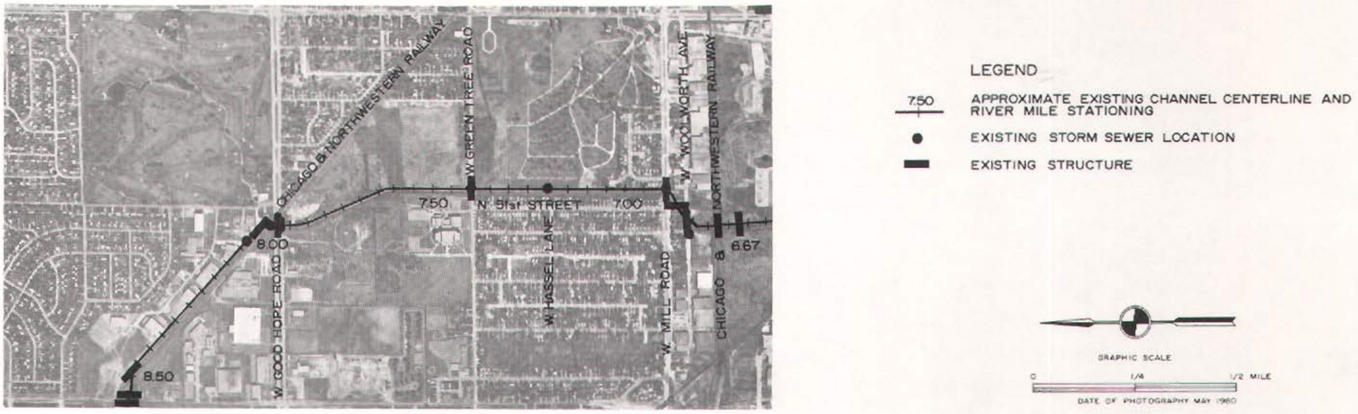
There are presently eight major storm sewer outlets located between the Chicago & North Western Railway tracks (River Mile 6.73) and the upstream crossing of the Chicago & North Western Railway tracks (River Mile 8.49) which discharge into Lincoln Creek but do not have free outlets. As shown on Figure 10, the inverts of these storm sewer outlets are set at elevations below the existing channel bottom. Some of the sewers are provided with smaller diameter outlet pipes which slope upward to allow stormwater to be discharged above the channel bottom, while other sewers are filled with streambed material to the elevation of the existing channel bottom. This condition has been reported by the City of Milwaukee, Bureau of Engineers, to cause deposition of solids in the tributary storm sewer systems resulting in the need for special maintenance and the potential for storm water ponding in the tributary drainage areas due to the restricted capacity of the storm sewer outlets.

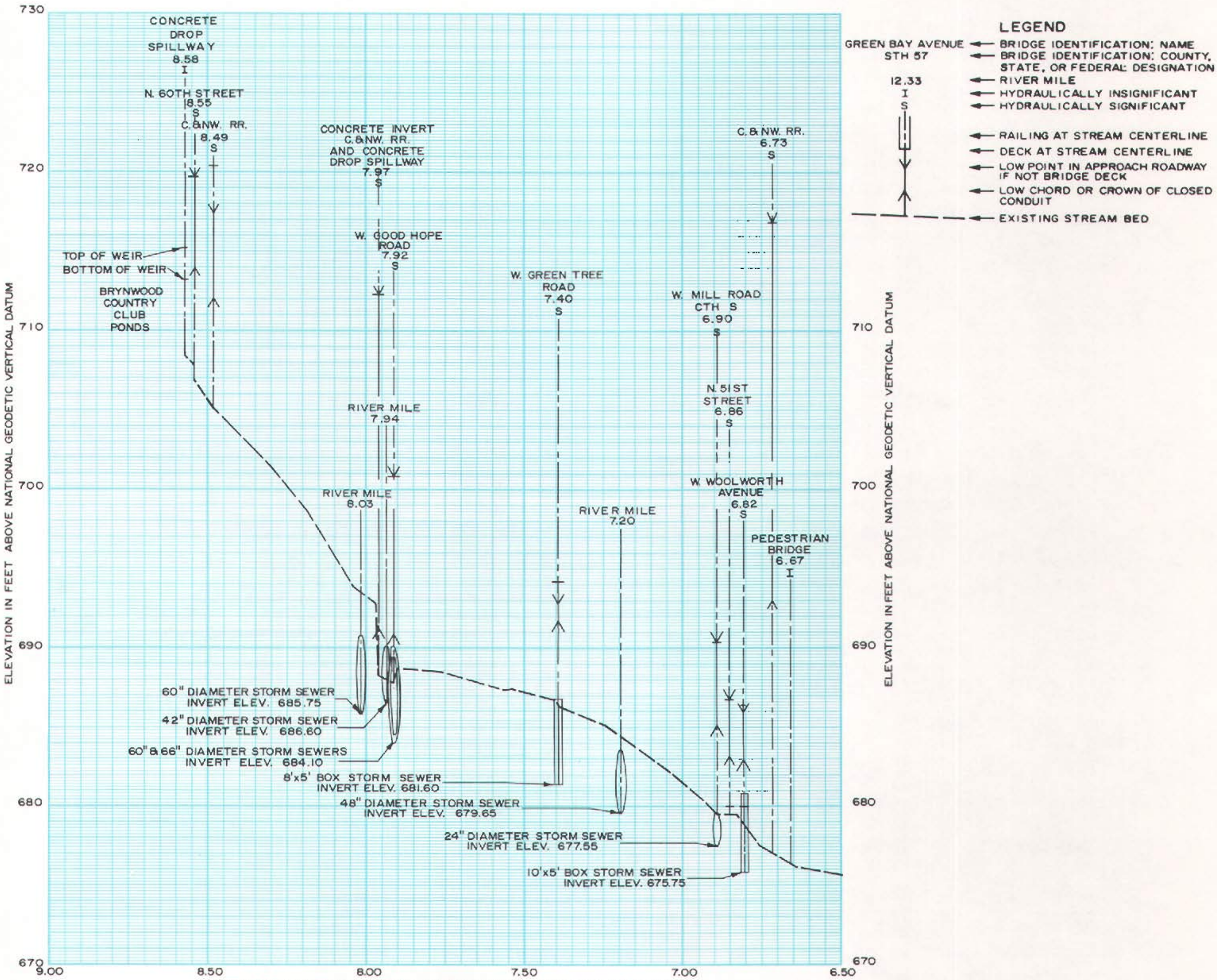
The previously described flood control alternatives for the Upper Lincoln Creek subwatershed were designed to resolve flooding caused directly by high water levels in the Lincoln Creek channel and were not intended to address the drainage problems attendant to the storm sewer outlet conditions described. A separate analysis, therefore, was conducted to evaluate alternative means of ameliorating the restricted storm sewer outlet condition. Two alternative plans were evaluated in addition to the "no action" alternative. The first alternative plan would provide for the deepening of the channel from upstream of the pedestrian bridge at River Mile 6.67 in the Havenwoods site to the Chicago & North Western Railway tracks at River Mile 8.49. The second alternative would provide for the construction of a new storm sewer parallel to the Lincoln Creek channel at an elevation lower than the planned channel elevation in order to collect storm water runoff from the restricted storm sewer outlets, the sewer thus discharging downstream at a lower elevation where a free outlet condition can be achieved.

<u>Storm Sewer Outlet Relief Alternative 1--No Action:</u> One alternative course of action to consider with regard to the storm sewer outlet problem in the Upper Lincoln Creek subwatershed is to do nothing--that is, to allow the situation to continue in its present state. Because the storm sewer outlets are partially restricted, it may be expected that solids buildup in the sewer will occur, thereby further restricting the capacity. This situation results in increased maintenance requirements and the potential for ponding because of the restricted storm sewer capacity. A specific cost for the additional maintenance requirements and potential flooding impacts, however, has not been estimated. The storm sewers concerned were designed on the premise that the channel would ultimately be lowered, providing a free outfall. It is accordingly unlikely that a "no action" course can be followed indefinitely. As storm water runoff and related storm sewer flows increase because of increased urbanization, the full capacity of the sewers will be required if ponding of water in the vicinity of the sewer inlets because of the restricted capacity is to be avoided. The ponding of storm water in the streets is disruptive of traffic flow and under certain conditions the ponded water may directly enter buildings located along the affected streets. Such ponding may also result in excessive inflow to and infiltration of sanitary sewers and the attendant surcharge of such sewers. This may, in turn, result in the backing up of the

Figure 10

PROFILE ILLUSTRATING THE EXISTING STORM SEWER OUTLETS
IN A PORTION OF THE UPPER LINCOLN CREEK SUBWATERSHED





Source: SEWRPC.

sanitary sewer flows into the basements of buildings with attendant damages and creation of a public health hazard. Accordingly, the "no action" alternative is regarded as unacceptable by the city engineer.

Storm Sewer Outlet Relief Alternative 2--Channel Deepening: The channel deepening alternative for the portion of the Upper Lincoln Creek subwatershed into which the eight storm sewer outlets discharge would consist of lowering the channel invert from approximately River Mile 6.67, just upstream of the pedestrian bridge in Havenwoods, to the Chicago & North Western Railway culvert (River Mile 8.49), a distance of about 1.8 mile. In Havenwoods, upstream of the pedestrian bridge, the channel would be lowered a maximum of one-half foot and no additional widening or stream bank modifications would be required. Upstream of Havenwoods, the channel bottom in the reach would be lowered from one to seven feet, with an average depth of excavation of approximately four feet. The channel would be lowered sufficiently to provide free outfall for the eight existing storm sewer outlets. The W. Mill Road structure (River Mile 6.90) would be cleaned out to expose the existing concrete invert, and the channel from W. Mill Road upstream to W. Good Hope Road (River Mile 7.92) would be reconstructed with a bottom width of five feet and side slopes of one on three. The concrete drop structure at the entrance to the Good Hope Road-Chicago & North Western Railway structure would be removed and the structure cleaned out to expose the existing concrete invert. The reach upstream to the Chicago & North Western Railway culvert (River Mile 8.49) would be reconstructed with a bottom width of five feet and side slopes of one on two. The channelized side slopes would then be revegetated. The velocities throughout the channelized reaches would be low enough to avoid the need for a concrete channel lining. The channel deepening alternative is shown on Figure 11.

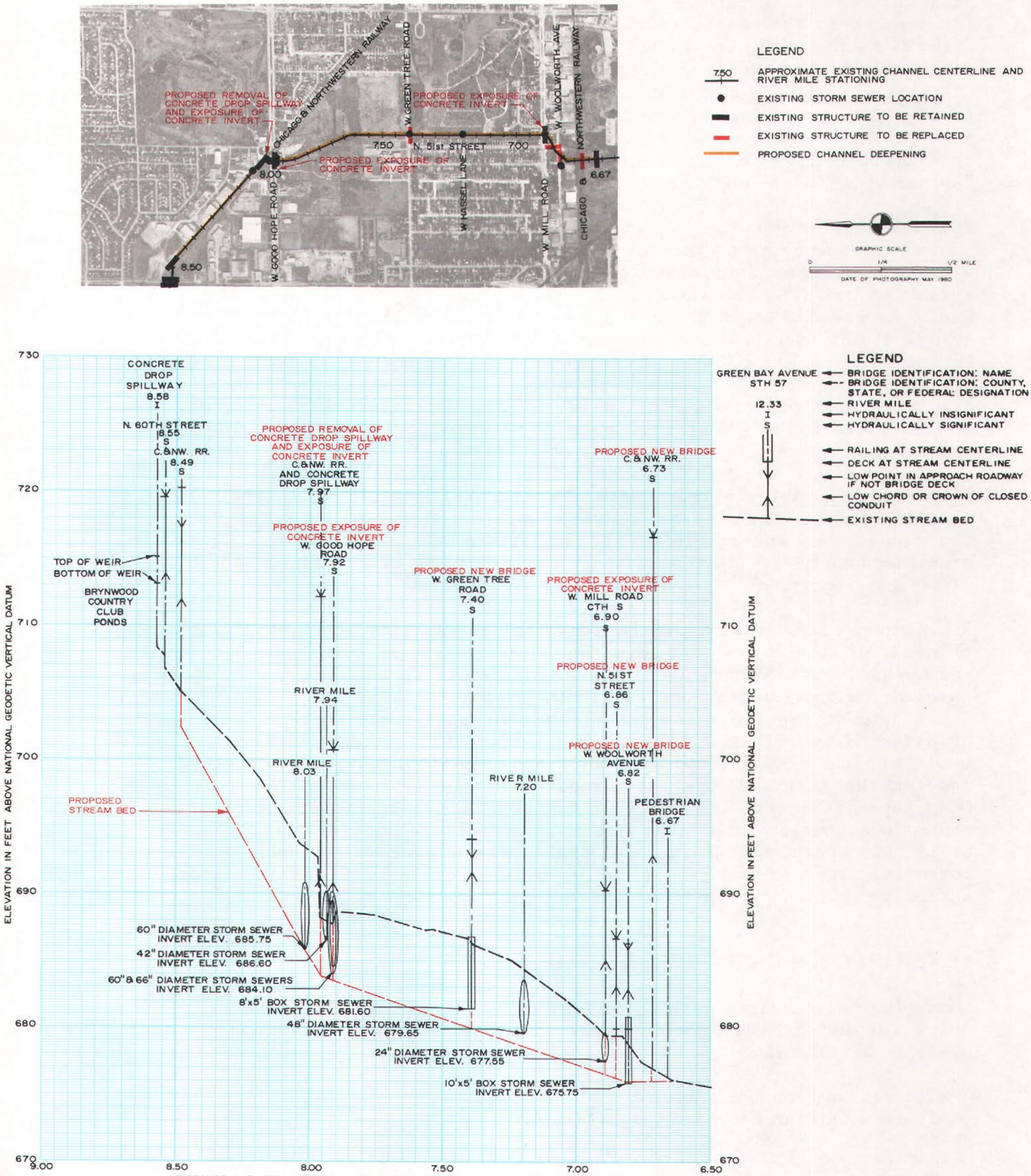
As part of the channel improvement, it would be necessary to reconstruct four bridges, both to provide adequate hydraulic capacity to pass flood flows and to accommodate lowering of the channel bottom. The following bridges would be removed and reconstructed, the Chicago & North Western Railway bridge (River Mile 6.73), the W. Woolworth Avenue bridge (River Mile 6.82), the N. 51st Street bridge (River Mile 6.86), and the W. Green Tree Road bridge (River Mile 7.40). The W. Woolworth Avenue and N. 51st Street bridges should be designed to accommodate the design flow with a combined headloss of 1.5 feet or less. The W. Green Tree Road bridge should be designed to accommodate the design flow with one foot of headloss or less through the structure. It should be noted that the Chicago & North Western Railway structure is also recommended to be replaced under the flood control plan for Lincoln Creek; and the capital cost for that replacement has been included under the recommended flood control plan, and is not, therefore, included in capital cost of this alternative drainage improvement plan.

The total capital cost of this alternative plan would thus approximate $753,000. Assuming amortization of this cost over a 50-year period at 6 percent rate of return yields an average annual cost of $47,400. Operating and maintenance costs are estimated at $2,000 per year, bringing the total average annual cost to $49,400.

Storm Sewer Outlet Relief Alternative 3--Parallel Storm Sewer: The parallel storm sewer alternative for the portion of the Upper Lincoln Creek subwatershed into which the eight storm sewer outfalls discharge would provide for the laying of approximately 1.23 miles of concrete pipe parallel to the Lincoln

Figure 11

PROFILE ILLUSTRATING CHANNEL DEEPENING ALTERNATIVE
FOR A PORTION OF THE UPPER LINCOLN CREEK SUBWATERSHED



Source: SEWRPC.

Creek channel from W. Woolworth Avenue (River Mile 6.82) to River Mile 8.05 just upstream of the Good Hope Road-Chicago & North Western Railway structure. The pipe would vary in size from 60-inch diameter at the upstream end to 78-inch diameter at W. Woolworth Avenue. The pipe would be laid at sufficient depth so that the invert would be below the inverts of the eight storm sewers discharging into this stream reach. The intercepting sewer would be of sufficient capacity to accommodate runoff from rainfall events having a recurrence interval of about once a year. A flow relief structure would be provided at the existing outlet of each storm sewer to permit overflow into Lincoln Creek channel when the capacity of the proposed intercepting sewer is exceeded.

The channel bottom from W. Woolworth Avenue downstream to River Mile 6.67, just upstream of the pedestrian bridge in Havenwoods, would be deepened to the elevation of the storm sewer outlet at W. Woolworth Avenue. A concrete drop structure would be provided at the downstream side of the existing W. Woolworth Avenue bridge structure to provide a gradual transition between the bridge invert and the lowered channel invert. This alternative is shown in Figure 12.

The total capital cost of this plan would be approximately $1,473,000. Assuming amortization of this cost over a 50-year period at 6 percent rate of return yields an average annual cost of $92,800.

Evaluation of Alternatives: Both the channel deepening alternative and the parallel storm sewer alternative, may be expected to have a minimal impact on the flood flows and stages of the downstream reaches of Lincoln Creek. These minor impacts are reflected in the flood flows and stages presented in Chapter IX of this report.

Based upon consideration of the technical feasibility, cost, and practicality of each of the three drainage improvement alternatives considered, it is recommended that the channel deepening alternative be adopted and implemented in order to provide free outfalls from the storm sewers discharging to Lincoln Creek between the two crossings of the Chicago & North Western Railway tracks at River Miles 6.73 and 8.49, respectively. This drainage improvement recommendation has been incorporated into the recommended plan set forth in Chapter IX. The costs of the recommended drainage improvement alternative have been segregated from the costs of the flood control recommendations since the storm sewer outlet conditions are not directly related to the flood problems of Lincoln Creek, but are a local drainage and sewer maintenance problem and a potential cause of indirect flooding because of lack of adequate storm sewer outlet capacity.

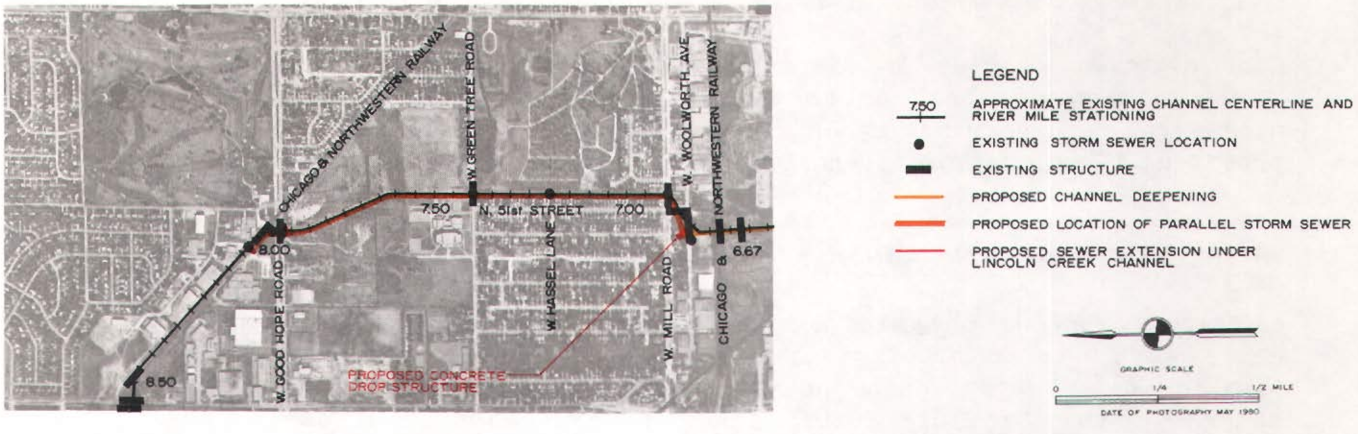
LOWER LINCOLN CREEK SUBWATERSHED

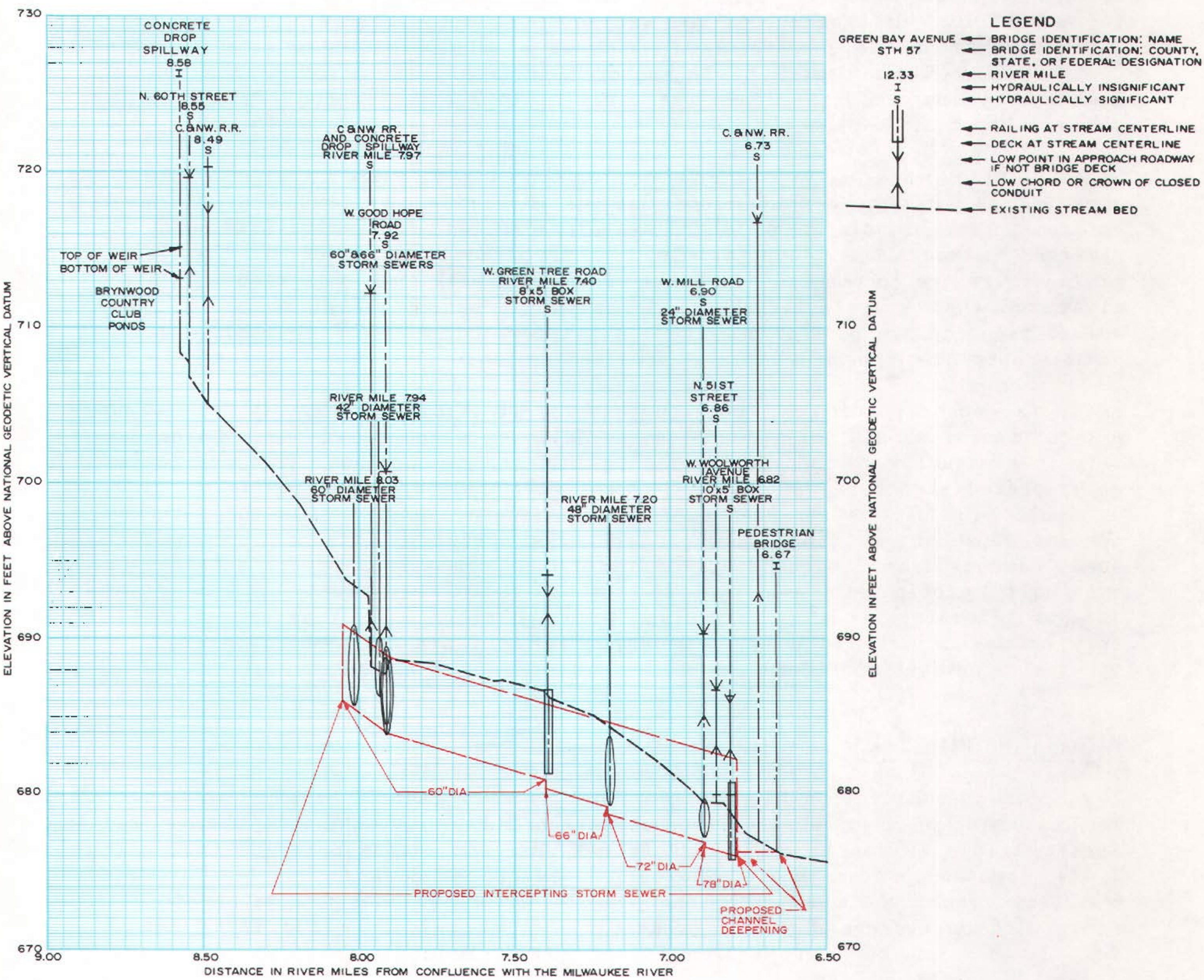
Four alternative plans were considered for alleviating flooding damages in the lower portion of the Lincoln Creek subwatershed, including the "no action" plan, as listed below:

Alternative Plan 1--No Action
Alternative Plan 2--Major Channelization

Figure 12

PROFILE ILLUSTRATING PARALLEL STORM SEWER ALTERNATIVE FOR A PORTION OF THE UPPER LINCOLN CREEK SUBWATERSHED





Source: SEWRPC.

Alternative Plan 3--Diking and Pumping
Alternative Plan 4--Structure Floodproofing, Elevation, and Removal

Each alternative plan is discussed in the following sections, which include a description of the plan, a review of its technical feasibility, and, as necessary, a determination of its economic viability. A discussion of other potential flood control alternatives evaluated is also presented.

Alternative Plan 1--No Action

As already noted, one alternative approach to the flood problem of the subwatershed is to do nothing--that is, to recognize the inevitability of extensive flooding but to decide not to mount a public program to abate the flood damages. Under probable future land use and existing stream channel conditions, the average annual flood damages in the subwatershed may be expected to approximate $617,000. This cost does not reflect an estimated $188,000 in annual flood damages associated with a small area located in the extreme lower reaches of the subwatershed, which would also experience flooding from the Milwaukee River caused by backwater conditions, and which would not be impacted by improvements within the Lincoln Creek subwatershed. This area is shown on Map 8 of Chapter VI.

Under existing land use and stream channel conditions, there is about a 10 percent chance in any year of flood damages occurring to about 80 residences located in the Lincoln Creek floodplain. In addition, flooded basements may be expected in many homes located outside, but directly adjacent to, the floodplain. There are no monetary benefits associated with the "no action" alternative, and the future average annual cost would be equivalent to the average annual flood damage cost of $617,000. A brief description of this alternative and its attendant economic costs is provided in Table 11.

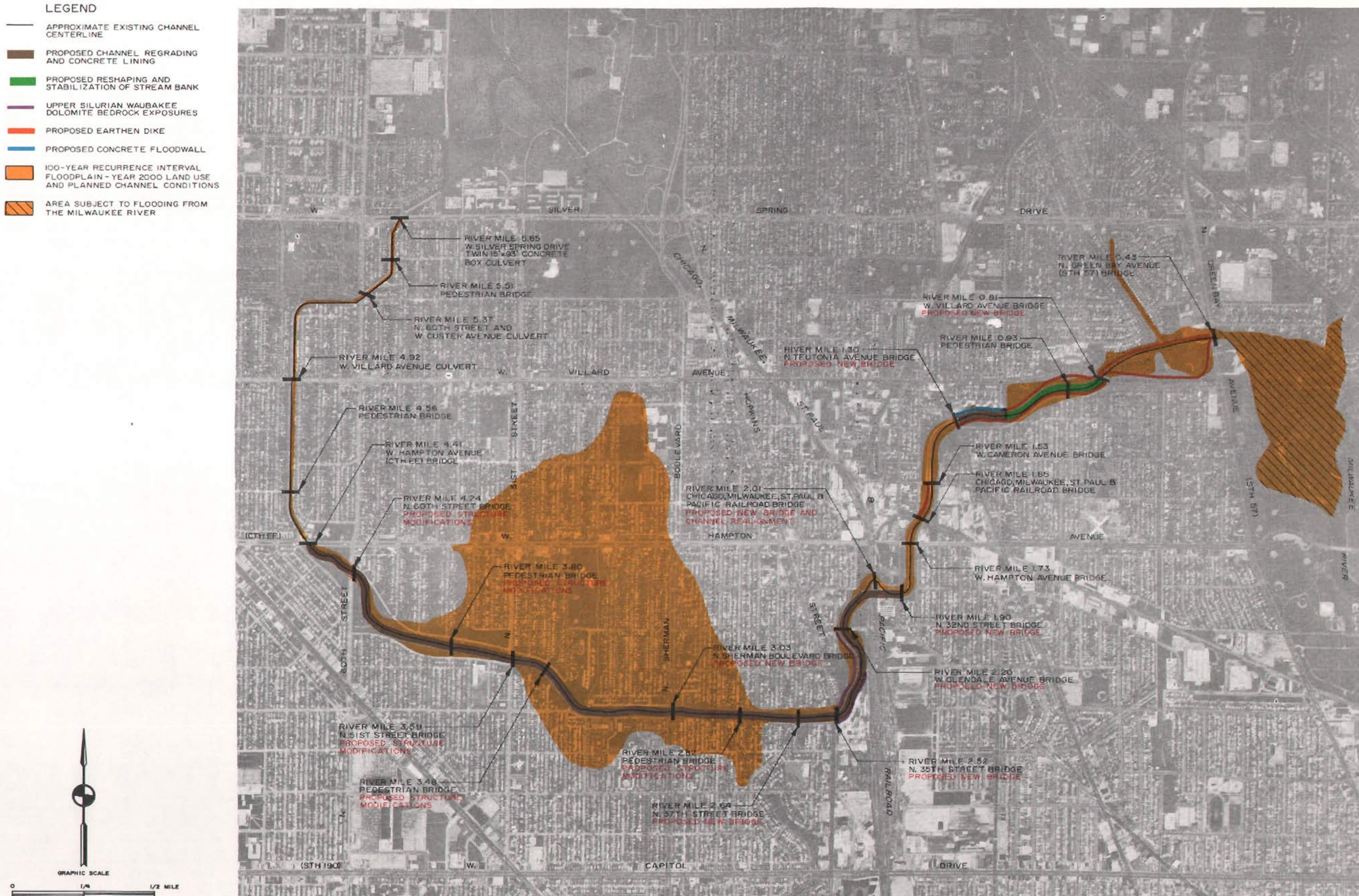
As in the upper portion of the subwatershed, it is highly unlikely that a "no action" course should, or indeed can, be followed since it will become necessary to eventually replace deteriorating culverts and bridges. If a particular deteriorated structure was known to constitute a severe restriction to flow, it would probably be replaced with a new structure having a larger waterway opening. Further, as flood flows and damages increased within the subwatershed, demands from the residents of the flood-prone areas may be expected to eventually precipitate some public action toward abatement of the flood damages. Therefore, this alternative, although technically feasible, is probably not practical. It does, however, offer a basis of comparison for the other alternatives considered.

Alternative Plan 2--Major Channelization

The major channelization alternative for the Lower Lincoln Creek subwatershed would consist of major channel reconstruction and improvement from the N. 32nd Street bridge (River Mile 1.90) to the W. Hampton Avenue bridge (River Mile 4.41), located upstream a distance of 2.51 miles, as shown on Map 12. Throughout this reach, the channel bottom profile would be lowered from one to six feet, with an average depth of excavation of approximately two feet. Except for the portion between N. 32nd Street (River Mile 1.90) and the Chicago,

Map 12

ALTERNATIVE PLAN 2: MAJOR CHANNELIZATION IN THE LOWER LINCOLN CREEK SUBWATERSHED



Source: SEWRPC.

Milwaukee, St. Paul & Pacific (the Milwaukee Road) railroad tracks (River Mile 2.01), the existing channel would be reconstructed with a bottom width of 30 feet and side slopes of one on three. The top width would vary from about 100 feet to about 200 feet, depending on the depth of excavation and the topography immediately adjacent to the existing channel. A concrete lining would be installed in the lower portion of the proposed channel and sized to pass the 10-year recurrence interval flood flow with two feet of freeboard. Channel side slopes above the concrete lining would be revegetated, and together the lower and upper portions of the proposed channel would pass the 100-year recurrence interval flood flow within the channel generally with at least two feet of freeboard.

The section of channel between N. 32nd Street and N. 35th Street is the most restrictive reach in the lower subwatershed. This restriction to flood flows is attributable primarily to a relatively small channel cross-section. Under this alternative, this channel reach would be reconstructed with the trapezoidal cross-section noted above, except through the most confined area between N. 32nd Street (River Mile 1.90) and the Milwaukee Road tracks (River Mile 2.01), where it may be necessary to use a rectangular channel cross-section. The channel bottom grade on the upstream side of N. 32nd Street would be lowered to the elevation of the existing channel bottom on the downstream side. The proposed channel would also include a concrete lining sized to pass the 10-year recurrence interval flood flow with two feet of freeboard, as noted above, and the entire channel cross-section would be designed to pass the 100-year recurrence interval flood flow with at least two feet of freeboard. It would also be desirable to straighten the alignment of the channel as it flows under the Milwaukee Road tracks (River Mile 2.01) by moving the channel approximately 200 feet to the south of the present bridge. The present bridge could be retained, but a new bridge would be constructed to accommodate the relocated channel.

It should be noted that there are two areas in this reach, as shown on Map 12, where bedrock is exposed along the Creek. The exposed rock is Upper Silurian Waubakee Dolomite. Those bedrock exposures are considered scientifically important as they represent the only known accessible exposure of this type in eastern Wisconsin. The detailed design of any channel improvement should seek to preserve these geologic outcrops or to provide comparable exposures after the improvements.

This flood control alternative for Lower Lincoln Creek would also involve the following diking and supplemental improvements to prevent flood damages in the area between N. Teutonia Avenue (River Mile 1.30) and N. Green Bay Avenue (River Mile 0.43): 1) the installation of approximately 8,400 feet of earthen dike, 2) the installation of about 800 lineal feet of concrete floodwall, and 3) the construction of four permanent storm water pumping stations and backwater gates. Along the north side of Lincoln Creek a concrete floodwall would be constructed from N. Teutonia Avenue at River Mile 1.30, a distance of 800 feet downstream to River Mile 1.15. This floodwall would range in height from two to three feet above the existing grade at the top of the bank. From that point, earthen dikes would be constructed for a distance of about 3,800 feet to the existing N. Green Bay Avenue structure at River Mile 0.43. Along the south side of Lincoln Creek, earthen dikes would be constructed for a distance of about 4,600 feet between N. Teutonia Avenue at River Mile 1.30 and N. Green Bay Avenue at River Mile 0.43. These dikes would range in height from two to four feet above the existing grade at the top of the bank between N. Teutonia Avenue (River Mile 1.30) and W. Villard Avenue (River Mile 0.81); and from three to five feet between W. Villard Avenue (River Mile 0.81) and N. Green Bay Avenue (River Mile 0.43). Approximately 500 feet of earthen dike ranging in height from three to four feet above the existing grade would also be required along the west side of the Creek between W. Cameron Avenue (River Mile 1.53) and the Chicago, Milwaukee, St. Paul & Pacific Railroad (River Mile 1.65). All the dikes would provide for two feet of freeboard under 100-year recurrence interval flood flows.

As a part of the channel improvements, it would be necessary to replace eight bridges, both to provide adequate hydraulic capacity to pass flood flows and to accommodate lowering of the channel grade. The following bridges would be removed and replaced with new bridges having adequate hydraulic capacity to pass the 100-year recurrence interval flood flow for planned channel and year 2000 land use conditions with a headloss of less than one foot: the W. Villard Avenue bridge (River Mile 0.81), the N. Teutonia Avenue bridge (River Mile 1.30), the N. 32nd Street bridge (River Mile 1.90), the Milwaukee Road bridge (River Mile 2.01), the W. Glendale Avenue bridge (River Mile 2.20), the N. 35th Street bridge (River Mile 2.52), the N. 37th Street bridge (River Mile 2.64), and the N. Sherman Boulevard bridge (River Mile 3.03). It is intended that all new bridges will be constructed with the bottom of the spans above the anticipated 100-year recurrence interval flood stage. Therefore, bridge sizes are not indicated in the above list.

It should be noted that hydraulic analyses indicated that it would be possible to allow a total combined headloss of up to two feet at one or at a selected combination of the new bridges. However, it would then be necessary to allow little or no headloss at certain other bridges to offset the higher upstream stages at these locations and prevent the design flood flow from exceeding the channel capacity. This allowable headloss, however, does provide some flexibility in the selection of the most economical bridge replacement scheme for this reach of Lower Lincoln Creek.

On the following bridges, the foundations for the center piers and abutments may have to be lowered to accommodate the proposed lowered channel bottom grade: the pedestrian bridge at River Mile 2.82, the pedestrian bridge at River Mile 3.48, the N. 51st Street bridge (River Mile 3.59), the pedestrian bridge at River Mile 3.80, and the N. 60th Street bridge (River Mile 4.24).

The following bridges or culverts were determined to have adequate capacity to pass the 100-year recurrence interval flood flow and are not located in a reach of the channel in which the grade is proposed to be lowered. Therefore, it is recommended that these culverts or bridges remain in place: the N. Green Bay Avenue bridge (River Mile 0.43), the pedestrian bridge at River Mile 0.93, the W. Cameron Avenue bridge (River Mile 1.53), the Milwaukee Road bridge (River Mile 1.65), the W. Hampton Avenue bridges (River Mile 1.73 and River Mile 4.41), the pedestrian bridge at River Mile 4.56, the W. Villard Avenue culvert (River Mile 4.92), the N. 60th Street and W. Custer Avenue culvert (River Mile 5.37), the pedestrian bridge at River Mile 5.51, and the W. Silver Spring Drive bridge (River Mile 5.65).

It should be noted that the N. Green Bay Avenue bridge at River Mile 0.43 may be expected to be overtopped by about 0.5 foot during a 50-year recurrence interval flood discharge once all of the recommended upstream channelization is in place. N. Green Bay Avenue is classified as an arterial street, and thus it should not be overtopped during a 50-year recurrence interval flood if sound transportation facility development standards are to be met. Future maintenance or reconstruction projects deemed necessary for this bridge should therefore include raising of the pavement elevation by about 0.5 foot.

Significant bank erosion and sloughing is occurring in the reach of the channel from W. Villard Avenue (River Mile 0.81) to N. Teutonia Avenue (River Mile 1.30). In addition, minor bank erosion is taking place at a number of locations along the channel from N. 35th Street (River Mile 2.52) to N. 60th Street (River Mile 4.24). In order to prevent further erosion along the reach immediately downstream of N. Teutonia Avenue, concrete lining similar to that in place upstream of N. Teutonia Avenue should be installed along the first 800 feet of channel to River Mile 1.15. The remaining eroding banks in the reach from W. Villard Avenue to N. Teutonia Avenue should be reshaped and stabilized with rock riprap or other suitable bank protection. The bank erosion in the section from N. 35th Street to N. 60th Street should be eliminated by installation of the proposed concrete lining.

Implementation of this alternative would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. Therefore, the average annual benefits of this alternative would approximate $617,000. The total capital cost of this plan would be $9,591,600. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $604,000. Operating and maintenance costs are estimated at $6,000 per year, bringing the total average annual cost to $610,000.

The ratio of the average annual benefit to the total average annual cost is 1.01, and the annual benefits exceed the annual costs by $7,000. Pertinent data on this alternative are presented in Table 11.

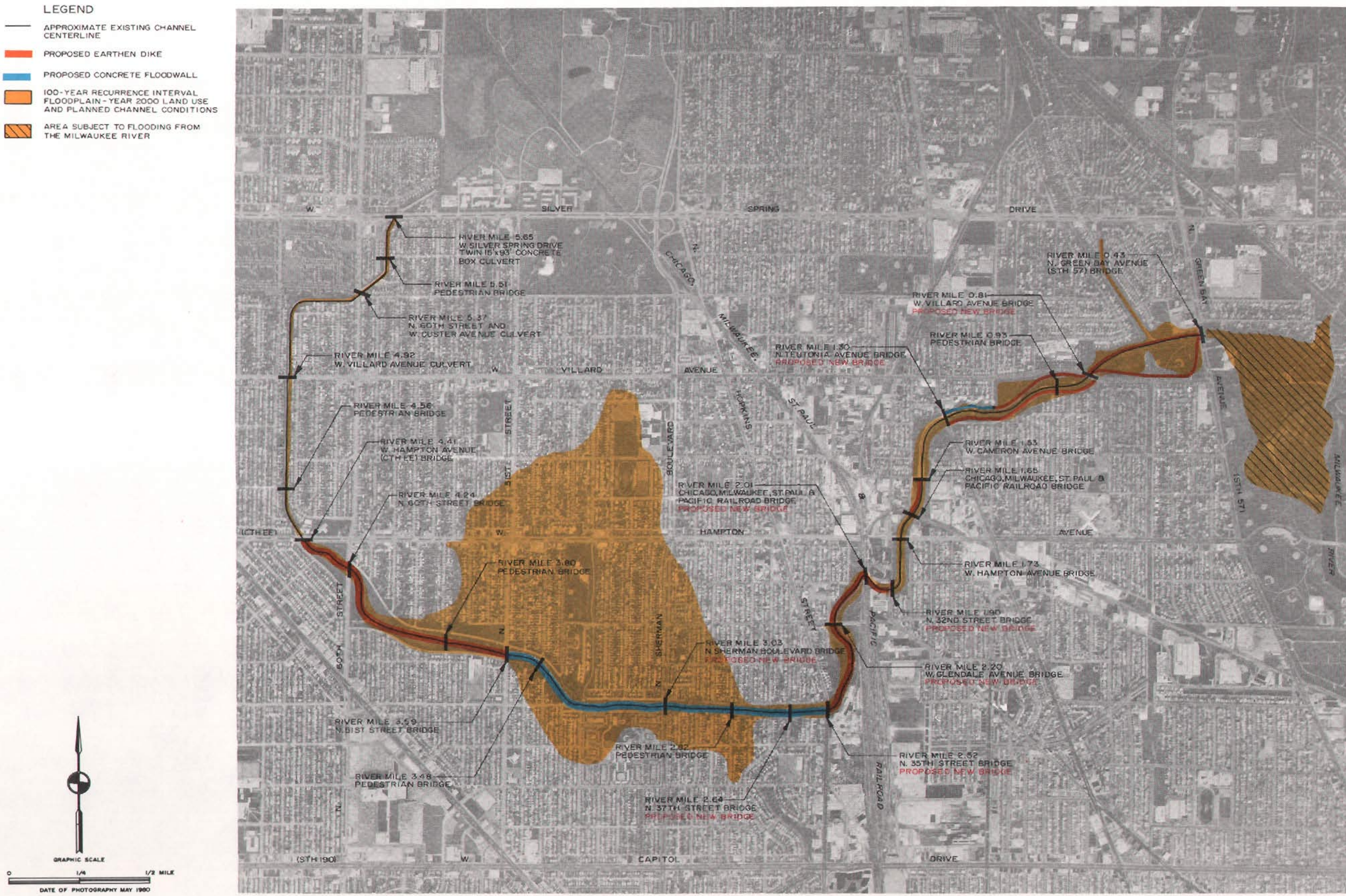
Alternative Plan 3--Diking and Pumping

In the Lower Lincoln Creek subwatershed, the following diking and supplemental improvements would be required to alleviate flooding damages: 1) 20,700 feet of earthen dike, 2) 12,200 feet of concrete floodwall, and 3) 16 permanent storm water pumping stations and backwater gates. The dikes, as shown on Map 13, would range in height up to nine feet, and would average approximately eight feet in height above the existing bank elevations and provide two feet of freeboard. In addition, it would be necessary to replace the eight bridges recommended for replacement under Alternative Plan 2, "Major Channelization."

Implementation of this alternative would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. Therefore, the average annual benefits of this alternative would approximate $617,000. The total capital cost of this plan would be $12,115,600. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $763,000. Operation and maintenance costs are estimated at $14,000 per year, bringing the total average annual cost to $777,000.

Map 13

ALTERNATIVE PLAN 3: LOCATION OF PROPOSED DIKES IN THE LOWER LINCOLN CREEK SUBWATERSHED



Source: SEWRPC.

The ratio of the average annual benefit to the total average annual cost is 0.79, and the annual cost exceeds the annual benefits by $160,000. Pertinent data on this alternative are presented in Table 11.

Alternative Plan 4--Structure Floodproofing, Elevation, and Removal

A structure floodproofing, elevation, and removal alternative flood control plan was analyzed to determine if such a structure-by-structure approach would be a technically and economically acceptable solution to the flood problem in the Lower Lincoln Creek subwatershed. For the purpose of this analysis, the 100-year recurrence interval flood stage under year 2000 plan conditions was used to estimate the number of flood-prone structures to be floodproofed, elevated, or removed and the approximate costs involved.

The analysis indicated that 1,570 structures may be expected to be located in the primary flood hazard area. Of these 1,570 structures, 825 would have to be elevated, 745 would have to be floodproofed, and none would have to be removed under this alternative.

Implementation of this alternative would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. Therefore, the average annual benefits of this alternative would approximate $617,000. The total capital cost of this plan would be $20,229,000. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $1,283,000.

The ratio of the average annual benefit to the total average annual cost is 0.48, and the annual costs exceed the annual benefits by $666,000. Pertinent data on this alternative are presented in Table 11.

Other Alternatives Evaluated

It should be noted that numerous alternatives not described above were evaluated for alleviation of the flooding problems in Lower Lincoln Creek in lieu of major channelization. The replacement of selected bridges would alleviate flooding in some reaches to a certain extent, but hundreds of structures would still remain in the 100-year recurrence interval floodplain. Replacement of the N. Sherman Boulevard bridge would result in the removal of many structures from the floodplain upstream of N. Sherman Boulevard, but would cause additional structures to be flooded downstream because of a large increase in flood flows attributable to the removal of this hydrologically significant structure. Storage of floodwaters on the U. S. Army property above W. Silver Spring Drive was evaluated assuming that runoff from Upper Lincoln Creek and from the intensively urbanized area north of W. Silver Spring Drive and west of Lincoln Creek would be controlled by the proposed reservoir. Significant reductions in flood flows and stages would be realized downstream of W. Silver Spring Drive. However, the most significant stage changes would occur between N. 60th Street (River Mile 4.24) and W. Silver Spring Drive, where flooding problems are minor for both existing and planned land use conditions. Beneficial effects would also extend downstream as far as N. 51st Street, with numerous structures being removed from the 100-year floodplain because of the reduction in flood flow caused by the detention structure. However, the effects of floodwater storage would be insignificant at N. Sherman Boulevard and points downsteam.

Combination storage and channelization was also addressed for Lower Lincoln Creek to minimize channelization. However, it was found that the length of reach to be channelized would not be significantly reduced from that under the major channelization alternative.

BENEFIT-COST CONSIDERATIONS

Table 11 summarizes benefit-cost analyses for each alternative utilizing two different interest rates--6 percent and 10 percent--and a 50-year period of economic analysis. These data are presented in order to demonstrate the impact of varying interest rates on the relationship between benefits and costs. As may be noted by review of Table 11, three of four alternatives evaluated for Upper Lincoln Creek and one of three alternatives evaluated for Lower Lincoln Creek have a benefit-cost ratio of greater than one if computed with an interest rate of 6 percent. None of the alternatives have a benefit cost ratio of greater than one if computed with an interest rate of 10 percent.

In this respect it should be noted that the Commission, in its economic analyses relative to flood control measures, uses an interest rate of 6 percent and a 50-year period of analysis. The use of this interest rate incorporates consideration of the ever present possibility of private investment as an alternative. Money invested by the property taxpayers concerned--who normally cannot command the highest rates of return--may be expected to range from 4 to 8 percent after taxes. Viewed in this context, use of a 6 percent rate of interest in the economic analyses is quite reasonable. A 50-year period of analysis is also reasonable given the inability to anticipate social, economic, and technical changes which may occur in the more distant future and influence project benefits and costs, and the fact that at 6 percent interest, benefits accrued after 50 years are very small, when discounted to the present.

In this respect it should also be noted that the benefit component of the benefit-cost ratios herein presented are somewhat understated, being based solely upon the avoidance of the direct monetary expenditures required to restore flood-damaged property to preflood condition. Such expenditures include costs for cleaning, repairing, and replacing residential, commercial, and industrial buildings and contents, and other objects and materials located outside the buildings that are on the property. Such expenditures also include costs for cleaning, repairing, and replacing roads and bridges, storm water drainage systems, sanitary sewer systems, and other utilities, as well as the cost of restoring damaged park and recreational lands. The benefits do not include indirect expenditures such as those associated with flood fighting, evacuation, and provision of emergency services; the indirect monetary losses entailed in lost wages, lost production, and lost sales; or the increased highway and railroad transportation costs entailed in flood-caused detours. Such indirect costs, while difficult to estimate with accuracy, constitute a real monetary burden on the economy of an area. Similarly, the benefit-cost analyses herein presented do not reflect the avoidance of intangible costs associated with flood-associated health hazards, property value depreciation, and the general disruption of normal community activities. Intangible losses and risks also include the severe psychological stress experienced by owners or occupants of structures in flood-prone areas. Benefit-cost analysis properly represents but one of many considerations in any determination to proceed with a public flood control project. There may be situations in which an affected local community may subjectively but strongly favor an alternative plan that has an objectively determined benefit-cost ratio of less than one; or conversely, may strongly oppose an alternative with a benefit-cost ratio of greater than one. Such determinations may be entirely proper if based upon careful deliberation concerning other than purely economic objectives by the responsible public governing bodies concerned.

Chapter IX

RECOMMENDED FLOOD CONTROL PLAN

INTRODUCTION

The preceding chapter of this report described and evaluated five alternative flood control plans for the Upper Lincoln Creek subwatershed and four such alternative plans for the Lower Lincoln Creek subwatershed. This chapter presents a description of the recommended flood control plan for Lincoln Creek as synthesized from the best of the various alternative flood control plans considered.

THE RECOMMENDED PLAN

Based upon consideration of the technical feasibility, economic viability, environmental impacts, potential public acceptance, and practicality of each of the alternatives considered, it is recommended that Alternative Plan 2--Limited Channelization in combination with Storm Sewer Relief Alternative 2--Channel Deepening--be adopted and implemented for Upper Lincoln Creek; and that Alternative Plan 2--Channelization--be adopted and implemented for Lower Lincoln Creek.

The total capital cost of the recommended combined flood control plan for Upper and Lower Lincoln Creek is estimated at $9.9 million. This cost does not include the cost--estimated at $753,000--for channel deepening required for storm sewer relief in Upper Lincoln Creek. The recommended plan is shown graphically on Maps 14A and 14B. The peak flood profile which would be attendant to the planned future land use and channel conditions in the subwatershed is shown in Figure 13. Both of the alternative plans which together constitute the recommended plan have the highest benefit-cost ratios of the alternative plans considered--1.52 and 1.01, respectively.

The recommended plan would essentially eliminate all flood-related damages along the entire Lincoln Creek channel under both existing and planned future land use conditions. It would also provide an adequate drainage outlet for the tributaries to Lincoln Creek. It should be noted in this respect, however, that the recommended plans pertain only to the main channel and do not address any possible drainage improvements that may be needed in the tributary subbasins.

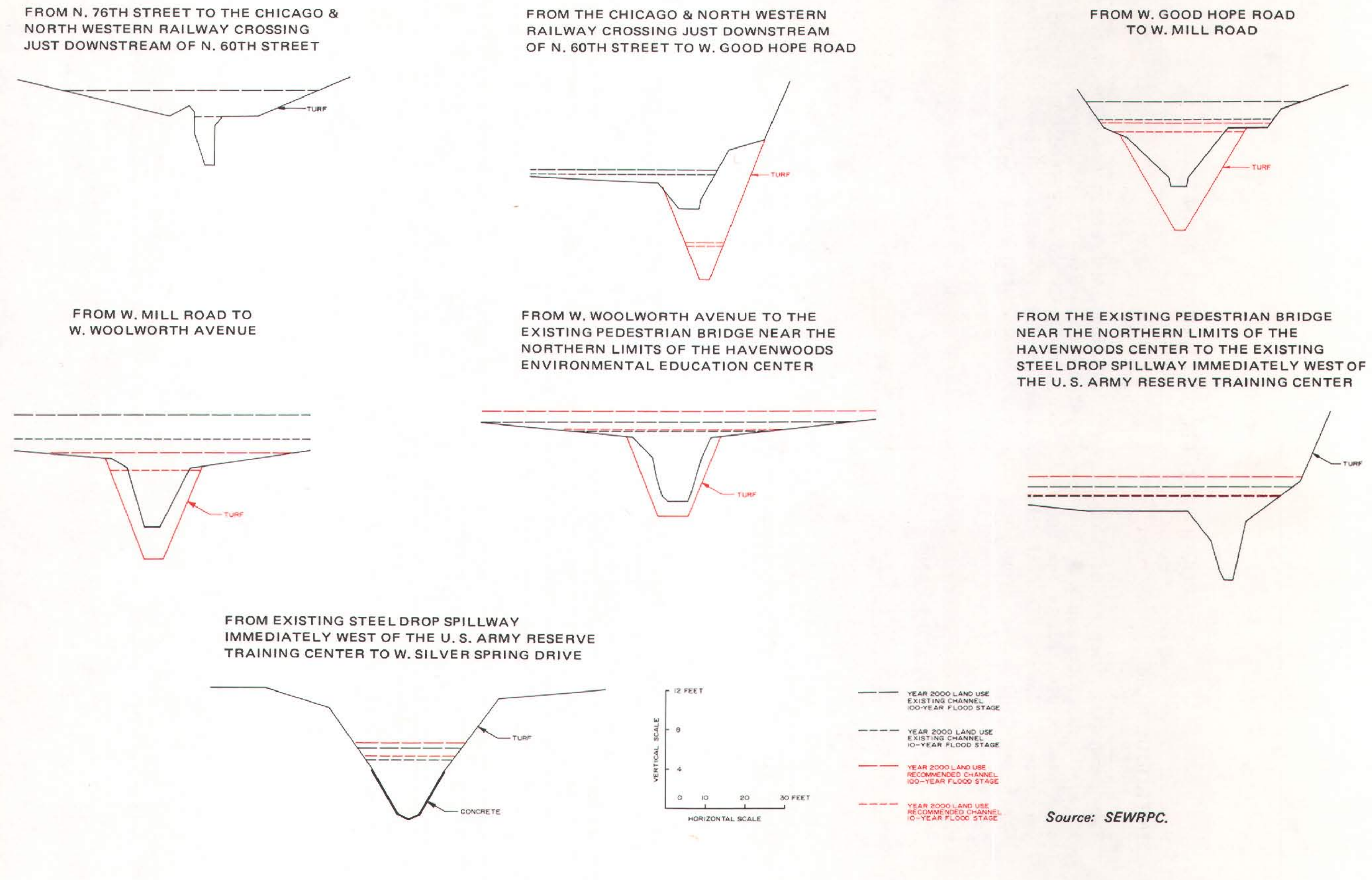
The recommended plans make the maximum use of storm water storage in existing ponding areas and in the channel itself. The channel would be designed to carry the 100-year recurrence interval flood event with two feet of freeboard. All flooding of existing structures located in the Lincoln Creek subwatershed due to floods of up to and including the 100-year recurrence interval flood on Lincoln Creek would be eliminated. The recommended plans are more fully described below.

The recommended flood control plan for Upper Lincoln Creek would require cleaning and debrushing or other actions which would result in improved hydraulic efficiency of the channel reaches extending from the steel drop structure at River Mile 5.79 to the Chicago & North Western Railway at River Mile 6.73. The channel invert between River Mile 6.67, just upstream of the

Map 14-A

RECOMMENDED FLOOD CONTROL PLAN FOR UPPER LINCOLN CREEK

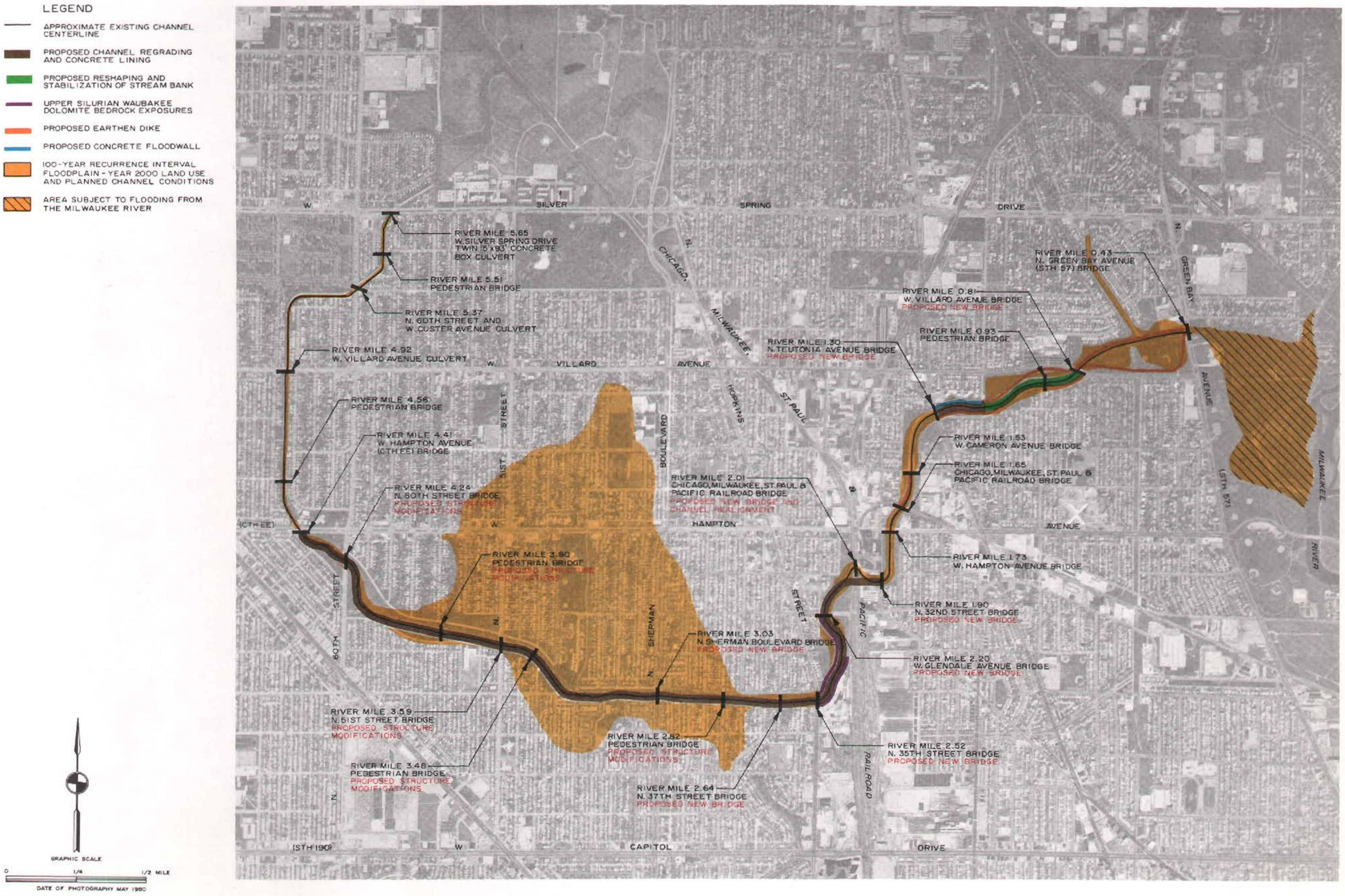
TYPICAL CROSS-SECTIONS OF THE EXISTING AND RECOMMENDED CHANNEL ALONG UPPER LINCOLN CREEK



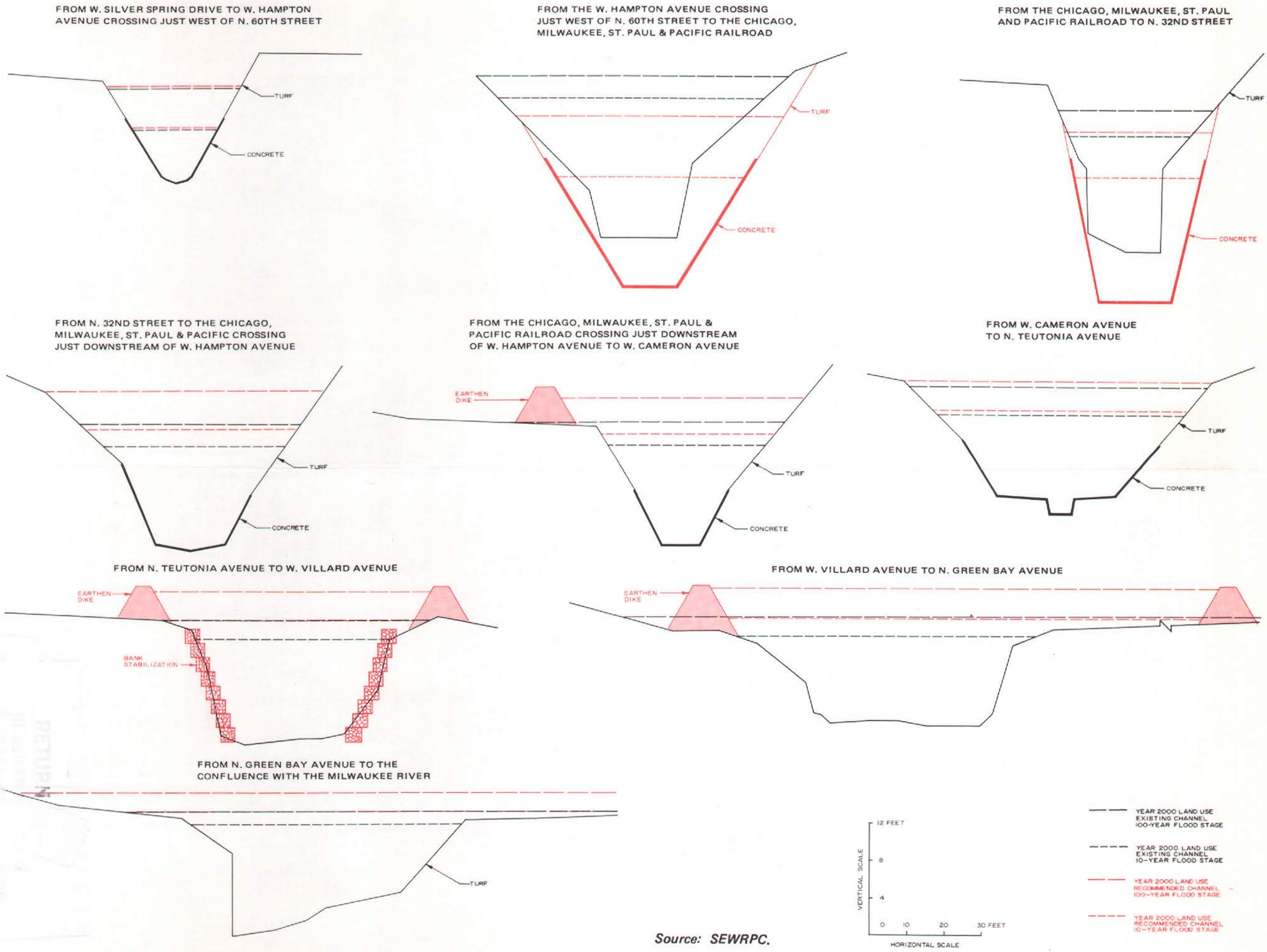
Source: SEWRPC.

Map 14B

RECOMMENDED FLOOD CONTROL PLAN FOR LOWER LINCOLN CREEK



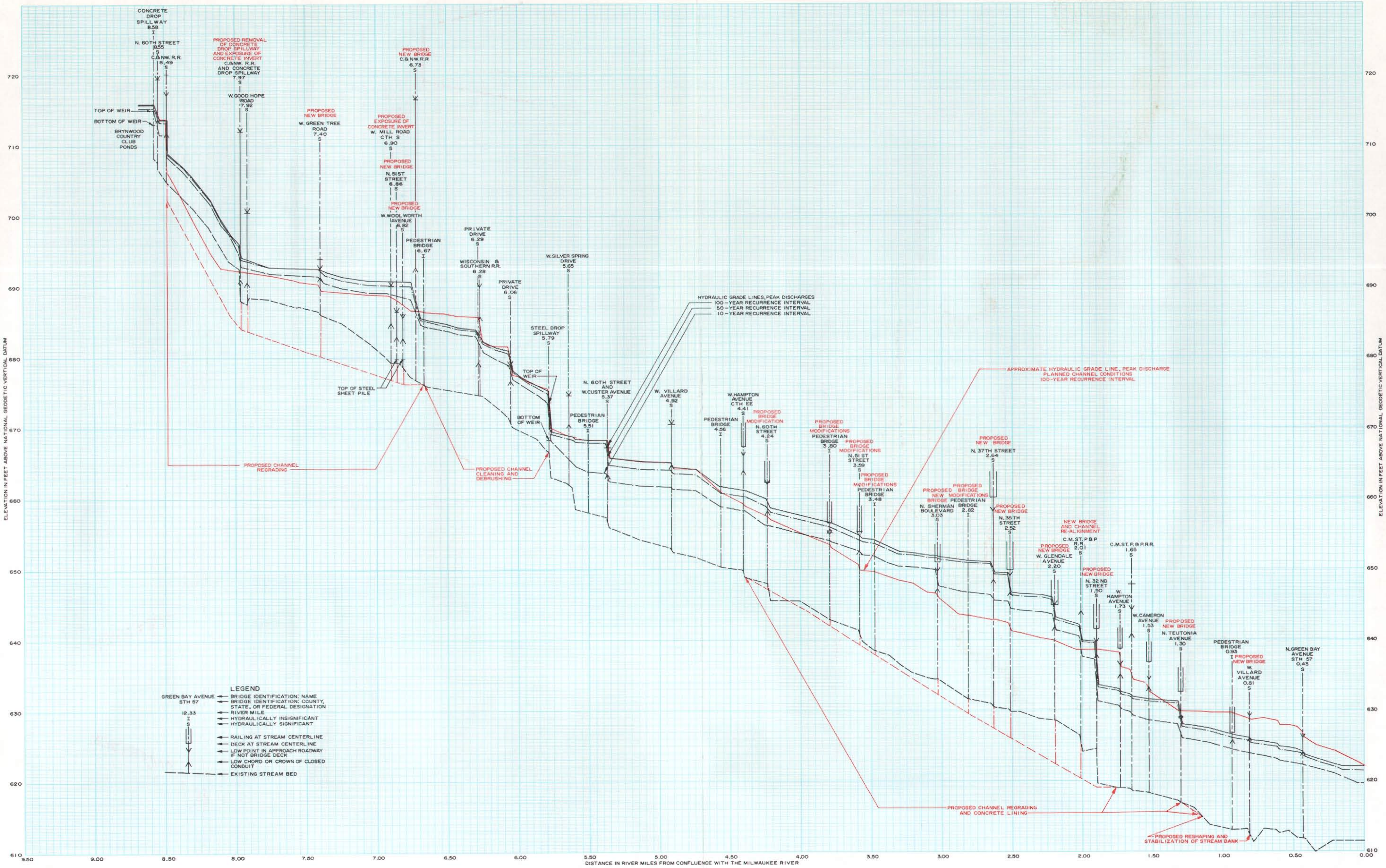
TYPICAL CROSS-SECTIONS OF THE EXISTING AND RECOMMENDED CHANNEL ALONG LOWER LINCOLN CREEK



Source: SEWRPC.

Figure 13

RECOMMENDED PLAN FLOOD STAGE PROFILE FOR LINCOLN CREEK



Source: SEWRPC.

pedestrian bridge in Havenwoods and W. Woolworth Avenue, would be lowered to approximately the same invert elevation as the storm sewer outlet at W. Woolworth Avenue. The channel from approximately River Mile 6.69 to W. Woolworth Avenue at River Mile 6.82 would be gradually widened from a channel bottom width of approximately 15 feet at River Mile 6.69 to a channel bottom width of approximately 30 feet at W. Woolworth Avenue. The channel bottom at the W. Mill Road (River Mile 6.90) and W. Good Hope Road-Chicago & North Western Railway (River Mile 7.97) structures would be lowered to the existing culvert invert elevations. The channel from W. Mill Road (River Mile 6.90) upstream to the Chicago & North Western Railway tracks (River Mile 8.49), a distance of about 1.6 miles, would be lowered from one to seven feet, with an average depth of excavation of approximately four feet. The channel would be lowered sufficiently to provide free outfall for the eight existing storm sewers discharging to this channel reach. The channel from W. Mill Road (River Mile 6.90) upstream to W. Good Hope Road (River Mile 7.92) would be reconstructed with a bottom width of five feet and side slopes of one on three. The concrete drop structure at the entrance to the W. Good Hope Road-Chicago & North Western Railway structure would be removed and the reach upstream to the Chicago & North Western Railway culvert (River Mile 8.49) would be reconstructed with a bottom width of five feet and side slopes of one on two. The regraded channel would be revegetated to control erosion. This channel cross-section and grade change would be adequate to accommodate the 100-year recurrence interval flood flow with two feet of freeboard through the developed portion of the reach from River Mile 7.97 to River Mile 8.40.

As part of the channel improvement, it would be necessary to reconstruct three bridges to accommodate the new channel grade: the W. Woolworth Avenue bridge (River Mile 6.82), the N. 51st Street bridge (River Mile 6.86), and the W. Green Tree Road bridge (River Mile 7.40). The W. Woolworth Avenue and N. 51st Street bridges should be replaced with structures able to accommodate the design flood flow with a combined headloss of 1.5 feet or less through the structures. The W. Green Tree Road bridge should be designed to accommodate the design flow with one foot of headloss or less through the structure.

A total of approximately 80 feet of earthen diking would be required along the banks on the upstream side of the W. Mill Road structure. The dikes would have a maximum height of two feet and would contain the 100-year recurrence interval flood flows within the channel and prevent weir flow over W. Mill Road.

Measures in addition to channelization that would provide adequate hydraulic capacity along Upper Lincoln Creek include the removal of the existing 8.5 foot wide-by-16.5 foot high concrete arch culvert under the Chicago & North Western Railway at River Mile 6.73 and replacement with a 30 foot wide-by- 10 foot high concrete box culvert. This culvert, or one of equivalent capacity, would accommodate the design flood flow with no appreciable headloss through the culvert.

Under the recommended plan, major channelization would be carried out along Lower Lincoln Creek, consisting of channel reconstruction and improvement from the N. 32nd Street bridge at River Mile 1.90 to the W. Hampton Avenue bridge at River Mile 4.41, a distance of 2.51 miles. Throughout this reach, the channel bottom would be lowered from one to six feet, with an average depth of excavation of approximately two feet. Except for the portion between N. 32nd

Street at River Mile 1.90 and the Chicago, Milwaukee, St. Paul & Pacific Railroad (the Milwaukee Road) tracks at River Mile 2.01, the existing channel would be reconstructed with a bottom width of 30 feet and side slopes of one on three. The top width would vary from about 100 feet to about 200 feet, depending on the depth of excavation and the topography adjacent to the existing channel. A concrete lining would be installed in the lower portion of the proposed channel and sized to pass the 10-year recurrence interval flood flow with two feet of freeboard. Channel side slopes above the concrete lining would be revegetated, and the lower and upper portions of the proposed channel together would be designed to pass the 100-year recurrence interval flood flow with two feet of freeboard.

The section of channel between N. 32nd Street and N. 35th Street is the most restrictive reach in the lower subwatershed. This restriction is attributable primarily to a relatively small channel cross-section. Under the recommended plan, this channel reach would be reconstructed with the trapezoidal cross-section noted above except through the most confined area between N. 32nd Street at River Mile 1.90 and the Milwaukee Road tracks at River Mile 2.01, where it may be necessary to use a rectangular channel cross-section. The channel bottom grade on the upstream side of N. 32nd Street would be lowered to the elevation of the existing channel bottom on the downstream side. The proposed channel would also include a concrete lining sized to pass the 10-year recurrence interval flood flow with two feet of freeboard, as noted above; and the entire channel cross-section would be designed to pass the 100-year recurrence interval flood flow with at least two feet of freeboard. It is recommended that the channel be realigned as it flows under the Milwaukee Road tracks at River Mile 2.01 by moving the channel approximately 200 feet to the south of the present bridge. The hydraulic analyses conducted under this study assumed the provision of a single, new, reconstructed channel to carry the flow. It would also be feasible to retain the present bridge and channel utilizing the existing hydraulic capacity of that bridge and channel during major flood events, while providing a somewhat smaller, new, relocated channel and bridge. This alternative would have to be addressed in the preliminary engineering studies preceding construction.

It should be noted that there are two areas in this reach, as shown on Map 12 in Chapter VIII, where bedrock is exposed along the creek. The rock exposed is Upper Silurian Waubakee Dolomite. These bedrock exposures are considered to be scientifically important as they represent the only accessible exposure of this formation in eastern Wisconsin. The design of any channel improvement should seek to preserve these geologic outcrops or to provide comparable exposures after the improvements.

The recommended flood control plan for Lower Lincoln Creek would also involve the following diking and supplemental improvements to prevent flood damages in the area between N. Teutonia Avenue (River Mile 1.30) and N. Green Bay Avenue (River Mile 0.43): 1) the installation of approximately 8,400 feet of earthen dike, 2) the installation of about 800 lineal feet of concrete floodwall, and 3) the construction of four permanent storm water pumping stations and backwater gates. Along the north side of Lincoln Creek a concrete floodwall would be constructed from N. Teutonia Avenue at River Mile 1.30 a distance of 800 feet downstream to River Mile 1.15. This floodwall would range in height from two to three feet above the existing grade at the top of the bank. From that point, earthen dikes would be constructed for a distance of about 3,800 feet to the existing N. Green Bay Avenue structure at River Mile 0.43. Along the south side of Lincoln Creek, earthen dikes would be constructed for a distance of about 4,600 feet between N. Teutonia Avenue at River Mile 1.30 and N. Green Bay Avenue at River Mile 0.43. These dikes would range in height from two to four feet above the existing grade at the top of the bank between N. Teutonia Avenue (River Mile 1.30) and W. Villard Avenue (River Mile 0.81), and from three to five feet between W. Villard Avenue(River Mile 0.81) and N. Green Bay Avenue (River Mile 0.43). Approximately 500 feet of earthen diking ranging in height from three to four feet above the existing grade would also be required along the west side of the Creek between W. Cameron Avenue (River Mile 1.53) and the Chicago, Milwaukee, St. Paul & Pacific Railroad (River Mile 1.65). All the dikes would provide for two feet of freeboard under 100-year recurrence interval flood flows.

As a part of the channel improvements along Lower Lincoln Creek, it would be necessary to replace eight bridges, both to provide adequate hydraulic capacity to pass flood flows and to accommodate lowering of the channel bottom. The following bridges would be removed and replaced with new bridges having adequate hydraulic capacity to pass the 100-year recurrence interval flood flow for planned channel and future land use conditions with a headloss of less than one foot: the W. Villard Avenue bridge (River Mile 0.81), the N. Teutonia Avenue bridge (River Mile 1.30), the N. 32nd Street bridge (River Mile 1.90), the Milwaukee Road bridge (River Mile 2.01), the W. Glendale Avenue bridge (River Mile 2.20), the N. 35th Street bridge (River Mile 2.52), the N. 37th Street bridge (River Mile 2.64), and the N. Sherman Boulevard bridge (River Mile 3.03). It is intended that all of the replacement bridges be constructed with the bottom of the spans above the anticipated 100-year recurrence interval flood stage.

It should be noted that the hydraulic analyses indicated that it would be possible to allow a total combined headloss of up to two feet at one or a selected combination of the new bridges. However, it would then be necessary to allow little or no headloss at certain other bridges to offset the higher upstream stages and prevent the design flood flow from exceeding the channel capacity. This allowable headloss, however, does provide some flexibility in the selection of the most economical bridge replacement scheme for this reach of Lower Lincoln Creek.

Because the N. 37th Street and N. Sherman Boulevard crossings are both hydrologically significant--in particular, the N. Sherman Boulevard crossing--replacement of these bridges with structures having larger waterway openings will significantly increase downstream flood flows and stages. Therefore, replacement of these two structures is not recommended until the recommended downstream channel improvements are in place.

On the following five bridges, the foundations for the center piers and abutments may have to be lowered to accommodate the proposed lowered channel bottom grade: the pedestrian bridge at River Mile 2.82, the pedestrian bridge at River Mile 3.48, the N. 51st Street bridge (River Mile 3.59), the pedestrian bridge at River Mile 3.80, and the N. 60th Street bridge (River Mile 4.24).

The following 11 culverts and bridges were determined to have adequate capacity to pass the 100-year recurrence interval flood flow and are not located in a reach of the channel in which the grade is proposed to be lowered: the N. Green Bay Avenue bridge (River Mile 0.43), the pedestrian bridge at River Mile 0.93, the W. Cameron Avenue bridge (River Mile 1.53), the Milwaukee Road bridge (River Mile 1.65), the W. Hampton Avenue bridges (River Mile 1.73 and River Mile 4.41), the pedestrian bridge at River Mile 4.56, the W. Villard Avenue culvert (River Mile 4.92), the N. 60th Street and W. Custer Avenue culvert (River Mile 5.37), the pedestrian bridge at River Mile 5.51, and the W. Silver Spring Drive bridge (River Mile 5.65). Therefore, these culverts and bridges can be retained.

It should be noted that the N. Green Bay Avenue bridge at River Mile 0.43 may be expected to be overtopped by about 0.5 foot during a 50-year recurrence interval flood discharge once all of the recommended upstream channelization is in place. N. Green Bay Avenue is classified as an arterial street, and thus it should not be overtopped during a 50-year recurrence interval flood if sound transportation facility development standards are to be met. Future maintenance or reconstruction projects deemed necessary for this bridge should therefore include raising of the pavement elevation by about 0.5 foot.

Significant bank erosion and sloughing occurs in the reach of channel between W. Villard Avenue (River Mile 0.81) and N. Teutonia Avenue (River Mile 1.30). In addition, minor bank erosion occurs at a number of locations along the channel between N. 35th Street (River Mile 2.52) and N. 60th Street (River Mile 4.24). In order to prevent further erosion in the area immediately downstream of N. Teutonia Avenue (River Mile 1.30), concrete lining similar to that in place upstream of N. Teutonia Avenue should be installed along the first 800 feet of the channel to River Mile 1.15. This lining would be about 60 to 80 feet wide and would be designed to protect the channel bottom from erosion due to increased channel velocities caused by upstream channel improvements. The eroding banks in the reach between W. Villard Avenue and N. Teutonia Avenue should be reshaped and stabilized with gabions, rock riprap, or other suitable bank protection. The bank erosion in the reach between N. 35th Street and N. 60th Street should be eliminated by installation of a concrete lining.

As part of the detailed design of the structural improvements recommended above, the horizontal and vertical location of local utility lines such as the 24-inch diameter and 42-inch diameter Milwaukee Metropolitan Sewerage District trunk sewers crossing Lincoln Creek at River Mile 3.59 and River Mile 2.52, respectively, should be carefully reviewed. The recommended channel improvements should be designed to accommodate the existing utilities, if at all possible. However, the effectiveness of the recommended flood control works should not be compromised, even if the channel improvements require utility reconstruction.

The estimated capital cost for implementation of the recommended plans for Upper and Lower Lincoln Creek is $10,674,000, with an estimated average annual operation and maintenance cost of $8,500. These costs include the cost for implementation of flood control measures in both Upper and Lower Lincoln Creek and costs for lowering the channel in Upper Lincoln Creek to accommodate the existing storm sewer outlets which are located below the existing channel bottom.

Implementation of the flood control portion of the recommended plan for Upper and Lower Lincoln Creek would essentially eliminate all damages resulting from floods on Lincoln Creek up to and including the 100-year recurrence interval event. The benefit-cost ratio of the combined plans would be 1.03, with average annual benefits approximating $649,000 and average annual costs approximating $631,000. The total capital cost of the flood control plan is estimated at $9,921,000 with an annual operation and maintenance cost of $6,500. These costs do not include the costs associated with the lowering of the channel in the Upper Lincoln Creek watershed to accommodate existing storm sewer outlets which are located below the existing channel bottom. The additional capital costs associated with the lowering of the channel to accommodate the storm sewer outlets would be approximately $753,000. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $47,400. Operating and maintenance costs are estimated at $2,000 per year, bringing the total average annual cost to $49,400. Thus the benefit-cost ratio of the continued flood control-drainage improvement plan would be 0.95, with average annual benefits approximately $649,000, excluding any benefits associated with channel deepening to accommodate existing storm sewer outfalls for drainage improvement.

Regulatory Floodway

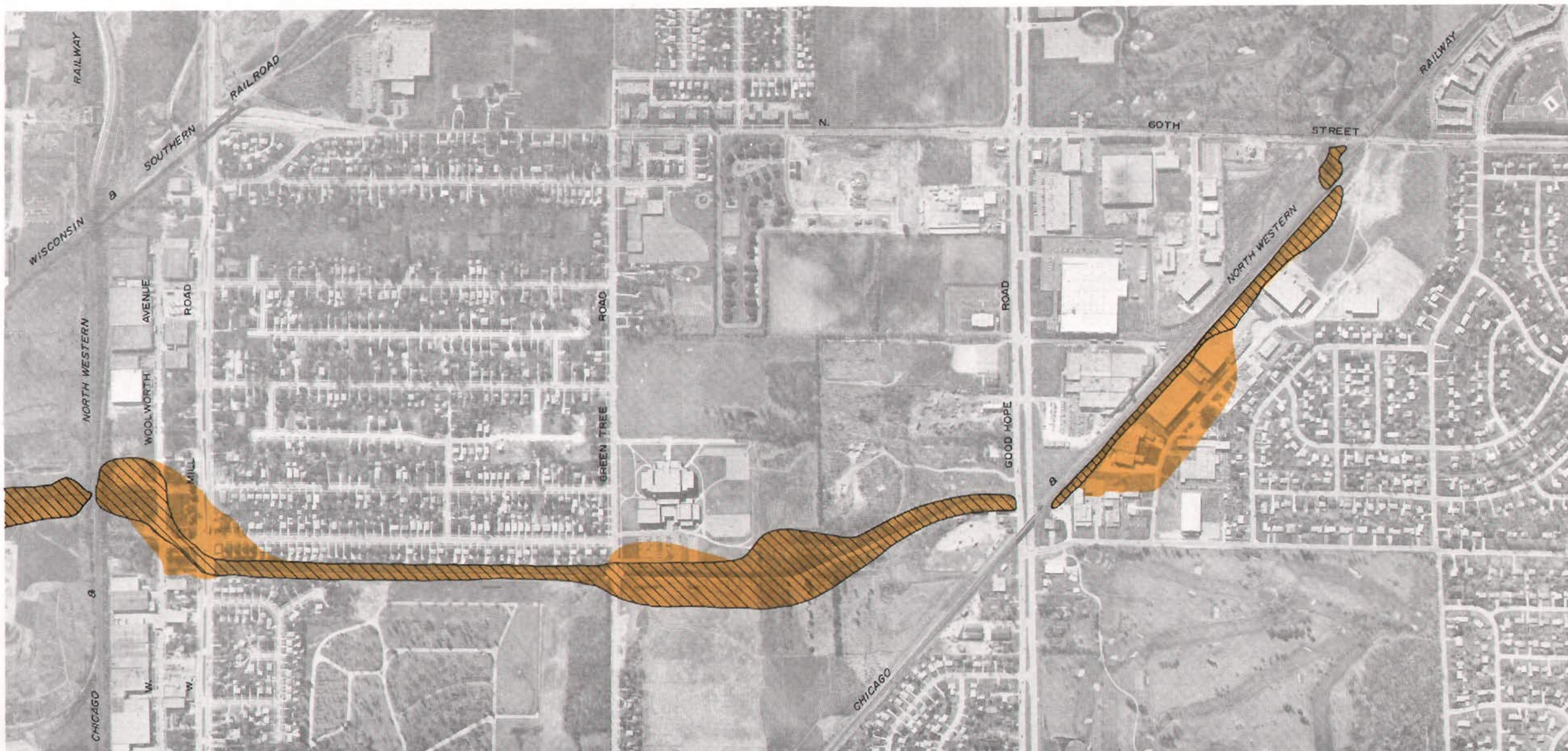
Prior to full implementation of the structural flood control measures recommended in this report, it is recommended that the City of Milwaukee adopt, for floodland zoning purposes, the proposed regulatory floodway shown on Map 15. The proposed floodway for Lower Lincoln Creek is identical to that developed under the federal flood insurance study of the City of Milwaukee. The federal flood insurance study, however, did not develop a floodway for Upper Lincoln Creek. The floodway for this reach--based on the existing channel configuration and capacity and plan year 2000 land use conditions--was developed under this study at the request of the City of Milwaukee. This floodway was developed in accordance with the requirements of Chapter NR 116 of the Wisconsin Administrative Code, and would not, therefore, cause increases in the 100-year recurrence interval flood stage of more than 0.1 foot should the associated flood fringe area be filled and developed.

Havenwoods Urban Environmental Education Center

Although it is recommended in this report that the Wisconsin Department of Natural Resources periodically clean out the channel of Lincoln Creek through the Havenwoods Urban Environmental Education Center in order to enhance the hydraulic capacity of this reach, equivalent measures could be developed by the Department which may be more compatible with the environmental education purposes of the Center. Any such measures, however, must be designed so as not to increase the 100-year recurrence interval flood stages both upstream and downstream of Havenwoods in order to be in compliance with Chapter NR 116 of the Wisconsin Administrative Code. Such measures, moreover, must be designed to avoid the extension of any significant backwater effects upstream through this reconstructed culvert under the Chicago & North Western Railway at River Mile 6.73 in order to avoid Havenwoods flooding in the N. Mill Road area.

Map 15

PROPOSED REGULATORY FLOODWAY FOR LINCOLN CREEK



LEGEND

100-YEAR RECURRENCE INTERVAL FLOODPLAIN BOUNDARY YEAR 2000 LAND USE, EXISTING CHANNEL CONDITIONS

PROPOSED REGULATORY FLOODWAY

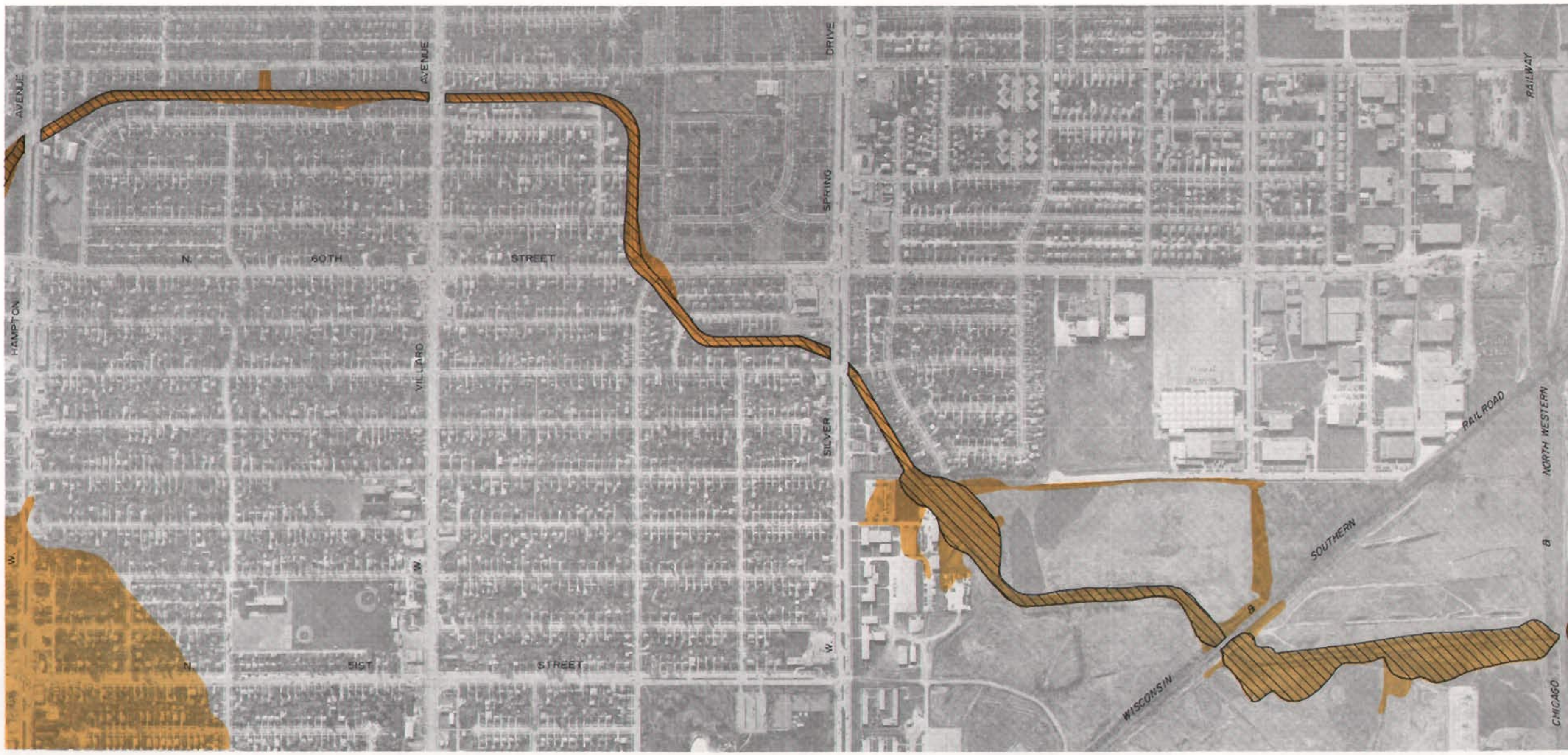
GRAPHIC SCALE

0 0.1 0.2 MILE

DATE OF PHOTOGRAPHY MAY 1980

Source: SEWRPC.

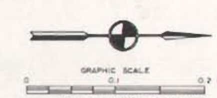
Map 15 (continued)



LEGEND

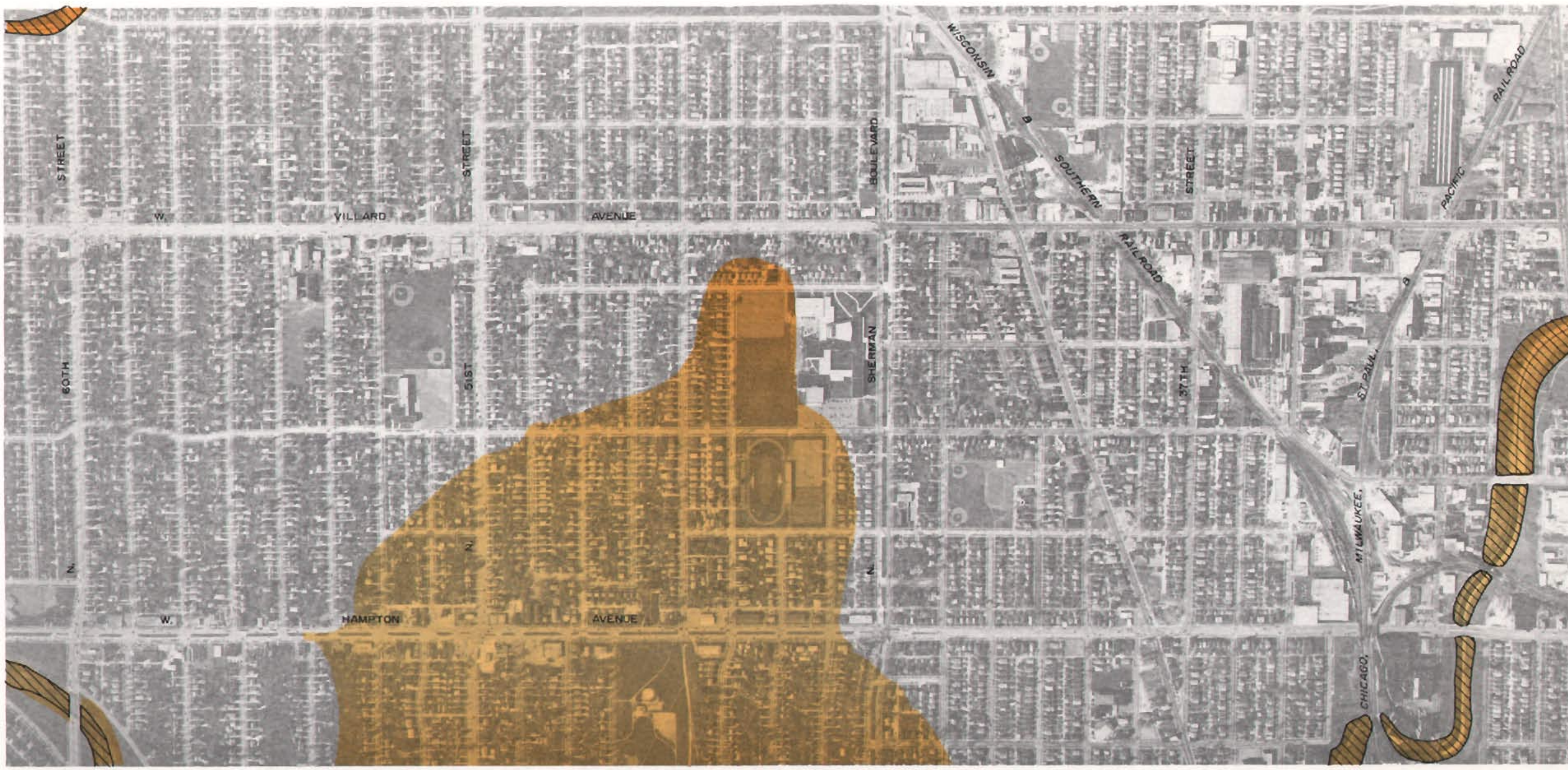
100-YEAR RECURRENCE INTERVAL FLOODPLAIN BOUNDARY
YEAR 2000 LAND USE, EXISTING CHANNEL CONDITIONS

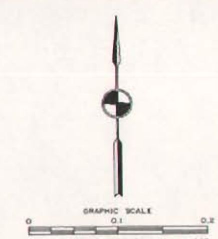
PROPOSED REGULATORY FLOODWAY



Source: SEWRPC.

Map 15 (continued)



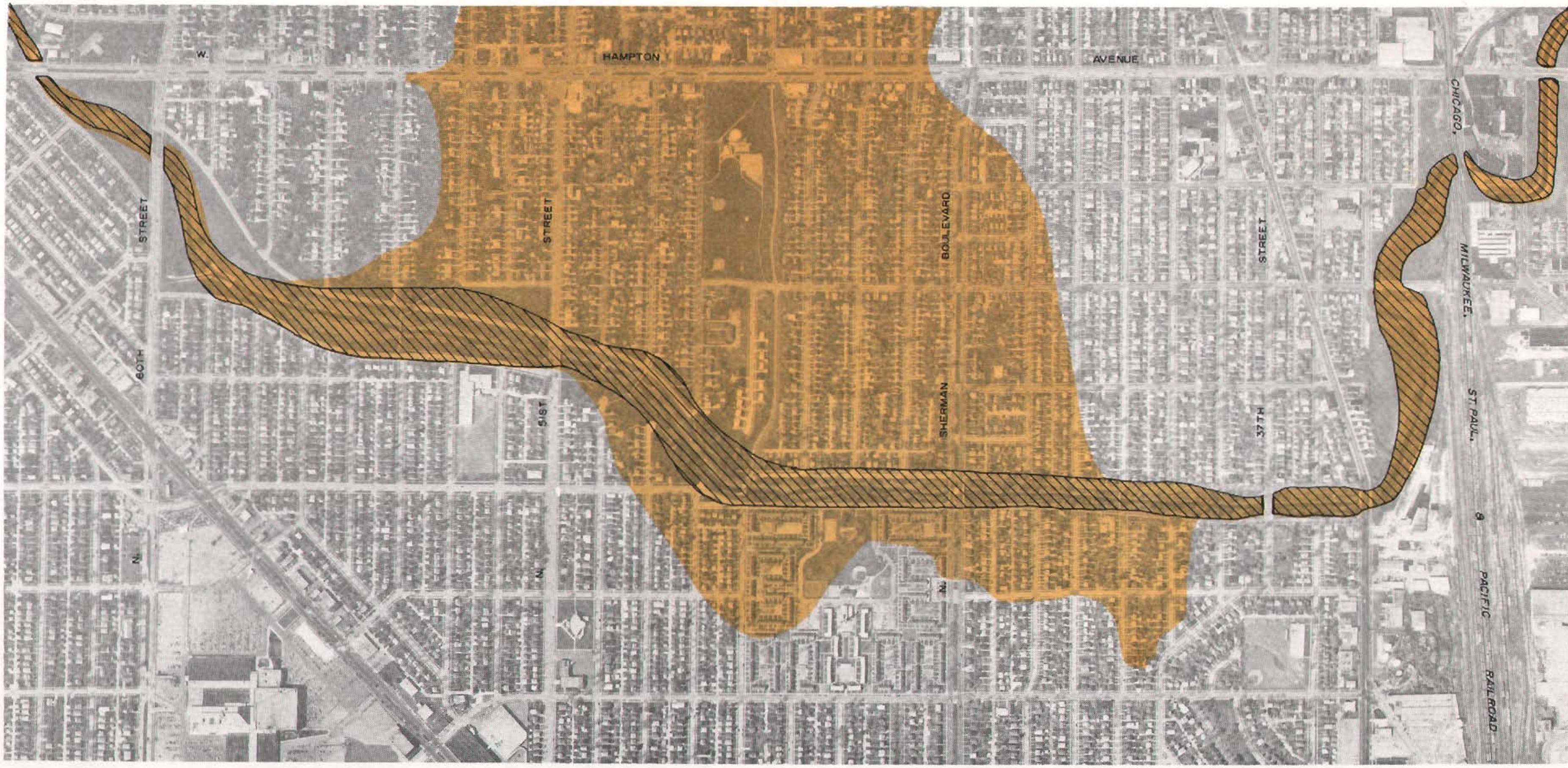


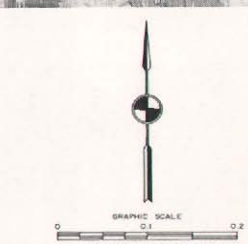
LEGEND

- 100-YEAR RECURRENCE INTERVAL FLOODPLAIN BOUNDARY YEAR 2000 LAND USE, EXISTING CHANNEL CONDITIONS
- PROPOSED REGULATORY FLOODWAY

Source: SEWRPC.

Map 15 (continued)





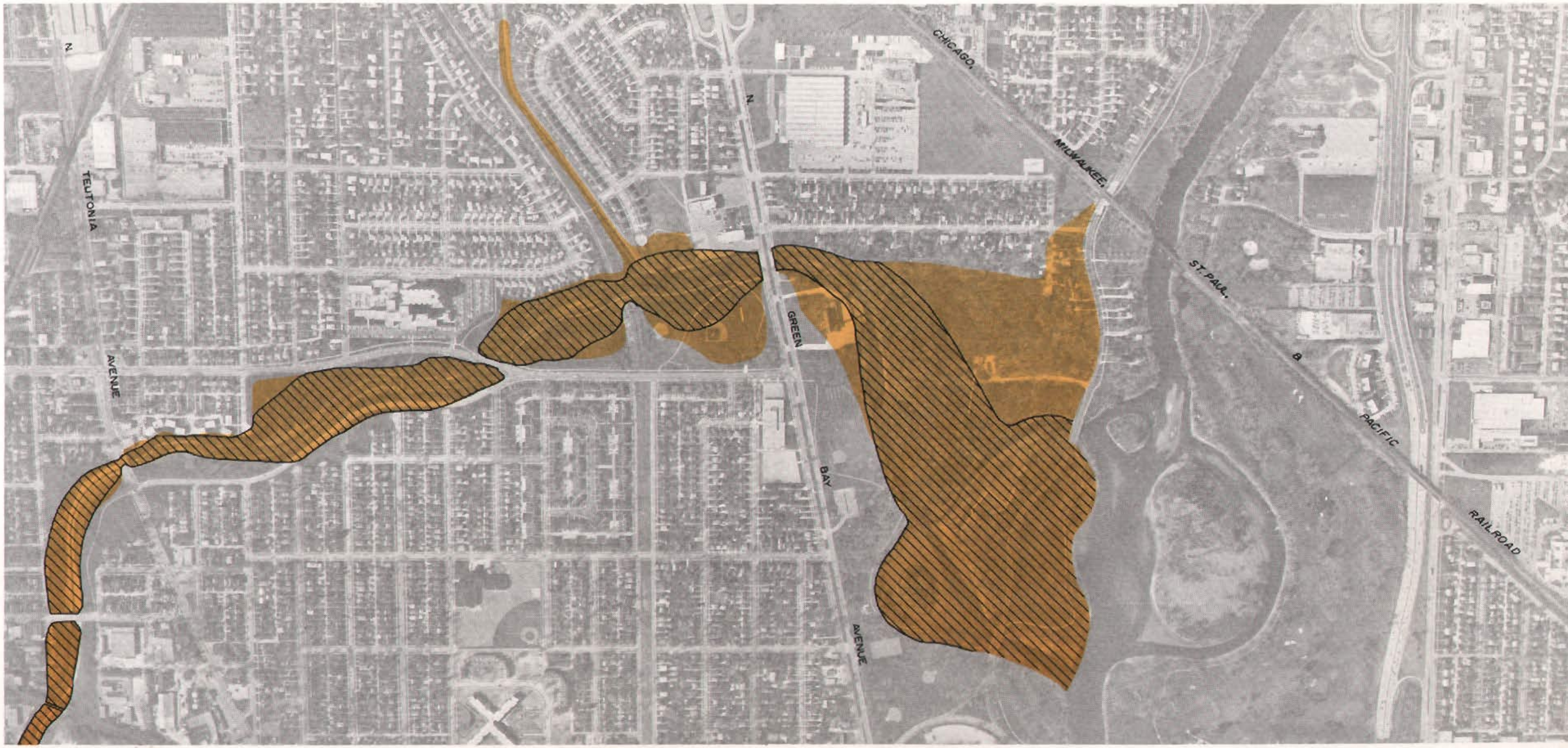
LEGEND

100-YEAR RECURRENCE INTERVAL FLOODPLAIN BOUNDARY YEAR 2000 LAND USE, EXISTING CHANNEL CONDITIONS

PROPOSED REGULATORY FLOODWAY

Source: SEWRPC.

Map 15 (continued)



GRAPHIC SCALE
0 0.1 0.2 MILE
DATE OF PHOTOGRAPHY MAY 1980

LEGEND

100-YEAR RECURRENCE INTERVAL FLOODPLAIN BOUNDARY YEAR 2000 LAND USE, EXISTING CHANNEL CONDITIONS

PROPOSED REGULATORY FLOODWAY

Source: SEWRPC.

Impacts of Recommended Channel Conditions on Flood Flows

Flood discharges for Lincoln Creek under both existing and plan year 2000 land use conditions and under existing channel conditions were presented in Chapter VI. The improvements recommended to alleviate flooding problems in the Lincoln Creek subwatershed will significantly affect flood flows in the subwatershed. The discharges under plan year 2000 land use conditions and recommended channel conditions are set forth in Table 12.

A review was made of the analyses conducted under the comprehensive watershed planning program for the Milwaukee River, as documented in SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, in order to assess the impact of the increased flows on the Milwaukee River downstream of Lincoln Creek. The 100-year recurrence interval flood discharge for Lincoln Creek under plan year 2000 land use conditions and recommended channel conditions is 13,970 cubic feet per second (cfs), substantially higher than the 7,980 cfs expected under existing land use and channel conditions. Because of this increase in peak discharge from Lincoln Creek, it was deemed necessary to consider the impact of this flow downstream of the confluence of Lincoln Creek with the Milwaukee River.

The estimated flow of the Milwaukee River just downstream of Lincoln Creek for a 100-year recurrence interval event under planned land use conditions is 16,400 cfs. Thus, the impact of the flow from Lincoln Creek, which can reach nearly 14,000 cfs under the recommended channel conditions, could have a significant impact on flood flows in the Milwaukee River. Accordingly, an evaluation was conducted of this potential impact.

A review of the timing of peak discharges generated upstream of Lincoln Creek in the Milwaukee River during major flood flow events indicates that the timing of the peak discharge is variable with the type of event, with the earliest peak occurring about eight hours after the beginning of a major rainfall event. The peak discharge from the Lincoln Creek subwatershed generally is expected to occur within three hours of the beginning of a major rainfall event. The types of storms which may be expected to generate high flows in Lincoln Creek were reviewed to determine if the resulting high flows could be expected to result in a peak flow on the Milwaukee River greater than previously estimated. A review of the two synthesized hydrographs shown in Figures 14 and 15 indicates that the peak discharges from Lincoln Creek are not expected to be coincident with peak discharges on the main stem of the Milwaukee River; accordingly, the impacts of the recommended channel improvements on the downstream peak flows should not be significant. Maximum precipitation storm events with a recurrence interval of 100 years and with varying durations of 1, 2, 4, 5, 6, and 12 hours were evaluated. The analyses indicated that the highest peak rate of flow on the Milwaukee River downstream of Lincoln Creek for these storms--14,500 cfs--may be expected to occur with a one-hour storm, and that the peak rate of flow may be expected to drop as the duration of the rainfall storm event increases. The peak rate of flow on the Milwaukee River downstream of Lincoln Creek was estimated at 8,200 cfs for a 12-hour, 100-year recurrence interval rainfall event. These peak rates of flow resulting from rainfall events compare to the estimated maximum 100-year recurrence interval flood flow rate of 16,400 cfs which may be expected to be caused by a spring snowmelt condition in the Milwaukee River watershed, the

Table 12

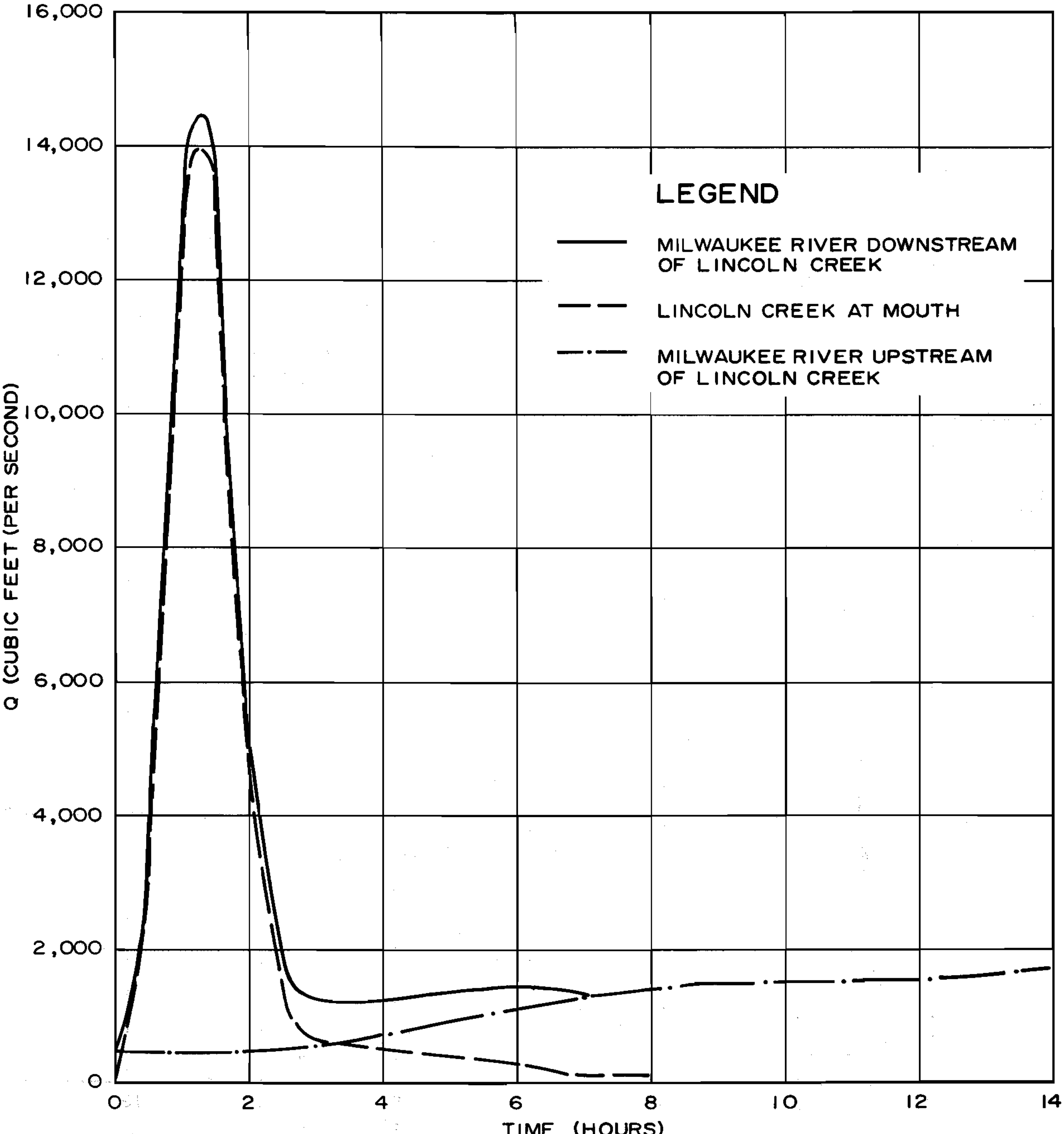
FLOOD DISCHARGES FOR LINCOLN CREEK FOR YEAR 2000 LAND USE CONDITIONS FOR RECOMMENDED CHANNEL CONDITIONS

Location	River Mile	Peak Flood Discharge (cubic feet per second) Planned Land Use, Planned Storage, and Recommended Channel Conditions		
		10-Year	50-Year	100-Year
Mouth at Milwaukee River	0.00	7,700	12,470	13,970
N. Green Bay Avenue	0.43	7,700	12,470	13,970
W. Villard Avenue	0.81	6,960	11,050	12,650
Pedestrian Bridge	0.93	6,960	11,050	12,650
N. Teutonia Avenue	1.30	6,960	11,050	12,650
W. Cameron Avenue	1.53	6,700	10,650	12,200
Chicago, Milwaukee, St. Paul & Pacific Railroad	1.65	6,700	10,650	12,200
W. Hampton Avenue	1.73	6,700	10,650	12,200
N. 32nd Street	1.90	6,700	10,650	12,200
Chicago, Milwaukee, St. Paul & Pacific Railroad	2.01	6,610	10,540	12,080
W.Glendale Avenue	2.20	6,610	10,540	12,080
N. 35th Street	2.52	5,350	8,540	9,790
N. 37th Street	2.64	5,350	8,540	9,790
N. Sherman Boulevard	3.03	5,140	8,200	9,430
N. 51st Street	3.59	4,030	6,310	7,350
Pedestrian Bridge	3.80	4,030	6,310	7,350
N. 58th Street (extended)	4.16	4,030	6,310	7,350
N. 60th Street	4.24	3,200	5,030	5,860
W. Hampton Avenue	4.41	3,200	5,030	5,860
Pedestrian Bridge	4.56	2,500	3,930	4,600
W. Villard Avenue	4.92	1,140	1,840	2,170
N. 60th Street	5.37	1,140	1,840	2,170
W. Silver Spring Drive	5.65	--	--	--
Downstream Side	--	1,140	1,840	2,170
Upstream Side	--	620	980	1,110
Drop Structure	5.79	620	980	1,110
U. S. Army Bridge	6.06	590	930	1,050
Wisconsin & Southern Railroad	6.28	530	850	950
Havenwoods Bridge	6.29	530	850	950
Chicago & North Western Railway	6.73	610	980	1,120
W. Woolworth Avenue	6.82	610	980	1,120
N. 51st Street	6.86	610	980	1,120
W. Mill Road	6.90	610	980	1,120
W. Green Tree Road	7.40	560	850	965
W. Good Hope Road (structure outlet)	7.92	420	640	750
Chicago & North Western Railway (structure inlet)	7.97	210	290	310
Chicago & North Western Railway	8.49	210	290	310
N. 60th Street	8.55	--	--	--
Downstream Side	--	210	290	310
Upstream Side	--	350	590	700

Source: SEWRPC.

Figure 14

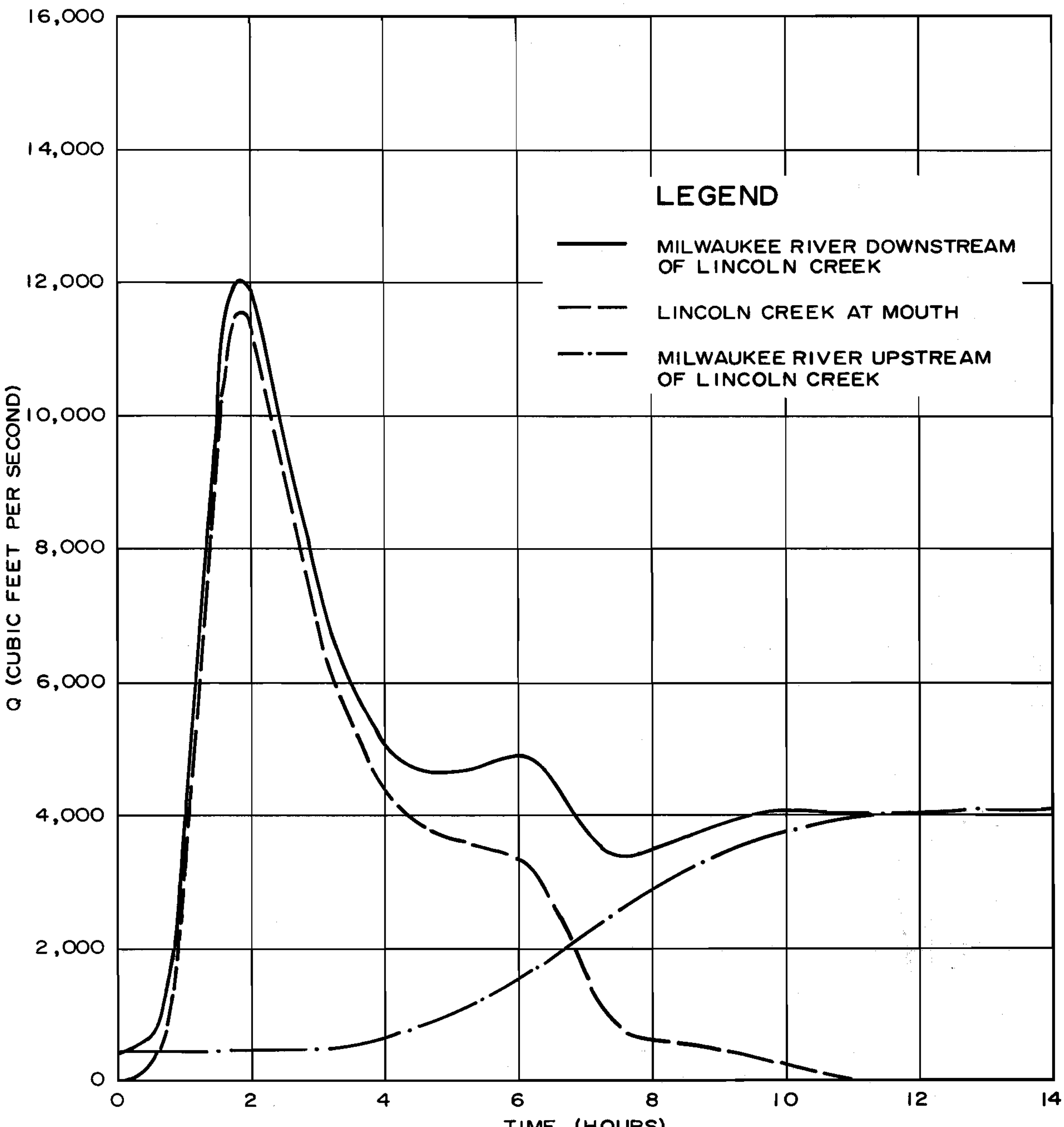
COMPARISON OF FLOOD HYDROGRAPHS FOR MILWAUKEE RIVER AND LINCOLN CREEK FOR A ONE-HOUR DURATION, 100-YEAR RECURRENCE INTERVAL STORM



Source: SEWRPC.

Figure 15

COMPARISON OF FLOOD HYDROGRAPHS FOR MILWAUKEE RIVER AND LINCOLN CREEK FOR A SIX-HOUR DURATION, 100-YEAR RECURRENCE INTERVAL STORM



Source: SEWRPC.

expected critical flood condition on the Milwaukee River. Thus, it may be concluded that the channel improvements recommended for Lincoln Creek should not increase the design flood flows for the Milwaukee River downstream of Lincoln Creek, as those flows were used in the preparation of the Milwaukee River watershed plan.

CONCLUDING REMARKS

The foregoing recommendations to control flooding along Lincoln Creek in the City of Milwaukee have been made based upon systems level analyses. This systems level planning work was conducted in the absence of any large-scale topographic maps prepared to SEWRPC-recommended standards, even though the Commission has recommended since 1964 that local units of government prepare such maps. Upon adoption of a recommended flood control plan for Lincoln Creek, it will be necessary to undertake engineering studies to precisely determine the location and configuration of the recommended channelization improvements. As a first step in this process, the Commission recommends that the implementing agencies obtain large-scale topographic maps prepared to SEWRPC-recommended standards for the riverine areas of the Lincoln Creek subwatershed. The availability of such maps would greatly assist in the conduct of the necessary engineering studies, and would also assist in implementing any necessary floodplain zoning that may be required by the City of Milwaukee and the Federal Emergency Management Agency.

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Chapter X

PLAN IMPLEMENTATION

INTRODUCTION

The flood control measures recommended in the Lincoln Creek plan are structural in nature, and include both major and minor channelization and replacement or modification of designated bridges crossing the main channel of the stream. The recommended measures would, if implemented, abate the most severe existing flood problems of the subwatershed, and, assuming substantial implementation of the adopted regional land use plan, would avoid the creation of future flood problems in the subwatershed. The plan cannot, however, be considered to be complete until the means for its implementation have been specified. Accordingly, this chapter identifies those units and agencies of government which must act to implement the plan, together with the specific implementation actions required.

Implementation of the plan will require the cooperative actions of five primary units and agencies of government: the Federal Emergency Management Agency, the Wisconsin Department of Natural Resources (DNR), the Milwaukee Metropolitan Sewerage District (MMSD), the City of Milwaukee, and Milwaukee County. A sixth potential implementing agency, the U. S. Army Corps of Engineers, could participate in plan implementation should the responsible local units of government seek Corps assistance. The plan implementation recommendations contained in this chapter are, to the maximum extent possible, based upon and related to the existing programs of these five units and agencies of government and are predicated upon existing enabling legislation.

PRINCIPLES OF PLAN IMPLEMENTATION

It is important to recognize that plan implementation measures should grow out of formally adopted plans. Action policies and programs should not only be preceded by formal plan adoption and, following such adoption, be consistent with the adopted plans, but should emphasize implementation of the most important and essential elements of the plan, and those areas of action which will have the greatest impact on guiding and shaping development in accordance with those elements.

The planning process used to prepare the Lincoln Creek flood control plan constituted the first, or systems planning, phase of what may be regarded as a three-phase public works development process. Preliminary engineering is the second phase in this sequential process, with final design being the third and last phase.

The systems planning phase concentrates on the precise definition of the problems to be addressed and on the development and evaluation of alternative measures for resolution of these problems on a technically sound, areawide basis. Systems planning is intended to permit the selection, from among the alternative measures available, of the most effective measure to resolve the identified problems in accordance with agreed-upon objectives and supporting standards.

The preliminary engineering phase of the three-phase public works development process should be able to proceed on the presumption that the optimum solution in terms of technical practicality, economic feasibility, environmental consequences, and other considerations has been identified under the previous systems planning phase. Preliminary engineering should be able to focus solely on examining variations of the solution recommended in the systems plan, and on examining the technical, economic, environmental, and other features of those variations in depth in order to determine the best way to carry out the recommended solution.

Starting with the precise solution to the problem at hand as set forth in the final, approved version of the preliminary engineering report, the final design phase of the process develops the detailed construction plans and specifications needed to implement the recommended solution. In the case of a public works project involving construction, the plans and specifications should be in sufficient detail to permit potential contractors to submit bids for the project and to actually construct the recommended works. The agency responsible for carrying out the final phase should also have responsibility for securing the necessary permits and other approvals from regulatory and review agencies, for providing supervisory and inspection services during actual construction, and for certifying to the responsible governing bodies concerned that the completed construction has been carried out in substantial accord with the plans and specifications.

For many reasons, the three-phase public works development process does not always proceed in the simple three-step fashion as described above. In some situations an iterative process is set in motion whereby a reexamination of an earlier step is required. In every case, each step in the process is subject to the review and approval of the elected governing bodies concerned and the provision by those bodies of the necessary funding.

In some special situations, the public works development process can be carried out without proceeding through the above three phases. For example, systems planning in the area of floodland management may lead to the recommendation that structure floodproofing and removal be used to resolve flood problems. In this instance, assuming adoption of the plan recommendations by the governmental units and agencies concerned, the preliminary engineering phase can be combined with the final design phase, the goal of which would be to provide a precise identification of structures requiring floodproofing and those requiring removal, and of the manner in which floodproofing and removal should be carried out. A similar observation applies to plan implementation through the exercise of zoning and other public land use controls.

PLAN IMPLEMENTATION ORGANIZATIONS

Examination of the various agencies that are available under existing enabling legislation to implement flood control plans reveals an array of departments, commissions, committees, boards, and districts at all levels of government[1].

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[1]A more detailed discussion of the duties and functions of local, areawide, and state agencies as they relate to plan implementation may be found in SEWRPC Technical Report No. 2, Water Law in Southeastern Wisconsin, 2nd Edition, April 1977, and in SEWRPC Technical Report No. 6, Planning Law in Southeastern Wisconsin, 2nd Edition, April 1977.

Those agencies whose actions will have a significant direct effect upon the successful implementation of the recommended comprehensive watershed plan and whose full cooperation in plan implementation will be essential are identified and discussed below. The agencies are, for convenience, discussed by level of government; however, the interdependence between the various levels as well as between agencies of government and the need for close intergovernmental cooperation cannot be overemphasized.

County Park and Planning Agencies

Because of the character and ownership of the riverine areas involved, Milwaukee County must be involved in implementation of the recommended flood control plan for Lincoln Creek. County government has a great deal of flexibility available in forming agencies to perform the park and outdoor recreation and planning functions which may relate to flood control plan implementation. In Milwaukee County, the County Board has recently reassumed full authority and responsibility for park and parkway planning, acquisition, development, operation, and maintenance. The County Board acts through its Parks, Recreation and Culture Committee in matters dealing with parks and parkways. Milwaukee County has also created a County Planning Commission to perform, essentially, a capital budgeting and programming function. This planning commission reviews all requests for capital improvements by Milwaukee County agencies.

Soil and Water Conservation Districts

Stream bank stabilization practices are an important element in the full implementation of the floodland management plan for Lincoln Creek. Lack of such practices will eventually have an adverse effect upon water quality conditions, aquatic habitat, and aesthetics, as well as upon flood control. Soil and water conservation districts, as authorized under Section 92.05 of the Wisconsin Statutes, have the authority to develop plans for the conservation of soil and water resources, prevention of soil erosion, and prevention of floods. Technical and educational services can be provided to aid in the establishment of both urban and rural land management practices. Soil and water conservation districts have the authority to acquire through eminent domain any property or rights therein for watershed protection, soil and water conservation, flood prevention works, and fish and wildlife conservation and recreation works.

In Wisconsin, soil and water conservation districts are by law geographically coterminous with counties. Milwaukee County, which contains the Lincoln Creek subwatershed, consists of such a district. This district, which is in effect governed by the Energy, Environment and Extension Education Committee of the Milwaukee County Board, has entered into basic and supplemental memoranda of understanding with the U. S. Department of Agriculture, Soil Conservation Service, for technical assistance. Thus, there exists within the County and the subwatershed a duly constituted body responsible for carrying out erosion control programs and representing the County with respect to such programs as may be administered by state and federal agencies. Because all of Milwaukee County lies within incorporated units of government, the soil and water conservation district can provide educational, financial, and technical assistance but cannot exercise any regulatory powers, as it may in unincorporated areas.

Municipal Planning Agencies

Municipal planning agencies include city plan commissions created pursuant to the Wisconsin Statutes. Such agencies are important to flood control plan implementation at the local level, particularly with respect to implementation of recommended zoning and other public land use controls. The City of Milwaukee has established a plan commission in accordance with Section 27.11 of the Wisconsin Statutes. Within the City, the Department of City Development studies and makes recommendations on the physical, economic, and cultural condition of the City. The City Plan Commission and Department of City Development have important roles in the adoption of needed floodland zoning measures in the Lincoln Creek subwatershed. The city's Department of Public Works, Bureau of Bridges and Public Buildings, has responsibility for the operation and maintenance of all city-owned bridges. Another bureau of the Department of Public Works, the Bureau of Engineers, provides planning, engineering, survey, and inspection services for the city's public works program. The city's Building Inspection and Safety Engineering Department is responsible for enforcing the city's building and zoning ordinances, including floodland zoning.

Milwaukee Metropolitan Sewerage District

The Milwaukee Metropolitan Sewerage District is a special-purpose unit of government which is governed by two commissions which share a common staff and normally act jointly--the Metropolitan Sewerage Commission of the County of Milwaukee and the Sewerage Commission of the City of Milwaukee.[2] The Milwaukee Metropolitan Sewerage District consists of all of Milwaukee County except the City of South Milwaukee. The Metropolitan Sewerage Commission of the County of Milwaukee, which exists pursuant to the provisions of Section 59.96 of the Wisconsin Statutes, has the authority to improve any watercourse within the District by deepening, widening, or otherwise changing the watercourse as may be necessary to carry off surface waters or drainage waters. The Metropolitan Sewerage Commission, however, may only exercise its powers outside the City of Milwaukee. The Sewerage Commission of the City of Milwaukee has authority to improve watercourses within the City of Milwaukee.

Wisconsin Department of Natural Resources

The Wisconsin Department of Natural Resources has broad authority and responsibility in the areas of park development, natural resources protection, water quality control, and water regulation. The Department has the obligation to establish standards for floodplain zoning and the authority to adopt, in the absence of satisfactory local action, floodplain zoning ordinances. The Department also has authority to regulate water diversions, shoreland grading, dredging, encroachments, and deposits in navigable waters; the construction of neighboring ponds, lagoons, waterways, stream improvements, and pierhead and bulkhead lines; the construction, maintenance, and abandonment of dams; and water levels of navigable lakes and streams and lake and stream improvements,

[2]As of the date of publication of this report, State legislation had been enacted to reorganize the District, providing a single governing body.

including the removal of certain lake bed materials. Finally, the Department has the authority to administer state financial aid programs for water resource protection. Importantly, the Department is the owner and operator of the Havenwoods Urban Environmental Education Center, which is traversed by Lincoln Creek.

Federal Emergency Management Agency

The Federal Emergency Management Agency serves as the main contact in the federal government on emergency matters. Among its activities are the provision of technical assistance programs to state and local governments to reduce or eliminate flood risks and the administration of programs to assist individuals and businesses in obtaining insurance protection against, among other emergencies, floods. The Agency promulgates floodland management regulations which must be met if flood-prone properties are to be eligible for federal flood insurance.

U. S. Army Corps of Engineers

The U. S. Army Corps of Engineers can conduct planning studies, and construct flood control facilities as authorized by the U. S. Congress. There are two programs which could be used by the Corps to undertake plan implementation activities on Lincoln Creek. Under Section 205 of the federal Flood Control Act of 1948, as amended, the Corps is authorized under its small continuing authorities program to contribute to the design and construction phases of certain flood control projects, provided the maximum cost to the Corps is $4 million or less. Projects to be included under this program are authorized by the Chief of Engineers. A second program, the general investigation program, requires explicit Congressional authorization and appropriation. This type of project would be done in several phases, including a three-stage feasibility study followed by a construction phase. Both the feasibility study and the construction phase require explicit Congressional approval, and implementation of projects under the program can require more than a decade to accomplish. There is no limit to the funding which can be made available under this program. However, both of the programs require that the projects be demonstrated to be economically feasible and environmentally sound.

While the structural flood control elements comprising the recommended Lincoln Creek flood control plan can be implemented by existing local units and agencies of government, the Corps of Engineers could participate in the implementation of the plan provided that responsible local agencies or units of government determine to pursue participation in implementation. This would require strong Congressional as well as local support. Local implementation would be more certain and expeditious, but this certainty and expediency must be weighed by the governing bodies concerned against the potential financial support that may be available for plan implementation.

PLAN ADOPTION AND INTEGRATION

Adoption, endorsement, or formal acknowledgement of the comprehensive watershed plan by the local legislative bodies and the existing local, areawide, state, and federal level agencies concerned is highly desirable to assure a common understanding among the several governmental levels and to enable their staffs to program the necessary implementation work.

Upon adoption or endorsement of the Lincoln Creek flood control plan by a unit or agency of government, it is recommended that the policy-making body of the unit or agency direct its staff to review in detail the elements of the flood control plan. Once such review is completed, the staff can propose to the policy-making body for its consideration and approval the steps necessary to fully integrate the plan elements into the plans and programs of the unit or agency of government. More specifically:

1. It is recommended that the Milwaukee County Board formally adopt the Lincoln Creek flood control plan, by resolution pursuant to Sections 27.04(2) and 66.945(12) of the Wisconsin Statutes, after a report and recommendation by the County Parks, Recreation and Culture Committee and County Planning Commission.

2. It is recommended that the Soil and Water Conservation District of Milwaukee County adopt those portions of the recommended Lincoln Creek flood control plan affecting it so as to establish a basis for the provision of technical services for erosion control measures.

3. It is recommended that the Metropolitan Sewerage Commission of the County of Milwaukee and the Sewerage Commission of the City of Milwaukee, acting jointly, adopt the recommended Lincoln Creek flood control plan as such plan affects the work of those bodies.

4. It is recommended that the City Plan Commission of the City of Milwaukee adopt the recommended Lincoln Creek flood control plan, by resolution pursuant to Section 62.23(3)(b) of the Wisconsin Statutes, and certify such adoption to the Common Council, and that the Council also act to formally adopt the recommended plan.

5. It is recommended that the Wisconsin Natural Resources Board endorse the Lincoln Creek flood control plan.

6. It is recommended the the Federal Emergency Management Agency endorse the Lincoln Creek flood control plan and utilize this plan in the administration of its flood insurance program.

7. It is recommended that the U. S. Army Corps of Engineers acknowledge the Lincoln Creek flood control plan.

8. It is recommended that the Southeastern Wisconsin Regional Planning Commission adopt the Lincoln Creek flood control plan as a refinement to the adopted comprehensive plan for the Milwaukee River watershed.

FLOODLAND MANAGEMENT PLAN ELEMENT IMPLEMENTATION

The major floodland management recommendation contained in the Lincoln Creek flood control plan is the application of structural flood control measures to abate existing and future flood problems. It is recommended that the channel modification subelement be implemented expeditiously through the cooperative efforts of the City of Milwaukee, Milwaukee County, and the Milwaukee Metropolitan Sewerage District. More specifically, it is recommended that the District design, construct, and maintain the major channel improvements recommended along Lower Lincoln Creek from N. 32nd Street upstream to W. Hampton Avenue, a distance of 2.5 miles. It is further recommended that the District design, construct, and maintain the channel improvements and dikes recommended along Lower Lincoln Creek from N. Green Bay Avenue upstream to N. Teutonia Avenue, a distance of about 0.9 mile, and the dikes recommended along the west side of the Creek between W. Cameron Avenue and the Chicago, Milwaukee, St. Paul & Pacific Railroad, a distance of about 500 feet. Along Upper Lincoln Creek, it is recommended that the District design and construct the channel improvements recommended along Upper Lincoln Creek from River Mile 6.67 downstream of the Chicago & North Western Railway south of W. Woolworth Avenue to the Chicago & North Western Railway just east of N. 60th Street, a distance of about 1.8 miles. It is recommended that the District remove the drop structure at the inlet to the W. Good Hope Road culvert concurrently with channel improvements to be made above this structure. It is further recommended that the District clean out the channel from the drop structure at River Mile 5.79 upstream to the Wisconsin & Southern Railroad, a distance of about 0.5 mile. It is emphasized that in this latter reach, channel enlargement is not called for, but simply the removal of debris and deadfalls, and the removal of live, woody plants smaller than two inches in diameter where such plants are concentrated in sufficient numbers to significantly impede the flow of floodwaters. Such cleaning should be done carefully to preserve as much as practical of the existing terrestrial and aquatic wildlife habitat and pool and riffle regime in this reach. The foregoing recommendations addressed to the District are made in recognition that the District's authority in these matters is permissive and nonmandatory in nature.

It is further recommended that Milwaukee County cooperate fully in the major channel improvements through the provision of attendant construction easements and rights-of way and modify, as necessary, the three pedestrian bridges located at River Miles 2.82, 3.48, and 3.80 to accommodate the proposed lowered channel bottom grade.

It is further recommended that the District work with the railroad companies involved in the design and construction of the bridge required to carry the Milwaukee Road over the recommended channel relocation at River Mile 2.01, and the replacement bridge or culvert under the Chicago & North Western Railway at River Mile 6.73.

It is recommended that the Wisconsin Department of Natural Resources clean out the channel from the Wisconsin & Southern Railroad Company tracks upstream through Havenwoods to the Chicago & North Western Railway, also preserving as much as practical of the existing terrestrial and aquatic wildlife habitat and pool and riffle regime in this reach.

It is recommended that the City of Milwaukee remove and replace or modify, as necessary, the bridges at W. Villard Avenue, N. Teutonia Avenue, N. 32nd Street, W. Glendale Avenue, N. 35th Street, N. 37th Street, N. Sherman Boulevard, N. 51st Street downstream of N. 60th Street, N. 60th Street, W. Woolworth Avenue, N. 51st Street upstream of W. Woolworth Avenue, and W. Green Tree Road, all as necessary to provide the required hydraulic capacity and to accommodate channel improvements to be made by the District. The replacement of the N. 37th Street bridge should not be undertaken until downstream channel improvements by the District are in place to accommodate the increased downstream flood flows that will be attendant to the removal of this hydrologically significant structure.

It is similarly recommended that the City of Milwaukee replace the hydrologically significant structure at N. Sherman Boulevard only after downstream channel improvements by the District are in place, and only after the N. 37th Street bridge has been replaced by the City of Milwaukee.

The recommended implementation responsibilities are summarized in Table 13. The capital costs associated with the various components of the recommended plan are summarized by agency in Table 14.

Table 13

RECOMMENDED PLAN IMPLEMENTATION RESPONSIBILITIES FOR THE LINCOLN CREEK FLOOD CONTROL PLAN

Action or Project	Responsible Agency					
	Milwaukee Metropolitan Sewerage District	Milwaukee County	City of Milwaukee	Wisconsin Department of Natural Resources	Federal Emergency Management Agency	SEWRPC
Actions Relating to Plan						
Plan Adoption/Endorsement	X	X	X	X	X	X
Revise Federal Flood Insurance Study			X	X	X	
Revise Floodplain Zoning Ordinance			X	X	X	
Upper Lincoln Creek						
Channel Deepening and Widening from Chicago & North Western Railway Crossing to W. Good Hope Road	X					
Remove Concrete Drop Spillway Upstream of W. Good Hope Road	X					
Channel Deepening and Widening from W. Good Hope Road to W. Mill Road	X					
Replace W. Green Tree Road Bridge			X			
Construct Dikes Upstream of W. Mill Road	X					
Channel Deepening from W. Mill Road to W. Woolworth Avenue	X					
Replace W. Woolworth Avenue Bridge			X			
Replace N. 51st Street Bridge			X			
Channel Deepening and Widening from W. Woolworth Avenue to Pedestrian Bridge at Havenwoods	X					
Replace Concrete Arch Culvert Under Chicago & North Western Railway	X[a]					
Channel Cleaning and Debrushing through Havenwoods				X		
Channel Cleaning and Debrushing through U. S. Army Reserve Training Center	X					
Lower Lincoln Creek						
Channel Reconstruction, Concrete Lining, and Revegetation from W. Hampton Avenue to N. 32nd Street	X					
Construct New Milwaukee Road Bridge	X[a]					
Modify N. 51st Street and N. 60th Street Bridge Structures			X			
Modify Three Pedestrian Bridges		X				
Replace N. Sherman Boulevard, N. 37th Street, N. 35th Street, W. Glendale Avenue, and N. 32nd Street Bridges			X			
Construct Dikes Along West Bank Between the Chicago, Milwaukee, St. Paul & Pacific Railroad Crossing Downstream of Hampton Avenue and W. Cameron Avenue	X					
Construct Concrete Flood Wall Along North Bank and Concrete Channel Bottom Lining from N. Teutonia Avenue to N. 27th Street Extended	X					
Construct Dikes Along the North Bank from N. 27th Street Extended to W. Villard Avenue and Along the South Bank from N. Teutonia Avenue to W. Villard Avenue	X					
Reshape and Stabilize Stream Banks from N. 27th Street Extended to W. Villard Avenue	X					
Replace N. Teutonia Avenue and W. Villard Avenue Bridges			X			
Construct Dikes Between W. Villard Avenue and N. Green Bay Avenue	X					

[a] *It is intended that the Milwaukee Metropolitan Sewerage District coordinate its channel improvement efforts with the railroads involved. The railroad companies would have the responsibility to replace or reconstruct the identified culverts and bridges.*

Source: SEWRPC.

Table 14

SUMMARY OF RECOMMENDED PLAN CAPITAL COSTS

Implementing Agency	Improvements	Estimated Capital Cost
Milwaukee Metropolitan Sewerage District..........	Channel Improvements and Diking	$ 4,472,000
	Bridge Replacement and Modification	3,068,000
Subtotal		$ 7,540,000
City of Milwaukee..........	Bridge Replacement and Modification	$ 3,062,000
Milwaukee County...........	Bridge Modification	60,000
Wisconsin Department of Natural Resources.....	Channel Debrushing	12,000
Total		$10,674,000[a]

[a]Of the total capital cost of the recommended plan, $9,921,000 may be attributed flood control, and $753,000, involving channel deepening to accommodate existing storm sewer outfalls, to improved drainage.

Source: SEWRPC.

Chapter XI

SUMMARY AND CONCLUSIONS

The flood control plan for Lincoln Creek, as presented herein, constitutes an extension and refinement of the Milwaukee River watershed plan completed by the Southeastern Wisconsin Regional Planning Commission in 1972;[1] and of the flood control plan for Lincoln Creek prepared by the Commission in September 1977 in response to a formal request from the Sewerage Commission of the City of Milwaukee and presented in an earlier edition of this report.[2] The refinement was undertaken because of the availability of new topographic data from the U. S. Geological Survey, the Wisconsin Department of Natural Resources (DNR), and the Milwaukee Metropolitan Sewerage District, and because the DNR requested an evaluation of additional flood control alternatives for the Havenwoods Urban Environmental Education Center. Financial support for the study was provided by the City of Milwaukee, Department of City Development. Field survey data needed to prepare the plan were provided by the Milwaukee Metropolitan Sewerage District.

The Lincoln Creek subwatershed is located entirely within Milwaukee County, and almost entirely within the City of Milwaukee. Small portions of the subwatershed are located in the Village of Brown Deer and the City of Glendale. Lincoln Creek originates in the northwestern part of the City of Milwaukee in the vicinity of N. 76th Street and W. Good Hope Road, and flows generally in a southeasterly direction through the City of Milwaukee for a distance of approximately nine miles to its confluence with the Milwaukee River. Lincoln Creek has a drainage area of about 19.26 square miles. For the purpose of this report, that portion of Lincoln Creek lying north of W. Silver Spring Drive, which drains an area of approximately 4.09 square miles, has been designated as "Upper Lincoln Creek;" that portion lying south of W. Silver Spring Drive, which has a drainage area of approximately 15.17 square miles, has been designated "Lower Lincoln Creek."

The recently acquired topographic data were utilized to make a refined application of the hydrologic and hydraulic simulation model of the Lincoln Creek subwatershed previously developed by the Commission. The model was calibrated using historic flood stage data collected by the City of Milwaukee and by the Milwaukee Metropolitan Sewerage District. The refined flood discharges and associated flood stages for existing land use and channel conditions were generally lower than those presented in the federal flood insurance study (FIS) for the City of Milwaukee and in the flood control plan for

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[1]See SEWRPC Planning Report No. 13, A Comprehensive Plan for the Milwaukee River Watershed, Volume One, Inventory Findings and Forecasts, and Volume Two, Alternative Plans and Recommended Plan.

[2]See SEWRPC Community Assistance Planning Report No. 13, Flood Control Plan for Lincoln Creek, Milwaukee County, Wisconsin, First Edition, September 1977. This report supersedes and replaces the first edition in its entirety.

Lincoln Creek completed in 1977 by the Commission. The refined discharges and stages were also generally lower for plan year 2000 land use and existing channel conditions.

The refined analyses indicated that 1,494 structures were located within the 100-year recurrence interval flood hazard area along Lincoln Creek, substantially less than the 2,270 structures estimated to be located in this flood hazard area by the federal flood insurance study, and the 2,710 structures estimated to be located in this flood hazard area in the earlier flood control plan. The reduction in the number of structures in the floodplain was due primarily to the refined analyses made possible by the availability of the new topographic data.

Average annual flood damages along Lower Lincoln Creek under existing 1975 and plan year 2000 land use and existing channel conditions were estimated at $444,000 and $617,000, respectively. A 100-year recurrence interval flood may be expected to result in damages of about $12,700,000 under 1975 land use conditions, and about $14,400,000 under plan year 2000 land use conditions. Most of the flood damages along Lower Lincoln Creek are incurred between N. 37th and N. 53rd Streets. Average annual flood damages along Upper Lincoln Creek under existing 1975 and plan year 2000 land use and existing channel conditions were estimated at $17,900 and $32,300, respectively. A 100-year recurrence interval flood may be expected to result in damages of about $252,000 under 1975 land use conditions, and about $308,000 under plan year 2000 land use conditions. Most of the flood damages along Upper Lincoln Creek are incurred in the vicinity of W. Mill Road and in the industrial area located north of W. Good Hope Road.

To alleviate flood damages at the locations cited above, a number of alternative flood control measures were designed, tested, and evaluated. These measures included major and minor channelization; replacement of hydraulic structures; storage; diking and pumping; and the floodproofing, elevation, or removal of structures in the floodplain. Combinations of these measures were also evaluated. The implementation costs of the various alternatives considered were estimated and compared to the direct monetary damages abated to determine a benefit-cost ratio. Included in the alternatives analyses was an evaluation of a combination wetland basin/flood control structure on the Havenwoods Urban Environmental Education Center site proposed by the DNR.

UPPER LINCOLN CREEK SUBWATERSHED

The alternatives described and evaluated for Upper Lincoln Creek subwatershed are briefly summarized below:

Alternative Plan 1--No Action

Although technically feasible, the first alternative plan considered--No Action--is not considered practical. If no action is taken, 25 structures along Upper Lincoln Creek will continue to experience flood damage, and the average annual flood damage cost of $32,300 may be expected to continue to be incurred, with damages attendant to a 100-year recurrence interval flood reaching $308,000. It is highly unlikely that the residents of the flood-prone areas would be content to allow a flood damage problem of this magnitude to continue, and it is likely that they would demand some public abatement action.

Alternative Plan 2--Limited Channelization

Alternative Plan 2--Limited Channelization--would provide for minor channelization between W. Good Hope Road and the Chicago & North Western Railway tracks just east of N. 60th Street, a distance of about 0.4 mile; and from the Chicago & North Western Railway tracks south of W. Woolworth Avenue upstream through Mill Road, a distance of about 0.2 mile. Along with these minor channel improvements, this alternative would involve the replacement of the Chicago & North Western Railway bridge, limited diking above W. Mill Road, and channel cleanout and debrushing through the U. S. Army property and the Havenwoods Urban Environmental Education Center, a distance of about 0.9 mile.

Channelization through the Havenwoods Urban Environmental Education Center was not considered necessary. Channelization through the Center would not benefit the U. S. Army and Havenwoods properties because the floodplains involved are in primarily natural, open uses. Flood velocities in this channel reach, moreover, are not high enough to justify channelization for bank erosion control.

Implementation of Alternative Plan 2 would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The channel improvements contemplated under this alternative would not significantly increase downstream flood stages. The capital cost of this alternative is estimated at $329,600, with annual operating and maintenance costs estimated at $500. The ratio of average annual benefits to the total average annual cost of this alternative plan is 1.52, with average annual benefits of $32,300 and average annual costs of $21,300.

Alternative Plan 2 is considered to be feasible from a technical and economic point of view.

Alternative Plan 3--Floodwater Storage

Alternative Plan 3--Floodwater Storage--would provide for the construction of two detention reservoirs. One detention reservoir with a capacity of 84 acre-feet would be located on a 16-acre site between W. Good Hope Road and W. Green Tree Road. A second detention reservoir would be developed by constructing a new earthen dike and control spillway at the outlet of the lowest of 11 ponds located on the Brynwood Country Club grounds just west of N. 60th Street. The series of ponds would then have a capacity of about 40 acre-feet. In addition to these reservoirs, this alternative would involve the replacement of the Chicago & North Western Railway bridge as well as channel cleanout and debrushing of the channel through the U. S. Army property and Havenwoods, a distance of about 0.9 mile. This alternative would also require the floodproofing of seven structures located between W. Woolworth Avenue and W. Mill Road.

As part of this alternative, an analysis was made of the floodwater storage potential of a site in Havenwoods immediately upstream of the Wisconsin & Southern Railroad Company tracks. The Wisconsin & Southern Railroad track structure provides a moderate amount of floodwater storage because of its relatively small hydraulic capacity. It was concluded that no significant flood control benefit would be realized by providing additional floodwater storage at this site because: 1) flood damages between the site and W. Silver Spring Drive are minor under both existing and planned future land use conditions; and 2) flood flows in the heavily urbanized reach downstream of W. Silver Spring Drive would not be significantly reduced by the provision of additional floodwater storage at the Havenwoods site.

Implementation of Alternative 3 would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The capital cost of this alternative is estimated at $523,000, with annual operating and maintenance costs estimated at $1,100. The ratio of the average annual benefits to the total average annual cost of this alternative plan is 0.95, with average annual benefits of $32,300 and average annual costs of $34,000.

Alternative Plan 3 is considered to be feasible from a technical point of view. However, from an economic point of view costs exceed benefits and less costly alternatives are available.

Alternative Plan 4--Diking

Alternative Plan 4--Diking--would provide for the construction of 1,200 feet of earthen dike to confine floodwaters for a distance of about 500 feet along the west side of the channel above Mill Road and for a distance of about 700 feet along the east side of the channel above W. Good Hope Road. In addition to the construction of dikes, this alternative would involve the replacement of the Chicago & North Western Railway bridge, channel cleanout and debrushing of the channel through the U. S. Army property and the Havenwoods site, and floodproofing of seven structures located between W. Woolworth Avenue and W. Mill Road.

Implementation of Alternative Plan 4 would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The channel improvements contemplated under this alternative would not significantly increase downstream flood stages. The capital cost of this alternative is estimated at $404,000, with annual operating and maintenance costs estimated at $700. The ratio of average annual benefits to the total average annual cost of this alternative plan is 1.23, with average annual benefits of $32,300 and average annual costs of $26,200.

Alternative Plan 4 is considered to be feasible from a technical and economic point of view.

Alternative Plan 5--Structure Floodproofing, Elevation, and Removal

Alternative Plan 5--Structure Floodproofing, Elevation, and Removal--would provide for the elevation of 14 structures and the floodproofing of 11 structures. These 25 structures, consisting of 16 residences and 9 business and industrial structures located on the west side of the channel in the vicinity of W. Mill Road, between W. Woolworth Avenue and W. Mill Road, and on the east side of the channel just north of Good Hope Road, represent the total number of existing structures that may be expected to experience direct flooding in the Upper Lincoln Creek subwatershed.

Implementation of Alternative Plan 5 would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The capital cost of this alternative is estimated at $407,000. The ratio of average annual benefits to the total average annual cost of this alternative plan is 1.25, with average annual benefits of $32,300 and an average annual cost of $25,800.

Alternative Plan 5 is considered to be feasible from a technical and economic point of view.

Additional alternatives were analyzed to provide free outlets for eight existing storm sewers which have inverts set at elevations below the existing channel bottom. These alternatives are briefly described below:

Storm Sewer Outlet Relief Alternative 1--No Action

Although technically feasible, the first alternative plan considered--No Action--is not considered practical. If no action is taken, the special sewer maintenance problems due to solids buildup in the sewer will continue and there would be potential for storm water ponding in the tributary drainage areas as a result of the restricted capacity of the storm sewer outlets.

Storm Sewer Outlet Relief Alternative 2--Channel Deepening

Alternative 2 for the relief of the existing storm sewer outfalls would provide for deepening of the channel from River Mile 6.67 upstream to the Chicago & North Western Railway culvert at River Mile 8.49. The channel would be lowered from one-half foot to seven feet, with an average depth of excavation of about four feet. The channel at the W. Mill Road and W. Good Hope Road structures would be lowered to meet the existing concrete inverts and the concrete drop structure at the entrance to the Good Hope Road-Chicago & North Western Railway structure would be removed.

This alternative would also include the reconstruction of the following four bridges: the Chicago & North Western Railway bridge (River Mile 6.73), the W. Woolworth Avenue bridge (River Mile 6.82), the N. 51st Street bridge (River Mile 6.86), and the W. Green Tree Road bridge (River Mile 7.40). The capital cost for replacing the Chicago & North Western Railway bridge, which is also recommended to be replaced in the flood control alternative, is included under the recommended flood control plan, and is not, therefore, included in the capital cost of this alternative.

The implementation of this alternative would essentially provide free outlet for the eight storm sewers described above. The capital cost of this alternative is estimated at $753,000.

Storm Sewer Outlet Relief Alternative 3--Parallel Storm Sewer

Alternative 3--Parallel Storm Sewer--would provide for the laying of 1.23 miles of concrete pipe parallel to the Lincoln Creek channel at sufficient depth to provide a free outlet for the eight existing storm sewers which presently have outlet inverts below the invert of the existing channel bottom.

The pipe would range in size from 60-inch diameter at the upstream end (River Mile 8.05) to 78-inch diameter at W. Woolworth Avenue. Riser structures would be provided to permit overflow into the Lincoln Creek channel when the intercepting sewer capacity is exceeded. This alternative would also require channel deepening downstream of W. Woolworth Avenue to River Mile 6.67 and a concrete drop structure below the W. Woolworth Avenue bridge structure.

The implementation of this alternative would essentially provide free outlet for the eight storm sewers. The estimated capital cost of this alternative would be $1,473,000.

LOWER LINCOLN CREEK SUBWATERSHED

The flood control alternatives considered for the Lower Lincoln Creek subwatershed are briefly summarized below. The alternatives do not address the small flood-prone areas in the extreme lower reaches of the subwatershed which experience flood damages during peak flows and stages on the Milwaukee River main stem.

Alternative Plan 1--No Action

As previously noted, one alternative approach to the flood problem in the Lincoln Creek subwatershed is to do nothing. The first alternative plan considered--No Action--is not considered practical. If no action is taken, 1,570 structures along Lower Lincoln Creek will continue to experience flood damage, and the average annual flood damage cost of $617,000 may be expected to continue to be incurred, with damages attendant to a 100-year recurrence interval flood reaching $14,400,000. It is highly unlikely that the residents of the flood-prone areas would be content to allow a flood damage problem of this magnitude to continue, and it is likely that they would demand some public abatement action.

Alternative Plan 2--Channelization

Alternative Plan 2--Channelization--would provide for major channelization along Lower Lincoln Creek consisting of channel reconstruction and improvement from the N. 32nd Street bridge to the W. Hampton Avenue bridge, a distance of about 2.5 miles. The existing channel in this area would be lowered and widened. The channel bottom would be lowered from one to six feet, with an average excavation of two feet. The channel would be given a trapezoidal slope with a bottom width of 30 feet and side slopes of one on three. Concrete lining would be provided in the channel up to the level needed to pass a 10-year recurrence interval flood flow with two feet of freeboard. Channel side slopes above the concrete would be revegetated. The channel cross-section would be designed to pass the 100-year recurrence interval flood with two feet of freeboard. The section of channel between N. 32nd Street and N. 35th Street is the most restrictive reach in the lower subwatershed. Under Alternative

Plan 2, this channel reach would be reconstructed with the trapezoidal cross-section noted above except through the most confined area between N. 32nd Street and the Chicago, Milwaukee, St. Paul & Pacific Railroad (the Milwaukee Road) tracks, where it may be necessary to use a rectangular channel cross-section. This alternative plan also envisions straightening the alignment of the channel as it flows under the Milwaukee Road tracks by moving the channel approximately 200 feet to the south of the present bridge. The present bridge and channel could be retained, but a new bridge would be constructed to accommodate the relocated channel.

It should be noted that there are two areas in this reach between N. 32nd Street and N. 35th Street where bedrock is exposed along the Creek. The exposed rock is Upper Silurian Waubakee Dolomite. Those bedrock exposures are considered scientifically important as they represent the only known accessible exposure of this type in eastern Wisconsin. The detailed design of any channel improvement contemplated should seek to preserve these geologic outcrops or to provide comparable exposures after the improvements.

As a part of the channel improvements under Alternative Plan 2, it would be necessary to replace eight bridges located between W. Villard Avenue and N. Sherman Boulevard, both to provide adequate hydraulic capacity to pass flood flows and to accommodate lowering of the channel grade. This alternative plan also envisions modification of the foundations for center piers and abutments for five other bridges located between and including the pedestrian bridge just upstream of N. 37th Street and N. 60th Street to accommodate the proposed lowered channel bottom grade.

Alternative Plan 2 for Lower Lincoln Creek also involves the following diking and supplemental improvements to prevent flood damages in the area between N. Teutonia Avenue and N. Green Bay Avenue: 1) the installation of approximately 8,400 feet of earthen dike, 2) the installation of about 800 lineal feet of concrete floodwall, and 3) the construction of four permanent storm water pumping stations and backwater gates. Approximately 500 feet of earthen dike ranging in height from three to four feet above the existing grade would also be required along the west side of the Creek between W. Cameron Avenue (River Mile 1.53) and the Chicago, Milwaukee, St. Paul and Pacific Railroad (River Mile 1.65). Alternative Plan 2 also envisions stream bank stabilization and other protection measures to reduce the bank erosion and sloughing which is occurring in the reach of the channel from N. Teutonia Avenue to W. Villard Avenue.

Implementation of Alternative Plan 2 for the Lower Lincoln Creek subwatershed would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. Channel improvements contemplated under this alternative would not significantly increase downstream flood stages on the Milwaukee River. The capital cost of this alternative is estimated at $9,591,600, with annual operating and maintenance costs estimated at $6,000. The ratio of average annual benefits to the total average annual cost of this alternative plan is 1.01, with average annual benefits of $617,000 and an average annual cost of $610,000.

Alternative Plan 2 is considered to be feasible from a technical and economic point of view.

Alternative Plan 3--Diking and Pumping

Alternative Plan 3--Diking and Pumping--would provide for the following diking and supplemental improvements required to alleviate flooding damages: 1) 20,700 feet of earthen dike along Lincoln Creek in the reaches between N. Green Bay Avenue and N. Teutonia Avenue, W. Cameron Avenue, and the Chicago Milwaukee, St. Paul & Pacific Railroad, W. Glendale Avenue and N. 35th Street, and N. 51st Street and N. 60th Street; 2) 12,200 feet of concrete floodwall between N. 35th Street and N. 51st Street and just downstream of N. Teutonia Avenue; and 3) 16 permanent storm water pumping stations and backwater gates at existing storm sewer outfalls. The dikes would range in height up to nine feet, and would average approximately eight feet in height above the existing bank elevations and provide two feet of freeboard. In addition, it would be necessary to replace the eight bridges recommended for replacement under Alternative Plan 2--Major Channelization.

Implementation of Alternative Plan 3 for the Lower Lincoln Creek subwatershed would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The improvements contemplated under this alternative would not significantly increase downstream flood stages. The capital cost of this alternative is estimated at $12,115,600, with annual operating and maintenance costs estimated at $14,000. The ratio of average annual benefits to the total average annual cost of this alternative plan is 0.79, with average annual benefits of $617,000 and an average annual cost of $777,000.

Alternative Plan 3 is considered to be feasible from a technical point of view. However, from an economic point of view, costs exceed benefits and less costly alternatives are available.

Alternative Plan 4--Structure Floodproofing, Elevation, and Removal

Alternative Plan 4--Structure Floodproofing, Elevation, and Removal--would provide for the elevation of 825 structures and the floodproofing of 745 structures within the 100-year recurrence interval flood hazard area along Lincoln Creek. These 1,570 structures include 1,544 residences and 26 industry and business structures. The capital cost of this alternative is estimated at $20,229,000.

Implementation of Alternative Plan 4 would essentially eliminate all damages from floods up to and including the 100-year recurrence interval event. The ratio of average annual benefits to the total average annual cost of this alternative plan is 0.48, with average annual benefits of $617,000 and an average annual cost of $1,283,000.

Alternative Plan 4 is considered to be feasible from a technical point of view. However, from an economic point of view, costs exceed benefits and less costly alternatives are available.

Other Alternatives Evaluated

It should be noted that a number of other flood control alternatives not described above were evaluated for alleviation of the flooding problems along Lower Lincoln Creek in lieu of major channelization, including the replacement of selected bridges which would alleviate flooding in some reaches. However, hundreds of structures would still remain in the 100-year recurrence interval floodplain. Storage of floodwaters on the U. S. Army property above W. Silver Spring Drive was also evaluated, assuming that runoff from Upper Lincoln Creek and from the intensively urbanized area north of W. Silver Spring Drive and west of Lincoln Creek would be controlled by the proposed reservoir. Significant reductions in flood flows and stages would be realized downstream of W. Silver Spring Drive under this option. However, the most significant stage changes would occur between N. 60th Street and W. Silver Spring Drive, where flooding problems are minor under both existing and planned future land use conditions. Beneficial effects would extend downstream as far as N. 51st Street, with approximately 2 percent of the 1,570 structures subject to damage being removed from the 100-year floodplain as a result of the reduction in flood flows caused by the detention structure. However, the effects of floodwater storage would be insignificant at N. Sherman Boulevard and locations downstream. A combination of storage and channelization was also addressed for Lower Lincoln Creek to minimize channelization. However, it was found that the length of reach to be channelized would not be significantly reduced from that under the major channelization alternative.

THE RECOMMENDED PLAN

Based upon consideration of the technical feasibility, economic viability, environmental impacts, potential public acceptance, and practicality of each of the alternatives considered, it is recommended that Alternative Plan 2--Limited Channelization--in combination with Storm Sewer Outlet Relief Alternative 2--Channel Deepening--be adopted and implemented for Upper Lincoln Creek; and that Alternative Plan 2--Channelization--be adopted and implemented for Lower Lincoln Creek.

The total capital cost of the recommended combined flood control plan for Upper and Lower Lincoln Creek is estimated at $9.9 million. This does not include the capital cost for the channel deepening and bridge replacements required to provide free outlet for eight existing storm sewers. The recommended plan is shown graphically on Maps 14A and 14B, shown on pages 92 and 93, respectively. The peak flood profile which would be attendant to the planned future land use and channel conditions in the subwatershed is shown in Figure 13 on page 94. Both of the alternative plans which together constitute the recommended plan have the highest benefit-cost ratios of the alternative plans considered--1.52 and 1.01, respectively.

The recommended plan would essentially eliminate all flood-related damages along the entire Lincoln Creek channel under both existing and planned future land use conditions. It would also provide an adequate drainage outlet for the tributaries to Lincoln Creek. It should be noted in this respect, however, that the recommended plans pertain only to the main channel and do not address any possible drainage improvements that may be needed in the tributary subbasins.

The recommended plans make the maximum use of stormwater storage in existing ponding areas and in the channel itself. The channel would be designed to carry the 100-year recurrence interval flood event with two feet of freeboard. All flooding of existing structures located in the Lincoln Creek subwatershed due to floods of up to and including the 100-year recurrence interval flood on Lincoln Creek would be eliminated. The recommended plans are more fully described below.

Upper Lincoln Creek

The preliminary recommended flood control plan for Upper Lincoln Creek is best understood by dividing the Creek into seven distinct reaches. The recommended plan for these seven reaches is summarized on Map 14A on page 92 with typical cross-sections shown for the recommended channel for each reach. The plan recommendations for each of these seven reaches are as follows:

1. From the Beginning of Upper Lincoln Creek at N. 76th Street Just North of W. Good Hope Road to the Chicago & North Western Railway Crossing Just Downstream of N. 60th Street. No changes are recommended along this 1.1-mile reach of Upper Lincoln Creek. For the most part, this reach of the Creek traverses the Brynwood Country Club.

2. From the Chicago & North Western Railway Crossing Just Downstream of N. 60th Street to W. Good Hope Road. Along this 0.6-mile reach of Upper Lincoln Creek, the existing channel is proposed to be widened and deepened to accommodate flood flows and provide free outlets for two existing storm sewer outfalls which presently have invert elevations lower than the existing channel bottom. The channel deepening would range from 2.5 to seven feet. The new channel would be turf lined. The existing concrete drop spillway at the upstream side of the W. Good Hope Road culvert would be removed, but the culvert itself would not have to be replaced. The culvert would have to be cleaned, however, to make the full depth available for flow.

3. From W. Good Hope Road to W. Mill Road. Along this 1.0-mile reach of Upper Lincoln Creek, the channel would be deepened, widened, and turf lined to provide free outlets for four existing storm sewer outfalls which now have inverts below the existing streambed elevation. The deepening would range from 2.5 feet to six feet. It would be necessary to replace the W. Green Tree Road culvert to accommodate the new channel. Low earthen dikes, ranging up to two feet in height, would be required along both sides of the Creek just upstream of W. Mill Road. These dikes would have a total length of about 80 feet, with about 75 feet required along the west bank of the Creek and about five feet required along the east bank of the Creek.

4. From W. Mill Road to W. Woolworth Avenue. Along this 0.1-mile reach of Upper Lincoln Creek, the channel would be lowered about 2.5 feet and would be turf lined. This lowering is necessary because of the lowered channel proposed upstream and to help provide a free outlet for one existing storm sewer outfall which discharges within the W. Mill Road structure. The channel lowering will require the replacement of the W. Woolworth Avenue and N. 51st Street culverts. The

W. Mill Road culvert was built to accommodate a lower channel; therefore, this culvert need not be replaced. However, it will be necessary to clean out the channel through the culvert down to the design depth of the culvert.

5. From W. Woolworth Avenue to the Existing Pedestrian Bridge Near the Northern Limits of the Havenwoods Environmental Education Center. In this 0.1-mile reach of Upper Lincoln Creek, it is recommended that the channel be widened and deepened in order to both accommodate flood flows and provide a free outlet for a partially buried existing storm sewer outfall at W. Woolworth Avenue. The deepening of the channel bottom would range from about 0.5 feet at the pedestrian bridge to about 2.5 feet at W. Woolworth Avenue. The new channel would be turf lined. In addition, the plan recommends that the existing concrete arch culvert under the Chicago & North Western Railway be removed and replaced with a new concrete box culvert 10 feet high-by-30 feet wide, or one of equivalent capacity, which would accommodate the design flood flow with no appreciable headloss through the culvert. The existing culvert is inadequate and creates backwater under flood flow conditions which extends back across W. Woolworth Avenue to W. Mill Road.

6. From the Existing Pedestrian Bridge Near the Northern Limits of the Havenwoods Center to the Existing Steel Drop Spillway Immediately West of the U. S. Army Reserve Training Center. This 0.9-mile reach of Upper Lincoln Creek extends through the U. S. Army property and the Havenwoods Center. It is recommended that the channel in this reach be cleaned and debrushed so as to facilitate and improve flood flows. No channel enlargement or deepening is recommended. It is recognized, however, that the Wisconsin Department of Natural Resources is currently identifying alternative projects related to Lincoln Creek at the Havenwoods Center. Alternatives under consideration include a wetland basin, the creation of a meandering stream channel, the installation of low dams, or a combination of such features. The Department has not yet developed specific plans for the project, so it was not possible within the context of the Commission's Lincoln Creek study to specifically evaluate alternative proposals. In the event that the Department undertakes any channel modifications, it is important that the modifications be designed so as not to increase 100-year recurrence interval flood stages upstream or downstream of Havenwoods. It is also important to note that any wetland basin would have insignificant flood control benefits downstream of W. Silver Spring Drive, and the cost of development would have to be justified on other than a flood control basis.

7. From the Existing Steel Drop Spillway Immediately West of the U. S. Army Reserve Training Center to W. Silver Spring Drive. No channel or structure changes are recommended in this 0.1-mile reach of Upper Lincoln Creek. The existing channel has a paved bottom and side slopes and is adequate to accommodate the 100-year recurrence interval flood flow.

Lower Lincoln Creek

The preliminary recommended flood control plan for Lower Lincoln Creek is best understood by dividing the Creek into eight distinct reaches. The recommended plan for these eight reaches is summarized on Map 14B on page 93 with the typical cross-sections shown for the recommended channel for each reach. The plan recommendations for each of these eight reaches are as follows:

1. From W. Silver Spring Drive to the W. Hampton Avenue Crossing Just West of N. 60th Street. No changes are required along this 1.2-mile reach of Lower Lincoln Creek. Within this reach the channel has already been deepened, widened, and lined with concrete. The channel has adequate conveyance capacity to accommodate the 100-year recurrence interval flood flow.

2. From the W. Hampton Avenue Crossing Just West of N. 60th Street to N. 32nd Street. Major channel improvements are recommended along this 2.5-mile reach of Lower Lincoln Creek. Throughout this reach the channel bottom would be lowered from one to six feet with an average depth of excavation of about two feet. Except for that portion of this reach between N. 32nd Street and the Milwaukee Road tracks, the existing channel would be reconstructed with a bottom width of about 30 feet and a top width varying from 100 to 200 feet, depending upon the depth of excavation and the topography adjacent to the existing channel. A concrete lining would be installed in the lower portion of the channel, with revegetation of the upper channel side slopes. Between N. 32nd Street and the Milwaukee Road tracks, it will probably be necessary to use a rectangular channel cross-section.

   In addition, the plan recommends that the channel itself be realigned as it flows under the Milwaukee Road tracks by moving the channel about 200 feet south of the present location. This will require the construction of a new bridge to carry the railroad tracks over the relocated channel. This new bridge could either be a replacement bridge for the existing Milwaukee Road bridge, providing by itself sufficient hydraulic capacity, or it could be a somewhat smaller bridge if subsequent preliminary engineering studies show that it would be desirable to keep the old bridge and use both the existing and relocated channels to carry flood flows.

   A number of bridge modifications may also be required in conjunction with the proposed channel improvements to accommodate the proposed lowered channel bottom grade. These include lowering of the center piers and abutments of the existing bridges carrying N. 51st Street and N. 60th Street across Lincoln Creek, and the three pedestrian bridges in this reach of the stream. The existing bridges would have to be replaced at N. Sherman Boulevard, N. 37th Street, N. 35th Street, W. Glendale Avenue, and N. 32nd Street. Since the bridges at N. Sherman Boulevard and N. 37th Street are particularly significant hydrologically; that is, they act as dams during major flood events and reduce downstream flood flows, the plan recommends that these two bridges not be replaced until the recommended channel improvements are carried out.

It should be noted that there are two areas in this reach, as shown on Map 12 on page 83 in Chapter VIII, where bedrock is exposed along the creek. The rock exposed is Upper Silurian Waubakee Dolomite. These bedrock exposures are considered to be scientifically important as they represent the only accessible exposure of this formation in eastern Wisconsin. The design of any channel improvement should seek to preserve these geologic outcrops or to provide comparable exposures after the improvements.

3. From N. 32nd Street to the Chicago, Milwaukee, St. Paul & Pacific Railroad Crossing Just Downstream of W. Hampton Avenue. No changes are recommended in the Lower Lincoln Creek channel along this 0.2-mile reach. The channel has already been improved through widening, deepening, and partial lining with concrete, and is adequate to convey the 100-year recurrence interval flood flow.

4. From the Chicago, Milwaukee, St. Paul & Pacific Railroad Crossing Just Downstream of W. Hampton Avenue to W. Cameron Avenue. This 0.1-mile reach of Lower Lincoln Creek has already been improved through widening, deepening, and partial lining with concrete. In order to contain future flood flows, however, the plan recommends that an earthen dike be constructed along the entire west bank. The dike would range from three to four feet in height.

5. From W. Cameron Avenue to N. Teutonia Avenue. The plan recommends no changes to the Lincoln Creek channel along this 0.2-mile reach. The channel has already been improved through deepening, widening, and partial concrete lining and is adequate to convey the 100-year recurrence interval flood flow.

6. From N. Teutonia Avenue to W. Villard Avenue. The plan recommends no lowering or deepening of the Lincoln Creek channel in this 0.5-mile reach. Measures are recommended, however, for channel and stream bank protection and for containment of future flood flows through the construction of dikes and flood walls. From N. Teutonia Avenue to N. 27th Street extended the plan recommends that the channel bottom be lined with concrete. This lining would be from 60 to 80 feet wide and would be designed to protect the channel bottom from erosion due to increased flood flow velocities caused by the recommended upstream channel changes.

   In that part of the reach from N. 27th Street extended to W. Villard Avenue, the plan recommends that the eroding banks be reshaped and stabilized with gabions, rock riprap, or other suitable bank protection measures. In order to protect adjacent properties from flooding along this reach, the plan further recommends that a concrete flood wall ranging from two to three feet in height be constructed along the north bank of the Creek, from N. Teutonia Avenue to N. 27th Street extended. In addition, earthen dikes, ranging in height from two to four feet, would be constructed along the north bank of the Creek from N. 27th Street extended to W. Villard Avenue and along the entire south bank from N. Teutonia Avenue to W. Villard Avenue. Finally, in order to provide adequate flood flow capacity, the existing bridges carrying N. Teutonia Avenue and W. Villard Avenue over Lincoln Creek would need to be replaced.

7. From W. Villard Avenue to N. Green Bay Avenue. Along this 0.4-mile reach of Lower Lincoln Creek, the plan recommends that earthen dikes ranging in height from three to five feet be constructed along both banks of the entire reach. Such dikes are required to prevent overland flooding from the increased flood flows due to the channel changes and bridge replacements recommended upstream.

8. From N. Green Bay Avenue to the Confluence with the Milwaukee River. No changes are recommended along this 0.4-mile reach of Lower Lincoln Creek. As noted earlier in this report, there is some overland flooding affecting homes along W. Lawn Avenue west of N. 13th Street. Such flooding can occur from either major floods on Lincoln Creek or on the Milwaukee River. The previously adopted Milwaukee River watershed plan recommends that floodproofing measures be undertaken to abate such flooding, including in those instances where the first floors of the homes lie below the 100-year recurrence interval flood elevation along the Milwaukee River either the elevation or removal of such homes.

Plan Costs

The estimated capital cost for implementation of the entire recommended flood control and drainage improvement plan for Lincoln Creek is $10.7 million (see Table 13 on page 118). The plan would have average annual operation and maintenance costs of about $8,500. These costs include all of the above-described flood control measures, including the channel deepening on Upper Lincoln Creek required to provide free outlets for eight existing storm sewers that were constructed with the inverts of the pipe below the existing channel bottom.

The total capital cost of the flood control plan alone--that is, not including the cost of those channel improvements required on Lincoln Creek solely to accommodate the storm sewer outlets--is estimated at $9.9 million, with an attendant average annual operating and maintenance cost of $6,500. On an average annual basis, the flood control plan would have benefits approximating $649,000 and costs approximating $631,000, with a resulting benefit-cost ratio of 1.03. The additional capital costs associated with the lowering of the channel to accommodate the storm sewer outlets would be approximately $753,000. Assuming amortization of this cost over a 50-year period at a 6 percent rate of return yields an average annual cost of $47,000. Operating and maintenance costs are estimated at $2,000 per year, bringing the total average annual cost to $49,400. When the additional costs associated with the channel improvements required to accommodate the existing storm sewer outlets are included, the benefit-cost ratio is reduced to 0.95, excluding any benefits that may be associated with the channel improvements required to accommodate the storm sewer outfalls.

Impacts of Recommended Channel Improvements on Flood Flows

Under existing land use and channel conditions, the 100-year recurrence interval flood discharge for Lincoln Creek at the confluence with the Milwaukee River is about 7,980 cubic feet per second (cfs). Upon implementation of the recommended flood control plan, and assuming that future land use development in the watershed will occur in conformance with the adopted regional land use plan, that discharge may be expected to increase to about 13,970 cfs, or by about 75 percent. Because of this substantial increase in peak flood flows, an analysis was conducted to determine the potential impact of that increase on flood stages along the main stem of the Milwaukee River below the confluence with Lincoln Creek.

The estimated 100-year recurrence interval flow on the Milwaukee River at the Lincoln Creek confluence under planned land use and existing channel conditions is about 16,400 cfs, not greatly different from the peak discharge of nearly 14,000 cfs expected from Lincoln Creek alone under planned channel and land use conditions. This illustrates the effects of urbanization and channelization on flood flows. In this respect it should be noted that the Milwaukee River at its confluence with Lincoln Creek drains an area of approximately 650 square miles, while Lincoln Creek itself drains an area of about 19.3 square miles.

The timing of the peak discharges is, however, important. The peak discharge from Lincoln Creek may be expected to occur within three hours of the beginning of a major rainfall. Peak flood flows along the Milwaukee River may be expected to occur in about three days. Accordingly, it was concluded that, while the channel improvements recommended for Lincoln Creek will increase peak flood flows from Lincoln Creek, such peak flows should not occur at the same time as the peak flood flows on the Milwaukee River at its confluence with Lincoln Creek. Accordingly, no significant change in design flood flows or stages for the Milwaukee River downstream of Lincoln Creek should occur.

PLAN IMPLEMENTATION

Only a relatively few units and agencies of government would be involved in implementation of the recommended flood control plan for Lincoln Creek. These agencies consist of the City of Milwaukee, Milwaukee County, the Milwaukee Metropolitan Sewerage District, the Wisconsin Department of Natural Resources, and the Federal Emergency Management Agency. The plan implementation responsibilities assigned to each of these agencies with respect to the Lincoln Creek flood control plan are summarized in Table 14 on page 119.

Basically, it is recommended that the Milwaukee Metropolitan Sewerage District assume responsibility for implementation of the channel improvements, and construction of dikes and floodwalls specified in the plan. The only exception to this would be the channel debrushing and cleaning recommendations through the Havenwoods Center which would be the responsibility of the Wisconsin Department of Natural Resources. Milwaukee County would have the responsibility of cooperating with the Milwaukee Metropolitan Sewerage District in making the channel improvements recommended through parkway areas and through the modification of pedestrian bridges in the parkway as required to accommodate the channel changes.

The City of Milwaukee would have to assume responsibility for all other bridge modification and replacement requirements except for the recommendations relating to the replacement of railroad bridges carrying Lincoln Creek under the Chicago & North Western Railway and the Milwaukee Road railroad right-of-ways. Such railroad bridge replacements would be the responsibility of the railroad companies concerned, working in cooperation with the Milwaukee Metropolitan Sewerage District.

Prior to full implementation of the structural flood control measures recommended in this report, it is recommended that the City of Milwaukee adopt, for floodland zoning purposes, the proposed regulatory floodway set forth in this report. For Lower Lincoln Creek, the proposed floodway is identical to that developed under the federal flood insurance study of the City of Milwaukee. The federal flood insurance study, however, did not develop a floodway for Upper Lincoln Creek. The floodway for this reach--based on the existing channel configuration and capacity and plan year 2000 land use conditions--was developed under this study at the request of the City of Milwaukee. This floodway was developed in accordance with the requirements of Chapter NR 116 of the Wisconsin Administrative Code and would not, therefore, cause increases in the 100-year recurrence interval flood stage of more than 0.1 foot should the associated flood fringe area be filled and developed.

PUBLIC REVIEW AND COMMENT ON RECOMMENDED PLAN

In order to obtain public reaction to the recommended Lincoln Creek flood control plan, the Commission and the City of Milwaukee jointly held a public meeting at 7:30 p.m. on September 23, 1982, in the auditorium of the Custer High School, 5075 N. Sherman Boulevard, Milwaukee. The recommended plan was summarized in the May-June 1982 issue of the SEWRPC Newsletter, Volume 22, No. 3, distributed prior to the September 23 meeting. The meeting was chaired by Milwaukee Alderman John R. Kalwitz. Minutes of the meeting are set forth in Appendix B, while the list of those attending the meeting is set forth in Appendix C. Written materials submitted prior to the public hearing, as well as Commission responses thereto, are reproduced in Appendix D. Written materials submitted after the public meeting and the Commission responses thereto are reproduced in Appendix E.

The record of the public informational meeting and hearing indicates considerable concern by the residents of the Lincoln Creek watershed, both over the flooding problems in the watershed and the floodplain zoning and flood insurance ramifications attendant thereto, and over the recommended flood control works as presented at the meeting. These concerns relate to downstream flood effects caused by increased urban development in the upper watershed combined with channel improvements; to the costs of the recommended flood control works and the timing of implementation of those works; and, most importantly, to the effect that the recommended downstream channel improvements might have on the appearance of the Lincoln Creek parkway. Clearly, the consensus of those present at the public hearing was that the benefits to be gained by resolving the flooding problems significantly outweighed the direct monetary costs of the project and any indirect costs attendant to the alteration of the environment along Lincoln Creek parkway. A number of individuals at the hearing expressed their support for the project, asking that it be undertaken as quickly as possible.

In summary, the record of the public hearing, including materials submitted before and after the hearing, indicates general support for undertaking the recommended flood control improvements, while recognizing that there will be costs associated with those improvements both in terms of the public monies that will have to be expended to undertake the improvements and in terms of the detrimental effects that such improvements may have on the natural environment along the Lincoln Creek parkway. No new information was presented before, at, or after the hearing, however, that would cause the Commission staff to reconsider the set of flood control recommendations set forth in this report.

CONCLUDING REMARK

The flooding and related drainage problems in the Lincoln Creek subwatershed are serious and costly. Many hundreds of structures lie in the existing floodplain and are thus subject not only to periodic flood damages but to federal and state flood insurance and related zoning regulations and requirements. The only feasible and practical way to eliminate such flooding problems and to remove these hundreds of homes and other structures from the floodplain maps under the regulatory requirements of the flood insurance program is to undertake the series of interrelated channel and structure improvements set forth in the recommended Lincoln Creek flood control plan. These recommended improvements, and in particular those related to channel deepening, widening, and concrete lining and the construction of related dikes and floodwalls, are made by the Commission only as a last resort. There appears to be no other feasible way to resolve the problem.

Urban development in the watershed has been permitted to destroy all of the wetlands that once provided natural flood flow regulation on Lincoln Creek. There are no sites available which can provide any significant amount of floodwater detention. A dike and floodwall system alone would not be feasible or cost-effective. Consequently, the only alternative left involves making significant changes to the existing channel, by restructuring the Creek bed. This is the price that the public, as a whole, must pay for a historic lack of foresightedness in resolving and protecting the natural floodlands and wetlands of this subwatershed.

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APPENDICES

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Appendix A

GLOSSARY OF TERMS

BACKWATER - The increased depth of water upstream from a dam or obstruction in a stream channel due to the existence of such obstruction, and the raising by it of the water level a considerable distance upstream.

CHANNEL - A perceptible natural or artificial waterway which periodically or continuously contains moving water or which forms a connecting link between two bodies of water. It has a definite bed and banks which confine the water.

CREST-STAGE GAGES - Devices designed to record the peak stage or crest elevation reached by a stream during periods of excess runoff.

CROSS-SECTIONS - Ground surface profiles extending across the floodplain perpendicular to the stream valley which are located at intervals along a stream to characterize the flow-carrying capacity of the stream and its adjacent floodplains.

CUBIC FOOT PER SECOND (cfs) - A unit of measure of the rate of liquid flow past a given point equal to one cubic foot in one second.

CULVERT - A closed conduit for the free passage of surface drainage water under a highway, railroad, canal, or other embankment.

DIKE - An artificial embankment constructed to hold a stream or other body of water so as to prevent flooding of the adjoining land or to prevent inflow into the water body of undesirable water.

DISCHARGE - The volume of water that passes through a given cross-section of a channel during a unit of time. This flow is commonly measured in cubic feet per second (cfs).

FLOOD - Any streamflow that substantially exceeds the average streamflow, and overtops the channel banks and inundates the adjacent normally dry floodlands.

FLOOD CREST - The highest elevation reached by flood waters in a flood event. It is commonly measured in feet above a reference datum, such as National Geodetic Vertical Datum.

FLOOD DAMAGE - Economic loss caused by a flood, including such loss from inundation, erosion, and sediment deposition. The loss may be evaluated in terms of cost of replacement, repair, or rehabilitation; decrease in market or sales value; or resulting decrease in income or production.

FLOOD FREQUENCY - A means of expressing the probability of flood occurrences; generally determined from statistical analyses. The frequency of a particular flood flow is usually expressed as occurring, on the average, once in a specified number of years.

FLOOD FRINGE - The flood fringe is that portion of the floodlands outside the the floodway, which is covered by flood waters during the regulatory flood; it is generally associated with standing water rather than rapidly flowing water.

FLOODPLAIN - The floodplain is the land which has been or may be hereafter covered by flood water during the regulatory flood. The floodplain includes the floodway and the flood fringe.

FLOODPROOFING - Floodproofing involves any combination of structural provisions, changes, or adjustments to properties and structures subject to flooding, primarily for the purpose of reducing or eliminating flood damage to properties, water and sanitary facilities, and structures and contents of buildings in flood hazard areas.

FLOOD STAGE - An arbitrarily fixed and generally accepted gage height or elevation above which a rise in the water surface elevation is termed a flood. It is commonly fixed as the stage at which overflow of the normal banks or damage to property would begin.

FLOOD STAGE PROFILE - A graph of peak water surface elevation as a function of position along a river or stream. The profile usually corresponds either to a flood event of specified recurrence interval or to a historic flood event. The channel bottom profile, as well as locations of bridges, culverts, and dams, are also normally depicted along with the flood stage profile.

FLOODWALL - A wall constructed to prevent floodwaters from entering areas to be protected in a floodplain.

FLOODWAY - A designated portion of the regulatory floodlands that will safely convey the regulatory flood discharge with small, acceptable upstream and downstream stage increases, generally limited in Wisconsin to 0.1 foot. The floodway, which includes the channel, is that portion of the floodlands not suited for human habitation. All fill, structures, and other development that would impair floodwater conveyance by adversely increasing flood stages or velocities, or would itself be subject to flood damage, should be prohibited in the floodway.

FREEBOARD - Freeboard is a factor of safety usually expressed in terms of a specified elevation in feet above a calculated flood level. Freeboard compensates for the many unknown factors that contribute to flood heights greater than the height calculated. These unknown factors include, but are not limited to, ice jams, debris accumulation, wave action, and obstruction of bridge openings and floodways.

HIGH WATER MARK - A natural mark left on a structure or natural feature, indicating the maximum stage of tide or flood. Common high water marks are mud lines, debris lines, seed lines, or discolorations left on hydraulic structures, buildings, stream banks, trees, or other locations experiencing flood inundation.

HYDRAULICALLY SIGNIFICANT - A hydraulically significant structure is a structure such as a culvert, bridge, or dam across a stream which increases the 100-year recurrence interval flood stage immediately upstream from the structure by 0.1 foot or more over the flood stage which would occur if the structure did not exist.

HYDRAULICS - That branch of science or of engineering which treats water or other fluid in motion.

HYDROGRAPH - A graph showing, for a given location on a stream or conduit, the stage, flow, velocity, or other property of water with respect to time.

HYDROLOGIC SIMULATION MODEL - A mathematical description of all or part of the hydrologic cycle usually programmed into a digital computer for computation of flow at designated locations within a watershed drainage system.

HYDROLOGICALLY SIGNIFICANT - A condition occurring when a hydraulic structure in a stream functions in effect like a flood control structure by causing significant storage of flood waters upstream and thereby significantly reducing peak flood flows and stages downstream.

HYDROLOGY - The applied science concerned with the waters of the earth in all their states--their occurrence, distribution, and circulation through the unending cycle of precipitation, runoff, streamflow, infiltration, and storage, eventual evaporation, and reprecipitation. It is concerned with the physical, chemical, and physiological reactions of water with the rest of the earth and its relation to the life of the earth.

INTERMITTENT STREAM - A stream that does not flow perennially, normally having zero flow one or more times annually when the groundwater table falls below the streambed.

LEVEE - A levee is a continuous dike or embankment of earth generally constructed parallel to a river or stream intended to protect the landward side from inundation by flood waters or to confine the streamflow to its regular channel.

MANNING ROUGHNESS COEFFICIENT - An empirical value used in Manning's equation for flow velocity which represents the resistance to flow by, or roughness of, a given channel or floodplain.

PEAK FLOOD DISCHARGE - The maximum instantaneous rate of flow in a channel and adjacent floodplain during a flood event.

PERENNIAL STREAM - A stream that flows continuously at all seasons of a year and during dry as well as wet years. Such a stream is usually fed by groundwater, and its water surface generally stands at a lower level than that of the water table in the locality.

REACH - A segment of a river or stream extending from one significant change in the hydraulic character of the river or stream to the next significant change. These changes are usually associated with breaks in the slope of the water surface profile, and may be caused by bridges, dams, expansion and contraction of the water flow, and changes in streambed slope or vegetation.

RECURRENCE INTERVAL - The average interval of time within which a flood of specified magnitude may be expected to be equalled or exceeded once.

REGULATORY (100-year) FLOOD - The 100-year recurrence interval flood event, that is, the flood event that may be expected to be reached or exceeded once on the average of every 100 years; or, stated differently, may be expected to have a one percent chance of being reached or exceeded in any given year.

RESERVOIR - A pond, lake, tank, basin, or other space, either natural or created in whole or in part by the building of engineering structures, which is used for storage, regulation, and control of water. Also called impoundment.

RUNOFF - That portion of rainfall or melted snow which ultimately reaches surface streams. The portion which flows off the surface without sinking into the ground is called the immediate runoff; the part which sinks into the ground but eventually returns to the surface by seepage and from springs is called delayed runoff. Runoff is faster and greater during heavy rainfall than during protracted drizzle, on clay soils than on sandy soils, on frozen soils than on frostless soils and in treeless areas than in forests. The ratio between runoff and rainfall varies considerably with climatic conditions.

SUBBASIN - Part of a drainage basin (watershed). Normally tributary to a small stream within a larger drainage system or to a reach of a large stream within the drainage system.

SUBWATERSHED - (see subbasin)

TIME OF CONCENTRATION - The time necessary for surface runoff to reach the outlet of a subbasin from the most remote point in the subbasin, the term "remote" being used to denote most remote in time and not necessarily distance.

UNIT HYDROGRAPH - A mathematically developed streamflow hydrograph for a given location within a drainage basin representing one inch of runoff from the basin. For a hydrograph for a larger runoff volume of similar duration, the unit hydrograph ordinates are simply multiplied by the runoff volume.

WATERSHED - A watershed is a region or area contributing ultimately to the water supply of a particular watercourse or body of water. Also referred to as drainage basin.

Source: Americal Society of Civil Engineers, American Public Health Association,American Water Works Association, U. S. Environmental Protection Agency, U. S. Geographic Survey, Wisconsin Department of Natural Resources, and SEWRPC.

Appendix B

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

MINUTES OF
PUBLIC INFORMATIONAL MEETING AND PUBLIC HEARING[1]
FLOOD CONTROL PLAN FOR LINCOLN CREEK

CUSTER HIGH SCHOOL
MILWAUKEE, WISCONSIN
7:30 P.M.
THURSDAY, SEPTEMBER 23, 1982

Alderman John R. Kalwitz, 2nd Aldermanic District, Milwaukee, Wisconsin, opened the meeting at 7:35 p.m. CDST.

ALDERMAN JOHN R. KALWITZ:

Good evening, I am Alderman Kalwitz, 2nd District. I would like to thank all of you who came out to attend this public informational meeting, which is also a public hearing for the Southeastern Wisconsin Regional Planning Commission. Because it is a public hearing, anyone who wishes may make a comment or ask a question. The only thing we ask is that you identify yourself each and every time you speak so that the Court Reporter at the end of the table can record your name.

Lincoln Creek periodically overflows its banks and floods its surroundings, an inconvenience to the people who reside in the area. The Southeastern Wisconsin Regional Planning Commission, with financial assistance from the City of Milwaukee and the Milwaukee Metropolitan Sewerage District, has prepared a plan which they believe will correct the flooding problems in the Lincoln Creek watershed.

Recently the City of Milwaukee adopted floodplain zoning along Lincoln Creek. Currently about 2,300 structures are located in the floodplain area. One important finding in the Southeastern Wisconsin Regional Planning Commission's study is that the designated floodplain area is, in fact, too large and that about 800 structures can be demapped. There will be an amendment to the zoning ordinance introduced to the Common Council shortly, removing those structures from the flood hazard area. I will send a letter to you notifying you of the change as soon as I get confirmation of the structures involved,as well as of the Common Council's willingness to act. Reducing the amount of floodplain zoning is a short-term objective of the study. Eliminating flooding altogether is a long-term objective. The Southeastern Wisconsin Regional Planning Commission plan accordingly provides an overall strategy for doing just that. It calls for such measures

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[1]For a list of Attendees, see Appendix C.

as channel deepening and widening; debrushing and cleaning growth from the stream bed; and building dikes and floodwalls.

Here tonight is the Director of the Southeastern Wisconsin Regional Planning Commission, who is Dr. Kurt Bauer. Also here tonight are several other individuals-- Mr. Thomas H. Miller, Senior Planner from the Department of City Development; Mr. Wilbur T. Holley, representative of the City Engineer's office; also Mr. John Vajcekauskis from the City Building Inspection Office, and Mr. Sylvester Hejlik from the Milwaukee Metropolitan Sewerage District. Also seated with me is County Board Supervisor Jim Krivitz of the 9th Supervisory District.

Dr. Bauer will make a presentation of the proposed watershed plan to those of you assembled here tonight; and after Dr. Bauer is finished, we will open the meeting to questions or comments that any of you might have.

MR. KURT W. BAUER, EXECUTIVE DIRECTOR, SEWRPC:

Thank you, Alderman Kalwitz. Supervisor Krivitz, ladies, and gentlemen. I have been asked to present to you here tonight a brief summary of the findings and recommendations of the Commission's study of the flooding problems of Lincoln Creek. I would like to do that with the help of this Commission Newsletter, a copy of which you should have obtained as you came into the room. If you haven't got a copy, please come up and get one because I am going to ask you to go through the Newsletter with me, turning the pages as I do. That will, I believe, be the quickest way to provide to you a summary of the plan, and also give you information on the plan which you can take home to study more carefully.

Alderman Kalwitz did a very good job of presenting the background information on the study. In so doing, he covered the first few pages of the Newsletter.

I would, therefore, ask you to turn to page 4 of the Newsletter where begins a list of the most important findings of the study. It is indicated there that Lincoln Creek has a drainage area of about 19 square miles. For the purposes of the study, that drainage area has been divided into two parts. That portion of the Lincoln Creek watershed lying north of W. Silver Spring Drive, and which has an area of about four square miles--the gray shaded area on Map 2, on page 5--has been designated as the Upper Lincoln Creek subwatershed. That portion lying south of W. Silver Spring Drive, which has an area of about 15 square miles, has been designated as the Lower Lincoln Creek subwatershed. The watershed is shown on Map 2 on page 5. All of the area inside the black line drains through Lincoln Creek to the Milwaukee River. The gray shaded area is the Upper Lincoln Creek subwatershed, and the rest is the Lower Lincoln Creek subwatershed.

The lower portion of the watershed is almost completely developed for urban purposes. No significant changes in land use are anticipated in the Lower Lincoln Creek subwatershed in the foreseeable future. In the upper subwatershed, land is still undergoing change from rural to urban use. For the purposes of the flood control planning, it was assumed that the entire upper subwatershed would be fully urbanized by the year 2000. Such development will increase the rate and amount of storm water runoff. The existing land use pattern in the Lincoln Creek subwatershed is shown on Map 3, on page 6, and the planned future land use portion is shown on Map 4 on page 7. If you study those maps, you will see the only significant changes anticipated in the land use pattern are in the upper subwatershed where open lands would be converted from rural to urban use.

It is noted that flooding is a serious problem in the watershed. The four largest recent flood events occurred in 1964, 1968, 1972, and 1973. These events resulted in the inundation of roadways and underpasses and of basements and first floors of buildings. Additional basement flooding was caused by sewer backups attributable to floodwaters entering the sanitary sewer system. It is indicated that from 1960 through 1975, more than 1,300 separate flooding and flood-related problems have been reported to the City Engineer by residents and property owners in the Lincoln Creek area. The problems include first floor inundation, yard flooding, and basement flooding, the most common complaint being basement flooding. The areas which tend most frequently to experience such problems are identified on Map 5, on page 9, by the blue shaded areas on the map. Not all of the problems are caused by Lincoln Creek overflowing its banks; some are caused by the backup of sanitary sewers into the basements of homes.

Flooding on Lincoln Creek is normally caused by intensive rainstorms--as opposed to snowmelt. It is indicated on page 8 that the 1973 flood event--the most severe of the recent such events--was caused by a very short but intensive rainstorm that had an estimated recurrence interval of about once in 40 years near N. 60th Street. That means that such a storm would have about a two and one-half percent chance of occurring in any given year. The 1973 flood event had a recurrence interval of about 15 years at the W. Hampton Avenue crossing near N. 32nd Street. The observed peak stages, estimated peak discharges, and recurrence intervals for the four major floods which have occurred in the subwatershed since 1960 are shown in Table 2 on page 10. You will note that none of these flood events have approached a 100-year recurrence interval--the so-called regulatory or design flood.

On page 11, it is noted that the Lincoln Creek channel has been straightened, reshaped, or modified in some manner for almost all of its approximately nine-mile length. There are 24 road bridges and culverts, seven pedestrian bridges, and five railway bridges and culverts which cross Lincoln Creek. Many of these bridges and culverts have inadequate waterway openings and thus impound water during major flood events, reducing downstream flood flows, but causing upstream flood damages.

On the bottom of page 11, it is noted that the Wisconsin Department of Natural Resources, in cooperation with the City of Milwaukee, is developing the Havenwoods Urban Environmental Education Center on the old U. S. Army disciplinary barracks site. The master plan for the development of that

Center includes development of two proposed wetland basins, with one basin proposed to be located directly on Lincoln Creek. One of the questions that was to be addressed in the study was: would these basins have a significant effect on flood flows and stages in the watershed.

On page 14, it is noted that, under existing land use and channel conditions, about 1,490 structures, primarily homes, are located in the area that would be subject to inundation during a 100-year recurrence interval flood event along Lincoln Creek--that is, by a flood that has a 1 percent chance of occurring in any given year. Map 7 on page 15 indicates the areas in the watershed that are subject to inundation during a 100-year recurrence interval flood event. You will note there are two colored areas on the map. The yellow area is the area which the Commission has identified as being subject to flooding. The red areas on the map indicate the additional areas that the federal flood insurance study has identified as being subject to flooding. As Alderman Kalwitz indicated, the study recommends that those red areas be removed from the flood hazard area, reducing the 2,300 dwellings affected to about 1,500 dwellings. Under planned future land use conditions, the number of structures that would be subject to inundation may--in the absence of any flood control measures--be expected to increase to about 1,650.

It is also noted on page 14 that a 100-year recurrence interval flood event may be expected to cause damages along Lower Lincoln Creek of about $12.7 million under existing land use conditions. Those damages by the turn of the century may be expected to increase--as a result of land use changes in the upper watershed--to about $14.4 million, with most of the damages occurring between N. 37th and N. 53rd Streets. Average annual flood damages along Lower Lincoln Creek are estimated at about $444,000 and $617,000, respectively, under existing and planned future land use conditions.

Flood damages along Upper Lincoln Creek are substantially less. A 100-year recurrence interval flood along Upper Lincoln Creek may be expected to cause damages of about $250,000 under existing land use conditions and about $310,000 under planned future land use conditions, with average annual damages estimated at about $18,000 and $32,000, respectively. These damages would occur largely in the vicinity of W. Mill Road and in an industrial area located north of W. Good Hope Road.

Map 7 also identifies in red those lands which were placed in the 100-year recurrence interval floodplain under the recently completed federal flood insurance study for the City of Milwaukee. That study was based upon data now rendered obsolete. About 780 structures of all types lie within this additional, previously identified floodprone area, and thus are currently subject to all of the regulations and attendant liabilities associated with being designated in a floodplain area under the Federal Flood Insurance Program. One of the recommendations in the current Commission study of Lincoln Creek, as noted earlier by Alderman Kalwitz, is that the City of Milwaukee formally transmit the final Commission report to the Wisconsin Department of Natural Resources and the Federal Emergency Management Agency with a request that those agencies appropriately revise the federal flood insurance study to reflect the more recent hydrologic and hydraulic data contained in the Commission report. Such actions would result in a revision to the federally prepared flood insurance maps for the City of Milwaukee and would remove the affected 780 structures from the designated floodplain. The City can also act to remove those structures from its floodland zoning district.

A small area along Lincoln Creek near the confluence with the Milwaukee River, also shown on Map 7, would experience flood damages not only from Lincoln Creek but also from major floods along the Milwaukee River. No attempt was made in the Lincoln Creek study to develop recommendations that would abate flood damages due to flooding in this area. Rather, homes located in this area should, wherever possible, be floodproofed except where such homes might be subject to first floor flooding. In those instances, the Commission's Milwaukee River watershed plan recommends that the homes either be elevated or removed.

It is noted on page 16 that the Commission, in conducting the study examined a wide range of available structural and nonstructural flood control measures. Each of the alternatives was first analysed to determine if it was technically feasible; that is, if it was not only physically capable of implementation but also capable of achieving a significant reduction in flood damages. Any alternatives that were found to be technically feasible were then carried to the level of detail needed to make economic comparisons, including estimates of capital and operation and maintenance costs.

The results of the analysis of alternative flood control plans for the Lincoln Creek watershed are summarized in Table 4, on page 18. In the Upper Lincoln Creek area, four basically different alternative flood control measures were analyzed in detail, in addition to a no action, or "do nothing" alternative. These were: 1) limited channelization, involving channel clearing and debrushing, with widening and deepening of channels only as necessary to improve hydraulic efficiency and add channel capacity; 2) flood water storage involving the construction of flood detention reservoirs at strategic locations and the use of natural floodland storage areas with restricted or controlled outlets; 3) the construction of dikes and floodwalls; and 4) structure floodproofing, elevation, and removal. In the Lower Lincoln Creek area, the alternatives analyzed in detail consisted of, in addition to the no action, or "do nothing" alternative: 1) major channelization, consisting of the widening and deepening of the channel, together with concrete lining; 2) the construction of dikes and floodwalls; and 3) structure floodproofing, elevation, and removal.

Analysis was made of the floodwater storage potential of a site in Havenwoods located immediately upstream of the Wisconsin & Southern--the former Chicago, Milwaukee, St. Paul and Pacific--Railroad right-of-way. The results of the analysis indicated that no significant flood control benefit would be realized by providing additional floodwater storage at this site. Storage of floodwaters on the U. S. Army property located above W. Silver Spring Drive was evaluated assuming that runoff from Upper Lincoln Creek and from the intensively urbanized area north of W. Silver Spring Drive and west of Lincoln Creek would be controlled by the proposed reservoir. The analyses indicated that significant reductions in flood flows and stages would be realized for a short distance immediately downstream of W. Silver Spring Drive. However, the most significant stage changes would occur between N. 60th Street and W. Silver Spring Drive, where flooding problems are minor under both existing and planned future land use conditions.

The analyses indicated that the effects of floodwater storage would be insignificant from N. Sherman Boulevard downstream. Moreover, an evaluation of a combination storage and channelization alternative for Lower Lincoln Creek was found to be not significantly different from a pure channelization alternative. Consequently, it was concluded that very little could be attained even under a proposal that would involve construction of a relatively large flood control reservoir on the U. S. Army property and, accordingly, this proposal was eliminated from further consideration.

The data set forth in Table 4 on page 18, include the results of benefit-cost analyses for each alternative flood control measure considered in both the Upper and Lower Lincoln Creek subwatersheds. Three of the four alternatives evaluated for the Upper Lincoln Creek area, and one of the three alternatives evaluated for the Lower Lincoln Creek area were found to have benefit-cost ratios of greater than one if computed with an interest rate of 6 percent. None of the alternatives were found to have a benefit-cost ratio greater than one if computed with an interest rate of 10 percent. It is, however, believed that the benefit component of the benefit-cost ratios calculated are somewhat understated being based solely on the avoidance of the direct monetary costs required to restore flood damaged property to pre-flood conditions.

The recommended flood control plan for the Lincoln Creek subwatershed was synthesized from the best alternative flood control plans considered. The selection of the recommended plan--which is subject to reconsideration following this public hearing--was based upon careful consideration of the technical feasibility, economic viability, practicality, potential public acceptance, and environmental impacts of the alternatives considered. The recommended plan would eliminate all flood damages from floods up to and including the 100-year recurrence interval event along the entire length of Lincoln Creek under existing and future land use conditions. It would provide an adequate drainage outlet for all storm sewers and storm water drainage channels tributary to Lincoln Creek.

The preliminary recommended flood control plan for the Upper Lincoln Creek area is best understood by dividing the Creek into seven distinct reaches. The recommended plan for these seven reaches is summarized on Map 8 on page 22. Figure 1 on page 23 shows typical cross-sections for the recommended channel for each reach. The plan recommendations for each of these seven reaches are as follows:

One. From the beginning of Lincoln Creek at N. 76th Street just north of W. Good Hope Road to the Chicago & North Western Railway crossing just downstream of N. 60th Street, no changes are recommended along this 1.1-mile reach.

Two. From the Chicago & North Western Railway crossing just downstream of N. 60th Street to W. Good Hope Road, along this 0.6-mile reach, the existing channel is proposed to be widened and deepened to accommodate flood flows and provide free outlets for two existing storm sewer outfalls which presently have invert elevations lower than the existing channel bottom. The channel deepening would range from 2.5 to seven feet. The new channel would be turf lined.

Three. From W. Good Hope Road to W. Mill Road, along this 1.0-mile reach, the channel would be deepened, widened, and turf lined to provide free outlets for four existing storm sewer outfalls which now have inverts below the existing streambed elevation. The deepening would range from 2.5 feet to six feet. It would be necessary to replace the W. Green Tree Road culvert to accommodate the new channel. Low earthen dikes, ranging up to two feet in height, would be required along both sides of the Creek just upstream of W. Mill Road. These dikes would have a total length of about 80 feet, with about 75 feet required along the west bank of the Creek and about five feet required along the east bank of the Creek.

Four. From W. Mill Road to W. Woolworth Avenue, along this 0.1-mile reach, the channel would be lowered about 2.5 feet and would be turf lined. This lowering is necessary to help provide a free outlet for an existing storm sewer outfall which discharges within the W. Mill Road structure. The channel lowering will require the replacement of the W. Woolworth Avenue and N. 51st Street culverts.

Five. From W. Woolworth Avenue to the existing pedestrian bridge near the northern limits of the Havenwoods Environmental Education Center, in this 0.1-mile reach, it is recommended that the channel be widened and deepened in order to both accommodate flood flows and provide a free outlet for a partially buried existing storm sewer outfall at W. Woolworth Avenue. The deepening of the channel bottom would range from about 0.5 foot at the pedestrian bridge to about 2.5 feet at W. Woolworth Avenue. The new channel would be turf lined. The existing concrete arch culvert under the Chicago & North Western Railway is recommended to be removed and replaced with a new concrete box culvert 10 feet high by 30 feet wide.

Six. From the existing pedestrian bridge near the northern limits of the Havenwoods Center to the existing steel drop spillway immediately west of the U. S. Army Reserve Training Center, this 0.9-mile reach extends through the U. S. Army property and the Havenwoods Center. It is recommended that the channel in this reach be cleaned and debrushed so as to facilitate and improve flood flows. No channel enlargement or deepening is recommended. The Wisconsin Department of Natural Resources is currently identifying alternative improvement projects related to Lincoln Creek at the Havenwoods Center. Alternatives under consideration include the creation of a wetland basin, the creation of a meandering stream channel, the installation of low dams, or a combination of such features. It is important that any such modifications be designed so as not to increase the 100-year recurrence interval flood stages upstream or downstream of Havenswood. Any wetland basin would have insignificant flood control benefits downstream, and the cost of development would have to be justified on other than a flood control basis.

Seven. From the existing steel drop spillway immediately west of the U. S. Army Reserve Training Center to W. Silver Spring Drive, no channel or structure changes are recommended in this 0.1-mile reach. The existing channel has a paved bottom and side slopes and is adequate to accommodate the 100-year recurrence interval flood.

The preliminary recommended flood control plan for Lower Lincoln Creek is best understood by dividing the Creek into eight distinct reaches. The recommended plan for these eight reaches is summarized on Map 9, on page 26. Figure 2 shows typical cross-sections for the recommended channel for each reach:

One. From W. Silver Spring Drive to the W Hampton Avenue crossing just west of N. 60th Street, no changes are required along this 1.2-mile reach. Within this reach the channel has already been deepened, widened, and lined with concrete. The channel has adequate conveyance capacity to accommodate the 100-year recurrence interval flood flow.

Two. From the W. Hampton Avenue crossing just west of N. 60th Street to N 32nd Street, major channel improvements are recommended along this 2.5-mile reach. Throughout this reach the channel bottom would be lowered from one to six feet with an average depth of excavation of about two feet. The existing channel would be reconstructed with a bottom width of about 30 feet and a top width varying from 100 to 200 feet. A concrete lining would be installed in the lower portion of the channel. Between N. 32nd Street and the Milwaukee Road tracks, it will probably be necessary to use a rectangular channel cross-section. The plan recommends that the channel itself be realigned as it flows under the Milwaukee Road tracks by moving the channel about 200 feet south of the present location. This will require the construction of a new bridge to carry the railroad tracks over the relocated channel. A number of bridge modifications may also be required in conjunction with the proposed channel improvements to accommodate the proposed lowered channel bottom grade. These include lowering of the center piers and abutments of the existing bridges carrying N. 51st Street and N. 60th Street across Lincoln Creek, and the pedestrian bridges in this reach of the stream. The existing bridges would have to be replaced at N. Sherman Boulevard, N. 37th Street, N 35th street, W. Glendale Avenue, and N. 32nd Street. Since the bridges at N. Sherman Boulevard and N. 37th Street are particularly significant hydrologically, that is, act as dams during major flood events and reduce downstream flood flows, the plan recommends that these two bridges not be replaced until the recommended channel improvements are carried out.

Three. From N. 32nd Street to the Chicago, Milwaukee, St. Paul & Pacific Railroad crossing just downstream of W. Hampton Avenue, no changes are recommended along this 0.2-mile reach. The channel has already been improved through widening, deepening, and partial lining with concrete, and is adequate to convey the 100-year recurrence interval flood flow.

Four. From the Chicago, Milwaukee, St. Paul & Pacific Railroad crossing just downstream of W. Hampton Avenue to W. Cameron Avenue, this 0.1-mile reach has already been improved through widening, deepening, and partial lining with concrete. In order to contain future flood flows, however, the plan recommends that an earthen dike be constructed along the entire west bank. The dike would range from three to four feet in height.

Five. From W. Cameron Avenue to N. Teutonia Avenue, the plan recommends no changes to the Lincoln Creek channel along this 0.2-mile reach. The channel has already been improved through deepening, widening, and partial concrete lining and is adequate to convey the 100-year recurrence interval flood flow.

Six. From N. Teutonia Avenue to W. Villard Avenue, the plan recommends no lowering or deepening of the Lincoln Creek channel in this 0.5-mile reach. Measures are recommended, however, for channel and stream bank protection and for containment of future flood flows through the construction of low dikes and flood walls. From N. Teutonia Avenue to N. 27th Street extended the plan recommends that the channel bottom be lined with concrete. This lining would be designed to protect the channel bottom from erosion due to the increased flood flow velocities caused by the recommended upstream channel changes. In that part of the reach from N.27th Street extended to W. Villard Avenue, the plan recommends that the eroding banks be reshaped and stabilized with gabions, rock riprap, or other suitable bank protection measures. The plan further recommends that a concrete flood wall ranging from two to three feet in height be constructed along the north bank of the Creek, from N. Teutonia Avenue to N. 27th Street extended. In addition, earthen dikes, ranging in height from two to four feet, would be constructed along the north bank of the Creek from N. 27th Street extended to W. Villard Avenue and along the entire south bank from N. Teutonia Avenue to W. Villard Avenue. Finally, in order to provide adequate flood flow capacity, the existing bridges carrying N. Teutonia Avenue and W. Villard Avenue over Lincoln Creek would need to be replaced.

Seven. From W. Villard Avenue to N. Green Bay Avenue, along this 0.4-mile reach, the plan recommends that earthen dikes ranging in height from three to five feet be constructed along both banks of the entire reach. These dikes could be made sinuous to blend into the land and cityscape.

Eight. From N. Green Bay Avenue to the confluence with the Milwaukee River, no changes are recommended along this 0.4-mile reach. It should be noted, however, in that reach there are homes subject to flooding not only from Lincoln Creek but from the Milwaukee River backing up along the Creek. There is no good solution to that flooding except to floodproof or elevate the homes and, in some cases, to remove the structure subject to flooding.

If the recommended improvements were made, the flood problems along Lincoln Creek would be essentially eliminated. If you will look again at the map on page 15, what we are saying is that, with implementation of the plan, not only the red but the yellow areas would, in essence, disappear from the map; and the flood flows would be contained entirely within the channel or within the channel and the dikes that would be built along the channel.

On page 13, it is indicated that the estimated capital cost for implementation of the entire recommended flood control and drainage improvement plan for Lincoln Creek is $10.7 million. The plan would have average annual operation and maintenance costs of about $8,500. These costs include all of the above described flood control measures, including the channel deepening on Upper Lincoln Creek required to provide free outlets for eight existing storm sewers that have been constructed with the inverts of the pipe below the existing channel bottom.

The total capital cost of the flood control plan alone--that is, not including the cost of those channel improvements required solely to accommodate the storm sewer outlets--is estimated at $9.9 million, with an attendant average annual operating and maintenance cost of $6,500. On an average annual basis, the flood control plan would have benefits approximating $649,000 and costs approximating $631,000, with a resulting benefit-cost ratio of 1.03, conservatively estimated. If the U. S. Army Corps of Engineers were making those estimates, they would probably compute a higher benefit-cost ratio.

Also on page 30, it is indicated that, under existing land use and channel conditions, the 100-year recurrence interval flood discharge for Lincoln Creek at the confluence with the Milwaukee River is about 7,980 cubic feet per second (cfs). Upon implementation of the recommended flood control plan, and assuming that future land use development in the watershed will occur in conformance with the adopted regional land use plan, that discharge may be expected to increase to about 13,970 cfs, or by about 75 percent. The recommended flood control works, however, would contain those flows.

On page 31, it is indicated that the peak discharge from Lincoln Creek may be expected to occur within three hours of the beginning of a major rainfall. Peak flood flows along the Milwaukee River may be expected to occur in about three days. Accordingly, it was concluded that, while the channel improvements recommended for Lincoln Creek will increase peak flood flows from Lincoln Creek, such peak flows should not occur at the same time as the peak flood flows on the Milwaukee River at its confluence with Lincoln Creek. Accordingly, no significant change in design flood flows or stages for the Milwaukee River downstream of Lincoln Creek should occur.

On page 32 it is noted that only a relatively few units and agencies of government would be involved in implementation of the recommended flood control plan for Lincoln Creek. These agencies consist of the City of Milwaukee, Milwaukee County, the Milwaukee Metropolitan Sewerage District, the Wisconsin Department of Natural Resources, and the Federal Emergency Management Agency. Basically it is recommended that the Milwaukee Metropolitan Sewerage District assume responsibility for implementation of the channel improvements and construction of dikes and floodwalls specified in the plan. The only exception to this would be the channel debrushing and cleaning recommendations through the Havenwoods Center, which would be the responsibility of the Wisconsin Department of Natural Resources.

Milwaukee County would have the responsibility of cooperating with the Milwaukee Metropolitan Sewerage District in making the channel improvements recommended through parkway areas and through the modification of pedestrian bridges in the parkway as required to accommodate the channel changes.

The City of Milwaukee would have to assume responsibility for all other bridge modification and replacement requirements except for the recommendations relating to the replacement of railroad bridges carrying Lincoln Creek under the Chicago & North Western Railway and the Milwaukee Road railroad right-of-ways. As the plan now stands, such railroad bridge replacements would be the responsibility of the Milwaukee Metropolitan Sewerage District. We received a letter today from the District asking that the plan be modified to indicate that the railroad companies concerned should be responsible for the replacement of those bridges and that the District has in the past, if necessary, gone to court to obtain action from railroad companies to provide adequate waterway openings under their rights-of-way. A copy of that letter will be made a part of the record of this hearing.

Finally, and importantly for some of you here tonight because it would be the first step in carrying out the plan, the City of Milwaukee would be responsible for initiating necessary changes to the federal flood insurance study and in the City of Milwaukee Floodplain Zoning Ordinance to remove from the floodplain those homes, which Alderman Kalwitz referred to, that are in fact not in a flood hazard area.

The concluding remarks on page 32 indicate that the flooding and related drainage problems in the Lincoln Creek subwatershed are serious and costly. Many hundreds of structures lie in the existing floodplain and are thus subject not only to periodic flood damages but to burdensome federal and state flood insurance and related zoning regulations and requirements. The only feasible and practical way to eliminate such flooding problems and to remove these hundreds of homes and other structures from the floodplain maps and attendant regulatory requirements is to undertake the series of interrelated channel and structure improvements set forth in the recommended Lincoln Creek flood control plan. These recommended improvements, and in particular those related to channel deepening, widening, and concrete lining and the construction of related dikes and floodwalls, are made by the Commission only as a last resort. We would prefer to have found other methods of abating the flood problems, but there appears to be no other feasible way to resolve the problem.

That, Ladies and Gentlemen, concludes what was perhaps an overly long presentation; but we did want everyone who took the trouble to come here tonight to be provided with a complete briefing on the findings and recommendations of the Commission study of Lincoln Creek. At this point, the plan is not in final form. We are anxious to hear your reaction to what has been done so far. If there are any new information or new ideas that should be brought to our attention, we want to hear about them; and, if necessary, we will change the preliminary plan before placing it in final form and sending it to the implementing agencies

Thank you very much for coming and for your patient attention. We will now turn the meeting back to Alderman Kalwitz.

ALDERMAN KALWITZ:

Thank you, Dr. Bauer. Are there any questions or comments?

Q. MR. HERBERT ZAUTKE, MILWAUKEE, WISCONSIN:

I am interested in the area from Sherman Boulevard to about 37th Street. That part of the creek is narrow. The banks are awful steep, and lowering the bed of that creek would just increase the problem of erosion that takes place. I see they want to eventually replace that bridge at Sherman and 37th Street; but it is probably 10 years ago that the creek overflowed its banks in that area. I live in the third house from the creek on 41st Street, and the creek was all the way up to my front lawn. The water really piles up in that area. If you are going to, like it said in here, be changing your bridge structures so they don't act as dams, it will be even worse. How are you going to take care of erosion if you deepen the bed of the creek. Common sense tells you that you have to widen it. It is awful narrow, and the deeper you go the steeper the banks will be and the more erosion you will have.

A. MR. BAUER:

Under the plan as it stands now, the channel in the reach you are talking about would be deepened and widened, and it would have to be lined with concrete pavement to avoid the erosion problems that you are talking about.

Q. MR. ZAUTKE:

That is what I am trying to address. How are you going to widen it? There is no room. You have Congress Street on both sides. The banks almost come right up to the roadways on the north and the south.

A. MR. BAUER:

There is adequate room for the channel cross section that is being proposed. I would suggest that after the meeting, you come up and look at the plans with us so we can show you the details of the recommended channel, the depth, the bottom width, and the side slopes. We believe the necessary channel can be accommodated in this reach between the existing roadways.

Q. MR. ZAUTKE:

Yes.

Q. MS. CARI BACKES, MILWAUKEE, WISCONSIN:

Right now I believe they are putting a new interceptor sewer in on Silver Spring. The boulevard is torn up between 57th Street and about 51st Street. I think it is an interceptor--

A. MR. SYLVESTER HEJLIK, MILWAUKEE METROPOLITAN SEWERAGE DISTRICT:

What is the question?

Q. MS. BACKES:

They are doing some sewer work on Silver Spring between 57th and 51st Streets. Is that interceptor part of the big one they have been building, attached to 51st, one that went in along Hampton and on Sherman? Is that all part of the same system? How is that going to affect your flood control plans.

A. MR. BAUER:

It would not affect the flood control plans in any way.

A. MR. HEJLIK:

That is correct.

A. MR. BAUER:

There is no relationship between the two.

Q. MS. BACKES:

Any new storm sewers that are being built north of Silver Spring, will they not connect to the interceptor, and where does it empty?

A. MR. BAUER:

Any new storm sewers would discharge directly into the creek. The so-called interceptor sewers discharge to the sewage treatment plants.

Q. MS. BACKES:

South or north, where would they empty?

A. MR. BAUER:

North of Silver Spring as land would be developed--depending on the street layouts and grades--the storm sewers would be brought to the creek as soon as possible. The interceptor sewer you are asking about is intended to carry sanitary sewage only and not storm water.

Q. MS. BACKES:

That is good to know. All the storm sewers will empty into the creek north of Silver Spring, and that is taken into account in here?

A. MR. BAUER:

Yes. In the Newsletter how much the flows may be expected to increase is discussed. If you look on page 30, it is pointed out there that the peak rate of discharge of the 100-year storm under present land use and present channel conditions is about 9,000 cfs. Under planned land use and channel conditions, that would be increased to almost 14,000 cfs, a substantial increase in the flow. That is the result of, in part, completion of urban development in the watershed and, in part, the result of the channel improvements that are recommended in the plan.

Q. MS. BACKES:

You have an increase of about 5,000 cfs that you are planning for. The point I am getting at is that I honestly think there is a potential to at least not add to what is happening downstream from Havenwoods. If we can impound water in Havenwoods--the new storm sewers will empty into the creek north of Silver Spring--if we can impound some of that water, why not do it? More streets are going in and houses, there will be less rainwater draining into the ground. Maybe you can eliminate putting up some extra storm sewers if the rest of the land north of Silver Spring were developed very carefully.

A. MR. BAUER:

It is pointed out in the Newsletter that the recommendation for channel improvements was made as a last resort--made reluctantly because the Regional Planning Commission staff would prefer other solutions, such as detention reservoirs on the Havenwoods site. The studies indicate, however, that such reservoirs would not control enough of the watershed area to have a significant effect on the downstream flood flows in areas subject to flood damages. If you look at the map on page 5, you can see that. The conclusion is, you might say, intuitively correct. If you look at the map on page 5, you can see that the area north of Silver Spring, the drainage area, is a relatively small part of the total drainage basin, only about four square miles of a total 19 square miles. You can see the large remaining part of the watershed that drains to the creek south of Silver Spring Drive. That area would not in any way be controlled by detention reservoirs on the Havenwoods site.

Q. MS. BACKES:

We had hoped we could use that as an example. So you are talking about further development draining to Lincoln Creek. If we had an example of Havenwoods of how you can eliminate some of the problem by preserving and protecting wetlands and lowlands, it would be desirable; but if you say no, I guess it is no.

A. MR. PHILIP C. EVENSON, ASSISTANT DIRECTOR, SEWRPC:

What you suggest can be done; but the point is that Lincoln Creek, as a watershed, is already so highly urbanized that what little you are able to do in influencing land development will not significantly change downstream flood flows. If you did it, fine. But it wouldn't change what you have to do to solve the problem downstream of Silver Spring Drive.

A. MR. BAUER:

What is being said is that you can still construct wetland basins on Havenwoods if you want to, but don't count on those basins providing any significant flood control benefits downstream. You wouldn't be telling the visitors to the Center the truth, if you told them the basins were doing that. We put the question box in the Newsletter just for you, Mrs. Backes. You can see from the map on Page 47 what has happened to the wetlands in the watershed. It is too late now, nobody can undo that. You can see what was done as the area was developed. Large former wetland areas were converted to urban use. When you do that, you create a flood problem. It is unfortunate, but it was done. Today you would keep those wetlands in open use. You would not be permitted to develop those areas. That wasn't the case back in the 1920's. You can see the map dates to 1919.

Q. MS. BACKES:

Some of that was there when we bought our house out there. Did you see any problems in the Little Menomonee?

A. MR. BAUER:

The Commission has made a watershed plan for the Menomonee River watershed. With respect to the Little Menomonee River, we are recommending that the natural areas, including the wetlands, along the river and in the drainage area tributary to the river be kept in natural open uses, including the portions draining down from Ozaukee County into Milwaukee County, to avoid excessive increase in flood flows as the area continues to urbanize.

Q. MR. WADE BANNERMAN, MILWAUKEE, WISCONSIN:

I live on 31st Street right in front of Lincoln Creek. When that creek gets high, everything you are talking about runs right in front of our house. Boy, that creek wasn't far from going over a couple of times. If you are going to widen and deepen all of these reaches going into this part of the creek, what are we going to do there? It is going to go over the top.

A. MR. BAUER:

What we are saying, Mr. Bannerman, is you have to start from downstream and work up or you will have the problem you are talking about. We make the point that there are certain bridges and certain channel improvements that should not be made until the downstream reaches are improved first.

Q. MR. BANNERMAN:

But all of this water runs into Lincoln Creek from all of these other mains. How are we going to keep that from overflowing because twice already--

A. MR. BAUER:

Under the plan, by making the channel bigger.

Q. MR. BANNERMAN:

You will get more water running into our reach.

A. MR. BAUER:

That is--

Q. MR. BANNERMAN:

You said you are not deepening or doing anything in that section from the railroad track to Teutonia.

A. MR. BAUER:

There are short reaches where the existing channel is adequate. The best way to see that is if after the meeting you come up and we go over with you to the large map and look at and talk about it. I think it will become clear that the reaches where no improvements are being recommended are only very short segments.

A. ALDERMAN KALWITZ:

Are there any other questions or comments?

Q. MS. JOAN GANDER, MILWAUKEE, WISCONSIN:

I live at 5453 N. 39th Street. I am President of the Milwaukee Northwest Side Community Alliance. I want to compliment the Southeastern Wisconsin Regional Planning Commission staff, Dr. Bauer, on a very easy to read plan presentation.

A. MR. BAUER:

Cindy and Phil are the ones to be complimented.

Q. MS. GANDER:

I will go through this Newsletter carefully. I wish we had gotten our hands on it sooner. This was published in May and June.

A. MR. BAUER:

Our Newsletters come out serially through the year. It normally takes us 30 to 45 days to write and print them. The May-June Newsletter accordingly comes out at the end of August or beginning of September. This came out about that time.

Q. MS. GANDER:

There were questions raised in my mind, as I went through this, that I would have liked to have had answered before tonight. It is easier for me to go through this as you did. On page 18 on Table 4, I would raise the question whether the 6 percent interest rate and 10 percent interest rate are realistic?

A. MR. BAUER:

That is a subject that is debated at length by professionals in the field. The federal government at the present time uses 7 and 5/8 percent for that interest rate. That is, the U. S. Corps of Engineers and other federal agencies involved in flood control and other water resource-related public works are directed to use that particular rate. What that rate of interest represents is what, in the planners and economists jargon, is the opportunity cost of the money that would be invested in the flood control works. The Regional Planning Commission believes that some figure between 6 and 10 percent is a reasonable measure of that cost. The taxpayers who must ultimately pay for these kind of public works generally don't have a lot of money to invest; and they cannot, therefore, command the higher interest rates that a big investor can. So most of the ordinary folk that live in a watershed like this one--the best that most of them can do is go to a bank or savings and loan and get a 5 3/4 or 6 percent rate of return on their savings. That is the opportunity cost of the monies they would otherwise be taxed to build the flood control works. If they have enough money to get a $10,000 certificate of deposit, they might get today maybe 8 or 9 percent--interest rates have been falling. We do think that those rates are a realistic measure of the opportunity cost of the money, and the rate used by the federal government falls right in between those two. As you raise that rate, you tend to make the flood control works less economic--that is, the benefit-cost ratio may become not only lower but perhaps less than one. If you lower that interest rate, the flood control works look better from an economic standpoint. We thought we would present two rates so the people would get some idea of the sensitivety of the benefit-cost ratios to the interest rates assumed.

Q. MS. GANDER:

I am confused. I understood the Sewerage Commission was going to float bonds to pay for this. How is this going to be paid for?

A. MR. BAUER:

That interest rate has nothing to do with the cost of any bonds that might or might not be used to carry out the recommended plan. That interest rate is used solely to compare the benefits that would be derived from the recommended flood control works to the costs of those works. You have to separate that in your mind totally from how the project might be financed. I know it seems confusing--and it is even confusing sometimes to professionals that work on these projects. We don't know at this time how the recommended flood control works will be funded. The elected bodies that ultimately to have to make the decision to proceed--all the Commission can do is make recommendations--those elected bodies will determine how the works are to be funded. The City of Milwaukee may have to replace some of the bridges, and the Common Council will determine how to finance those replacements. That is being done on the Kinnickinnic River right now. Alderman Kalwitz, I don't know if you are paying for those bridge replacements out of current taxes or out of bonding, or out of a combination of such financing. It could be done in a number of ways depending on when the work was to be done and how the budget deliberations were going at that time. You might pay for some of the works out of the tax levy. Similarly, the Milwaukee Metropolitan Sewerage District, if it came time to construct the channel improvements, might construct some with current taxes rather than bonding for them. There is a possibility that, as described in a longer report that will be filed with the implementing agencies--this Newsletter is only a summary of the report--the Corps of Engineers could perhaps provide funding for some of the improvements. That is something that the elected officials will have to decide whether they want to pursue. What I am saying in a long-winded way is that the interest rate used to compute the benefit-cost ratios is not to be confused with the interest rate you might have to pay on a municipal bond.

Q. MS. GANDER:

The $10.6 million cost cited on page 31, what does that represent?

A. MR. BAUER:

That represents the estimated cost in 1982 dollars of constructing all of the works that are recommended in the plan. So it would take $10.7 million--it is estimated--to carry out all of the improvements recommended in the plan if they were all made now.

Q. MS. GANDER:

This September?

A. MR. BAUER:

The costs are expressed in 1982 dollars. The actual dollar cost may, of course, be higher or lower, depending on the rate of inflation.

Q. MS. GANDER:

What is the going rate at which the City can borrow when it gets an AA or AAA rating?

A. ALDERMAN KALWITZ:

It has changed most recently. In the spring of the year, it was in the 8 to 9 percent range. That will change again depending on the time of year and the market conditions.

Q. MS. GANDER:

On page 19, I find that I don't understand two paragraphs. The first paragraph on the page discusses flood water storage, and the second says flood flows in the heavy urbanized reach downstream would not be significantly reduced by the provision of additional floodwater storage at Havenwoods. But the very next paragraph says storage of floodwaters on U. S. Army property--and I drop down two lines--would gain very little even with a relatively large flood control reservoir and, accordingly, this proposal was eliminated from further consideration.

A. MRS. CYNTHIA V. DeBRUINE, WATER RESOURCES ENGINEER, SEWRPC:

A reservoir on the Army property would control runoff from a highly urbanized area, which a reservoir on Havenwoods would not.

A. ALDERMAN KALWITZ:

Some other people may want to ask questions.

Q. MS. GANDER:

I am not through. Was the reservoir evaluated assuming that runoff from Upper Lincoln Creek would be controlled by the proposed reservoir? It goes on to say on page 19 that significant reductions in flood flows and stages would be realized downstream of Silver Spring. Those two paragraphs seem to contradict each other.

A. MRS DeBRUINE:

No, they do not. The flood flows would be reduced by the reservoir for a certain distance below Silver Spring Drive---

Q. MS. GANDER:

As far as 51st Street?

A. MRS. DeBRUINE:

---and if you look at the map, you would see that area affected does not have a flood damage problem. The flows are contained within the channel right now. Reducing flows in that area would not serve any purpose.

Q. MRS. GANDER:

If you reduce flows in that area, wouldn't it reduce the flows further on?

A. MRS. DeBRUINE:

It doesn't--there are storm sewers coming in below that reach from large urbanized area and increase the downstream flows. We analyzed the situation using simulation models, and the analyses indicated that the effect of the decreased flows from that reservoir would not be felt below 51st Street.

Q. MS. GANDER:

You are saying in here the reduction is significant.

A. MR. BAUER:

You have to examine the reduction in relation to the total flows. What would be a significant reduction immediately downstream of the reservoir would not be a significant reduction further downstream. I don't have the numbers at hand, but using hypothetical numbers to illustrate what is being said, if the flood flow in the creek immediately below the reservoir--if the peak flood discharge--is say 1,000 cfs without the reservoir, and - you build the reservoir, you may reduce that flow by say, 250 cfs, or by 25 percent, a significant reduction. Further downstream, however, the flow may be say, 10,000 cfs and a reduction of 250 cfs will contitute only 2.5 percent of that flow, an insignificant reduction, with no appreciable effect on stages downstream. What that says is that reservoirs protect a stream system only for relatively short distances below their outlet. Again, if you look at the shape of the Lincoln Creek watershed--as shown on page 5—the shape of the basin in such that there is a great deal more drainage area and, therefore, water entering the stream system from the area below Silver Spring that would not be controlled by the reservoirs than from areas above Silver spring that would be so controlled.

Q. MS. GANDER:

I can see that on page 5; but you, yourself, told us that the flood flow is going to increase by 75 percent because of development above Silver Spring.

A. MR. BAUER:

And because of the recommended changes in the channel and the consequent elimination of flooding; the increase is the result of two changes.

A. MR. EVENSON:

The effects of the two changes are not equal. The amount of flow increased through new land use development upstream is relatively small compared to the effect on flows downstream when you take out, for example, the Sherman Boulevard bridge that acts as a dam.

Q. MS. GANDER:

Where is that 75 percent increase coming from?

A. ALDERMAN KALWITZ:

There might be some other persons wanting to ask questions about the details of the plan.

Q. MRS. GANDER:

I would like to finish.

A. MR. BAUER:

Some of that increase comes from elimination of the existing flooding as a result of the proposed channel improvements. At the present time, during a major flood, flood waters are stored on people's property and in their basements and sometimes over their first floors. When you make the channel improvements to eliminate that flooding, you are eliminating that storage and increasing downstream flows.

Q. MS. GANDER:

I still don't understand why you contradict yourselves. Logic says if you can impound water on 237 acres north of Silver Spring, and you say it would have significant effect to 51st Street--then common sense would say impound some water on that land. I have to raise a question about politics between the Sewerage Commission, the Department of Natural Resources, and the Regional Planning Commission.

A. MR. BAUER:

There would be nothing in the plan to prevent the Wisconsin Department of Natural Resources from developing a reservoir on the Havenwoods site. Such a reservoir could be used for aesthetic and recreational purposes; but we don't think we should be fooling the public by saying that the reservoir would have a significant effect in eliminating flood damages downstream. The stream reach where the reservoir would reduce flows does not experience flood damages.

Q. MS. GANDER:

On page 20, you speak of tributaries and name one. How many others are there?

A. MR. BAUER:

I would have to count them on a map. If you look at the map on page 5, you can see the major points of inflow, indicated by the black arrows. Some of those inflows are surface streams, some are storm sewers. If you look on the large-scale map, you can count up the little surface tributaries that flow into Lincoln Creek. Many such tributaries have disappeared and have been put into storm sewers as the area has urbanized.

Q. MS. GANDER:

Your study says that you didn't deal with those. Why not if they are feeding into Lincoln Creek?

A. MR. BAUER:

Wahl Creek is an example. Improvements to that creek are a matter of urban stormwater drainage design and not of flood control design.

Q. MS. GANDER:

But it is coming in.

A. MR. BAUER:

This plan does not--is not intended to--make specific recommendations for the improvement of Wahl Creek, indicating, for example, that the Creek should be placed in a storm sewer and the storm sewer should be of specified size. That kind of planning is the responsibility of the City Engineer. The flows that are contributing to Lincoln Creek by Wahl Creek are, however, considered in the analyses.

Q. MS. GANDER:

What is a gabion?

A. MR. BAUER:

A wire mesh box that is filled with crushed rock and is then placed along a stream bank. If you look at the cross section on page 27, you will see there a stepwise appearance; that represents the "boxes" stacked up to protect the bank. Perhaps from that you can visualize how it would look very much like terraces. Beauty is in the eye of the beholder, but the gabions probably blend into a naturalistic setting better than a smooth pavement because the rock takes on a more natural appearance. They are a way of stabilizing the banks so you don't get erosion.

Q. MS. GANDER:

In No. 6 you speak of floodwalls. Are those concrete?

A. MR. BAUER:

Yes. They would not be very high, and would probably be six to nine inches thick.

Q. MS. GANDER:

When you speak of dikes, are you speaking of earth dikes?

A. MR. BAUER:

Yes.

Q. MS. GANDER:

In the next paragraph where you are talking about concrete floodwalls ranging from two to three feet high, you are recommending putting the stream into an open tunnel.

A. MR. BAUER:

The floodwalls would be located somewhere along the top of the bank, but back from the bank as far as practicable. The walls would not have the appearance of a cut or tunnel at all. If you have been to the City of Burlington, you would have seen the effect; that City has floodwalls through the downtown area. People think they are decorative.

Q. MS. GANDER:

Would they be like that? Decorative?

A. MR. BAUER:

Beauty is in the eye of the beholder, but a three foot high wall is not a visual impediment.

Q. MS. GANDER:

The area that the gentleman before spoke about between Sherman and 37th with Congress on both sides, has any thought been given to closing one side of Congress and using that? He was suggesting by deepening you would increase erosion. Was any thought given to closing one side of Congress?

A. MR. BAUER:

We did not consider that.

Q. MS. GANDER:

Any reason?

A. MR. BAUER:

There are homes fronting--

Q. MS. GANDER:

On the south side. I don't believe there are any that face--

Q. UNKNOWN:

Yes, there are.

A. MR. BAUER:

Normally, when you start talking about closing streets, you encounter a lot of public resistance. There has been some resistance of this kind along the Kinnickinnic River where a number of bridges are being removed and not put back for flood control purpoes. There has been some grumbling and complaints from people in the neighborhood that the work is interfering with pedestrian and vehicular traffic circulation.

Q. MS. GANDER:

In the part south and east of St. Michael's Hospital, you are talking about dikes ranging up to five feet high. In terms of the stream itself, where are those dikes going to be located.

A. MR. BAUER:

In implementing the plan, you would locate the dikes as far away from the top of the bank as practicable. They could be designed to be sinuous and fit into the landscape so they would not be obtrusive like a straight railroad embankment. They could be made to look attractive; and, if properly designed and built, most people would not realize there were dikes present.

Q. MS. GANDER:

Thank you.

Q. MR. ROBERT WAGNER, MILWAUKEE, WISCONSIN:

Couldn't the Army Corps of Engineers help us in this?

A. MR. BAUER:

That is a possibility. The Corps does have a program of constructing flood control works of the kind being recommended. That is a decision that will have to be made by the City Fathers and the District if they want to seek that help. Normally that requires strong congressional support because the Corps is very much attuned to the wishes of the Congress.

Q. MR. WAGNER:

The 5th Army Corps is located in Chicago.

A. MR. BAUER:

We used to deal with them but not any more. We now have to deal with the Detroit office of the Corps for watersheds, such as the Milwaukee River watershed, which drain to Lake Michigan.

Q. MR. WAGNER:

That I don't know.

A. MR. BAUER:

They just changed that.

A. MR. EVENSON:

Any project over $5 million would require specific congressional authorization. You are looking at a long process--it might take 10 years to get Corps action.

Q. MR. WAGNER:

By then we probably could have the project done locally.

A. ALDERMAN KALWITZ:

Assuming the project went forward. Whatever responsibility the City of Milwaukee might have, such as bridge replacement and so forth, I am sure every possibility of federal aid would be explored. We are and have built a number of bridges using federal funds, getting our own dollars back so to speak. The 27th Viaduct is an example of such a project. That would be explored. I will talk to the Department of Fiscal Liaison concerning this matter. We don't know exactly where this is going at this point in time. There is still some public reaction to be obtained. We are not going to assume solely local funding; every possibility of federal and state aid will be explored.

Are there any other questions or comments?

Q. MR. FREDERICK KRAUSE, MILWAUKEE, WISCONSIN:

If this plan is approved and they get financing, how many years would it take to build this thing from the river to where you are deepening channels to get more room? What is the time table in years?

A. MR. BAUER:

That is a hard question to answer because the timing really would depend upon the actions of the governing bodies concerned. There is no physical reason why a $10 million project couldn't be carried out over a period of three to five years. Perhaps a more realistic estimation for full implementation would be 10 years. It might take somewhere between five to 10 years to get a project of this kind completed. There is no reason why it couldn't be done sooner if firm direction from the elected bodies and the necessary money were provided. There is a political decision that has to be made.

Q. MR. KRAUSE:

With respect to deepening the channels and tearing out some of the bridges, if you start on the wrong end, we would get more floodwater down by us, where 32nd Street acts as a bottleneck. We would have more water than we would know what to do with. We have not had a drop of water in the basement since 1951.

A. MR. BAUER:

The Commission completed a study very similar to this for the Kinnickinnic River watershed about three years ago, and I think--very much to the City's credit--that the recommendations are being carried out very quickly by the City. This year the City will have removed all of the bridges that require removal, that were bottlenecks; and I think the District is getting ready to make the channel improvements. There the entire plan will have been carried out over perhaps a five-year period. It can be done.

Q. MR. KRAUSE:

If they would eliminate the bottlenecks on 35th, 21st, and Sherman--I don't know about 60th Street--and 51st Street--the water would flow real good. On the whole creek, eliminate the bottlenecks first. You are going to have to spend lots of money; go ahead; I will be dead by that time.

A. ALDERMAN KALWITZ:

With respect to your particular area not experiencing a problem, we would point out that there are a number of areas to the north, south, and east of you which do experience extensive flooding; and many people have lost thousands of dollars. Back in 1972, people suffered losses that went into the millions. There is a serious problem readily identified in documented citizen complaints going back at least 20 years. With some federal aid provided, it should be possible to carry out the plan in a reasonable period of time.

Q. MR. KRAUSE:

My house is built up three foot higher than the surrounding houses, and was one of only three houses in the area that didn't have water in the basement. They were going to regulate up to so many feet above some magical ground level which I never heard of. If your house is up higher, you still have to buy flood insurance. The next buyer buys my house--which never had a drop of water in the basement--but the next buyer will have to buy flood insurance, even though I never had water in 30 years. Dumb. Stupid.

A. ALDERMAN KALWITZ:

Agreed, that is why, based on this study, I propose to amend the City floodplain zoning and the federal insurance requirements. If this plan goes through, I would certainly do my best to expedite those amendments. It is a matter of priorities. Some monies will be spent for certain public projects. We should get some of those monies for public improvements on the north side; funds have been provided for the south side; we want some for our area. People don't want to continue to live with the flood hazard.

Are there any further questions or comments?

Q. MR. DONALD KNUTH, MILWAUKEE, WISCONSIN:

I am all for fixing up the Creek. When you drive down Sherman and see trees and junk in the Creek, only common sense says clear that out and the water will flow better. On page 21, paragraph 2, does this literally mean you are going to add more water to the Creek? If anybody is going to add a drop, you are doing wrong. There should be no more water added to the Creek in any way. We are paying taxes for sewers. The Sewerage Commission's job is to build sewers to carry the water. That is what we pay taxes for. The problem in this area is the storm sewers and sanitary sewers are connected. You get the people having their rain gutters going into sanitary sewers and flooding the system. We need the Creek made to handle more water, but we don't need more water coming into the Creek at any time. Part of the plan is to develop the upper area--on page 5--to sell land and put industries up there to put more water in the Creek. I am not for this. You are pulling the wool over our eyes.

A. MR. BAUER:

The assumption that was made in preparing the plan was that the remaining undeveloped lands in the upper watershed north of Silver Spring will eventually be developed for urban use. We think it is unrealistic to assume that those lands are going to stay in open use. Much as you might like it or I would like it, it isn't going to happen.

Q. MR. KNUTH:

I agree. But that water should go into the sewers and not in Lincoln Creek.

A. MR. BAUER:

There is a misunderstanding here. The kind of sewers that the storm water runs into discharge to the Creek. The kind of sewers that your sanitary plumbing in your house is connected to runs to the Jones Island and South Shore sewage treatment plants. They are not the same sewers.

Q. MR. KNUTH:

Don't we have storm sewers and sanitary sewers separate in other parts of the city?

A. MR. BAUER:

Yes.

Q. MR. KNUTH:

Why not in north Milwaukee?

A. MR. BAUER:

You do. The storm sewers discharge to the creek. The sanitary sewers discharge to sewage treatment plants. They do that now in the Lincoln Creek area. We point out that there are eight existing storm sewer outfalls right now that are not working properly because the bottoms of those storm sewers are below the creek bottoms. All storm sewers are supposed to run into a body of surface water and not into the sanitary sewers.

A. ALDERMAN KALWITZ:

Are there other questions or comments?

Q. MR. MILTON MILLER, MILWAUKEE, WISCONSIN:

I am hearing some comments about the appearance of Lincoln Creek. The neighbors and I were hoping that Lincoln Creek would continue to have a natural look rather than just be a storm sewer in the surface of the ground. We would miss that natural look very, very much. If you had to get rid of the bushes and trees, the grass and so forth, it would spoil the natural look of Lincoln Creek for many people.

A. MR. BAUER:

I would like to give you some comfort on that, but I am sorry I can't. The recommendations in the plan were made reluctantly and as a last resort. In the lower part of Lincoln Creek south of Silver Spring, the recommendation is to widen and deepen the Creek and to install a concrete lining. I understand what you are saying, and I appreciate it; Although we tried very hard, we could find no other solution to the flood problems. The only other course of action practicable would be to leave the situation as it is, and let the flood problems continue to exist. There is no other alternative--we believe that all feasible alternatives were examined. You could build a turf-lined channel. That would have a more natural appearance. The District doesn't like that, however, because you normally get severe erosion when a large flood event occurs and the flow velocities become very high; and then the District has to go in and do costly maintenance work on the channel. I think the District has a policy of not improving waterways without concrete linings. For the upper part of Lincoln Creek, we are recommending, in spite of the District's policy, that the channel be grass-lined to appear more natural. But the lower part of the creek is recommended to have a concrete lining. I know what you are saying, and I wish there were an alternative. We can't find one.

A. ALDERMAN KALWITZ:

Are there any other questions or comments?

Q. MS. MARIE DANIELS, MILWAUKEE, WISCONSIN:

How does that affect our property values? Will that keep going down until this is fixed?

A. ALDERMAN KALWITZ:

I would assume, if in fact the improvements are made, and the possibility of flooding within the Lincoln Creek watershed reduced, the improvements would improve property values. The improvements would remove you from the floodplain zoning district. I would think that would be a positive situation. It would certainly not decrease your values but, if anything, enhance them. I think right now, about 2,300 homes have a cloud over their property, that will be reduced by 800 on the basis of this plan report. The other 1,500 homes would remain in the floodplain until the channel improvements are made. If you have a potential buyer, and he is required to buy insurance even though he might not get a flood in 50 years, a cloud will hang over the property. This is one way to remove that cloud.

Q. MS. DANIELS:

But our taxes are not different now because we are living in the floodplain.

A. ALDERMAN KALWITZ:

That is based on market values. In the recent reassessment of property in the City, some of the areas north of the Lincoln Creek--along 35th north of Congress--showed that the assessed values average about 60 to 85 percent of market values, based on what homes are selling for.

Could I ask a question? Was there any thought given to using green concrete?

A. MR. BAUER:

No. That has been tried with median strips in highways, and not without criticism by the environmentalists.

A. ALDERMAN KALWITZ:

The concrete lining of the channel may become a focal point of opposition; and has in fact been a determining factor for the lack of support for some projects in other areas of the city in the past.

A. MR. BAUER:

I agree that can be a factor; and normally when channel improvements are proposed with a concrete lining, you do get objections from the people particularly who live along and can see the channel. But it is a matter of trading off the flood problem for the aesthetic impact. There is the alternative of building the channel with a turf lining if you are willing to take on the added maintenance costs of controlling erosion after every heavy flow. It is to avoid those maintenance costs that the District has instituted its policy of lining the channels with concrete. The velocities will get high and will in a major flood eventually wash out the turf lining and cause erosion.

A. ALDERMAN KALWITZ:

Are there any more questions or comments?

Q. MR. WADE BANNERMAN, MILWAUKEE, WISCONSIN:

Between the railroad track and Teutonia Avenue from the top of the cement channel lining about 20 feet up, it is all weeds. They don't even cut it any more. Weeds grow pretty high and that sometimes holds the flow back. At least 20 feet on the east side is all in weeds. They used to cut the grass down to the cement, but they don't do it any more.

A. MR. BAUER:

Everybody is trying to look at ways to cut back expenditures. You will notice that in highway maintenance too the highway department is no longer mowing the rights-of-way as they used to.

Q. MR. BANNERMAN:

But those weeds hold the water back.

A. MR. BAUER:

Yes, but the mowing costs money.

Q. MR. BANNERMAN:

It is a financial problem, yes.

A. ALDERMAN KALWITZ:

Are there any other questions or comments?

Q. MR. WALDEMAR E. POHLAND, MILWAUKEE, WISCONSIN:

I wonder whether this proposal can't be done in stages; and if our storm sewer outlets don't run into the creek, why don't we dredge around those and form pools? I don't know why we have to go through this entire creek bed, when we have problems in certain areas only.

A. MR. BAUER:

You could, indeed, carry out the plan in stages. However, in so doing, we would recommend just the reverse of what you are saying. You have to, as a first stage, start at the downstream end and work up because if, for example, you remove the Sherman Avenue bridge without building the downstream channel improvements and dikes, you are going to make the flood problem downstream much worse for those people. That doesn't seem fair. If you make the improvements in stages you must start at the bottom and work up.

With respect to storm sewer outlets, digging a hole for a pool won't improve the performance of the sewers because they have to have a free outlet to drain the areas they are intended to drain properly.

Q. MS. GANDER:

A few years ago we heard a figure that channelizing costs $1 million a mile. I am wondering what the comparative cost is for doing the gabion lining instead of concrete or sod.

A. MR. BAUER:

I don't have those figures at hand here tonight. But the gabions would generally be cheaper than concrete lining, and in many cases they are used as a substitute for the concrete lining.

Q. MS. GANDER:

Aesthetically, they are not quite as harsh.

A. MR. BAUER:

I don't think they are, but that is a matter of taste. Some people who look at a concrete lined creek, like Honey Creek, will say it is beautiful. The concrete is laid in flowing curves, and they say it is beautiful. Somebody else will say it is a monstrosity. To some degree, we are discussing individual tastes. But you go to a concrete lining, you do destroy any ability of the stream to support a fishery. Any biological life becomes untenable.

Q. MS. GANDER:

Is it possible to use gabions?

A. MR. BAUER:

Yes. That is a design detail that would have to be addressed in the preliminary engineering phase. Alderman Kalwitz, cut me off if I am talking too much. Improvements of the kind envisioned in the plan have to be brought about by an orderly public works development process. The preparation of this plan and, hopefully, its approval by the governing bodies concerned is only the first step in that process. The next step, if the elected bodies determined they wanted to proceed, would be to prepare preliminary engineering plans. In that step, details of the kind you are asking about would be looked into, and there would have to be another public hearing. Let's say the District, as recommended in the plan, assumed responsibility for the required channel improvements; they would prepare and present alternative preliminary engineering designs to the people in the neighborhood. They might say, in effect we can build a turf-lined channel for so much in capital costs, but it would cost so much to operate and maintain. We can use gabions, they would cost so much. We could use a concrete lining; that would cost so much. You would try to reach agreement among the interests concerned on the best alternative. The implementing agencies would then have to prepare construction plans and specifications. So this plan is only the beginning of the process. Yes, if I had anything to do with it, I would want to see gabions explored at least as an alternative to a concrete lining at least in some reaches and presented as an alternative with the costs to the people involved.

Q. MS. GANDER:

Did I understand you to say it is cheaper than concrete?

A. MR. BAUER:

Generally speaking, yes.

Q. MS. GANDER:

How do they compare effectively?

A. MR. BAUER:

They have a higher friction loss--the so-called Manning's M value is higher. There is more friction between the flowing water and the rock lining so you have to have a somewhat bigger channel if you have gabions than if you have a smooth concrete lining. Those are the kinds of trade offs that have to be made and looked at in detail.

Q. MS. LUNETTE E. REID, MILWAUKEE, WISCONSIN:

I was wondering why, if those of us who are here tonight--if we don't have the possibility of seeing this plan implemented in the next 10 years--why are we here tonight? I was hoping sooner. Ten years is a long time. The cost is going to be tremendous for us to carry as taxpayers.

A. MR. BAUER:

I'm sorry. What was your name?

Q. MS. REID:

Lunette Reid.

A. MR. BAUER:

Thank you. First of all, you have to start somewhere. Perhaps this planning should have been done 10 years ago. You have to make a beginning. The longest journey starts with a single step. We would note that parts of this plan can be implemented immediately. There are 800 homes in this watershed that are now under the cloud of floodland zoning, and the owners are required to buy federal flood insurance if they want to obtain federally insured mortgage financing. That cloud can be removed by simple acts of a legislative body and an administrative agency. Those acts can be taken within the next three to six months. Eight hundred homeowners can be helped in effect immediately. Beyond that, how fast some of these physical improvements take place will depend upon how well you can impress your needs and desires on your elected officials, and how well they can carry the required action within their legislative bodies. These are difficult times for your elected officials to be proposing costly programs. I, myself, feel-- by way of editorial comment--that these are times when we should be investing in public works because we would be thereby creating jobs, as well as solving problems; but that may be an old fashion view today. In the 1930's, the Federal Works Progress Administration built many public works projects--and put a lot of people to work--projects from which we are still benefitting today in this area. What I am trying to say is that part of the plan can be placed into effect immediately. How fast the other parts will come about will depend upon the political decisions that have to be made.

A. ALDERMAN KALWITZ:

The Southeastern Wisconsin Regional Planning Commission i going to present this plan to the governmental bodies concerned--the City, the District, the County, the DNR. I presume that, before they complete their report, which has been in the making several years, they want some reaction from the public. I believe the people of the Second District want these improvements. We will do everything possible to expedite the needed work as between the District and the City of Milwaukee. We have talked about the budget and long-range capital improvements. We have a long-range capital improvements program. These improvements are not now a part of that program. We are going to have to modify the program and are going to have to get the legislation in place authorizing the preliminary engineering. Certainly, with respect to the 800 households that should be removed from the floodplain, that will be an easier task; but we will expedite it.

Q. MS. REID:

Sometimes consultation eats up so much of the money, it prevents the needed work getting done.

A. ALDERMAN KALWITZ:

There is so much being spent downtown, we can ask for a fair share on the northwest side.

Does anybody else want to speak?

Q. MR. MILTON MILLER, MILWAUKEE, WISCONSIN:

What effect would this have on the Milwaukee River?

A. MR. BAUER:

We were concerned about that question ourselves because there are flood problems on the Milwaukee River. That concern is addressed in the Newsletter on page 30, and it is indicated there that the peak flood flows on Lincoln Creek occur within about three hours after the beginning of a major rainfall. The peak flows on the Milwaukee River at Lincoln Park occur about three days after a major rainfall begins. So the Lincoln Creek peak flows would have passed downstream before the peak flows on the Milwaukee River arrive and would cause no increase on the Milwaukee River. That was an important issue that we were concerned about, and we analyzed it carefully.

Q. MR. MILLER:

Was there any consideration given to having a large flood control sewerage system way underneath the ground rather than improving Lincoln Creek?

A. MR. BAUER:

No. We did not consider that alternative. Such a system has been proposed in the Chicago area. Perhaps you have been aware of that in the popular press. However, it is very expensive. You would be talking about a very costly system in which you would drop the stormwater runoff into storage tunnels and subsequently pump the stored water to the surface after the storm passed. It seemed to us that was impractical, given the high capital cost and the rising costs of energy. It seemed to us the more you can do with gravity flow, the better off you will be in the years ahead because energy costs, we think, are going to continue to rise; and the cost of pumping will go up.

A. ALDERMAN KALWITZ:

Any further questions?

Q. MS. BACKES:

What does the term "debrush" mean? Does that mean going in and taking everything away or do you have a definition?

A. MR. BAUER:

It would mean going in and selectively cleaning out the channel. It would be no different than cleaning out your backyard. If your landscaping gets too overgrown, you go in and clean it out. You are talking here about that kind of cleaning. We specifically recommended that that be done through the Havenwoods area by the Department of Natural Resources rather than by the Sewerage District because it was felt there would be the concern I know you have, and that the DNR would be more sensitive to that concern and would do a more careful selective clearing job. When you do that, there are trees, for example, that could remain because the trunks may not constitute a serious impediment to the flow; whereas, a lot of brush with fine branches may constitute a serious impediment and would have to removed. You would clean selectively.

A. ALDERMAN KALWITZ:

Are there any other questions? I would like to pose a question. How many of you here tonight support the general concept of what is being proposed in the plan if, in fact, the objective is to reduce flooding and eliminate floodplain zoning in the Lincoln Creek area?

How many of you have a general positive feeling with what is being proposed even though you might disagree with some details?

Please raise your hands. How many are opposed? Please raise your hands.

(Secretary's note: two of the 49 people present people raised their hands in opposition.)

Are there any feelings that those of you who expressed opposition have that you want to share with us?

Q. MR. ARTHUR R. HESSE:

The Creek does flood. But it happens only about once in 10 years. I live two houses from the Creek. When we do have water in the basement, if there is a backup, does it come from the sewer or from the Creek? Those are two different things. We have been there 20 years and had water in the basement once. The water does get high. Six or seven years ago it did come up the street like my neighbor mentioned. The place to start is at your dams down below which are holding back the flow of the water. You mentioned that you are going to start in lower. That is the ideal thing to do. If the water is stopped down below, it is going to build up. The street bridges and railroad bridges and some other things, they are the place to start. After that is done, you can evaluate the problem again. That is my personal opinion.

A. ALDERMAN KALWITZ:

Thank you. Are there any other comments? If not, please feel free to come up here after the meeting to examine the plan maps and discuss them with the staffs present. I think all the questions and comments were excellent. I am sure the people from the Southeastern Wisconsin Regional Planning Commission now have a good idea of what your concerns and feelings are with respect to the proposed plan. I thank you very much.

Alderman Kalwitz then adjourned the meeting at 9:30 p.m. CDST.

Respectfully Submitted,

Margaret M. Shanley
Recorder

Appendix C

ATTENDANCE RECORD AT PUBLIC HEARING
CUSTER HIGH SCHOOL
SEPTEMBER 23, 1982

Elected Public Officials

Kalwitz, John R.	Alderman, City of Milwaukee
Kondziella, James	Alderman, City of Milwaukee
Krivitz, James A.	Supervisor, Milwaukee County

Local Public Agency Staff

Holley, Wilbur T.	City Engineers Office, City of Milwaukee
Hejlik, Sylvester	Milwaukee Metropolitan Sewerage District
Miller, T. H.	Department of City Development, City of Milwaukee
Vajcekauskis, John J.	Building Inspection Department, City of Milwaukee

SEWRPC Staff

Kurt W. Bauer	Executive Director
Philip C. Evenson	Assistant Director
Cynthia V. DeBruine	Water Resources Engineer
Margaret M. Shanley	Executive Secretary

Press

M. Blackwell	The Milwaukee Journal

Attendees

Abfalder, M.	4228 N. 49th Street, Milwaukee
Backes, Carl	5708 N. 56th Street, Milwaukee
Ballard, Carl	4403 N. 38th Street, Milwaukee
Bannerman, Wade	4975 N. 31st Street, Milwaukee
Bohnak, Gladys	4364 N. 42nd Place, Milwaukee
Bohnak, Stanley	4364 N. 42nd Place, Milwaukee
Burdey, Mary	4400 N. 50th Street, Milwaukee
Daniels, M. E.	4324 N. Sherman Boulevard, Milwaukee
Daugherty, Daniel R.	4737 N. 56th Street, Milwaukee
DeLaurier, Donald	4928 N. 66th Street, Milwaukee
Gander, Joan	5453 N. 39th Street, Milwaukee
Geiger, Joseph O.	44077 N. Montreal Street, Milwaukee
Gokey, Lorene	4410 N. 50th Street, Milwaukee
Gokey, Vernon J.	4410 N. 50th Street, Milwaukee

Hagen, Marcus P.	4232 W. Courtland Avenue, Milwaukee
Hoeppner, Ernest	4762 N. 60th Street, Milwaukee
Horn, Erick	3115 W. Fairmont Avenue, Milwaukee
Huth, Clarence J.	4112 W. Hampton Avenue, Milwaukee
Johnson, Carl	5210 W. Glendale, Milwaukee
Johnson, Valeska	5210 W. Glendale, Milwaukee
Kalbes, Verna	4608 W. Congress Street, Milwaukee
Kiepke, Albert M.	4248 W. Glendale Avenue, Milwaukee
Kiepke, Mrs. A. M.	4248 W. Glendale Avenue, Milwaukee
Kjer, David D.	4667 N. 46th Street, Milwaukee
Klaus, C.	4316 N. Sherman Boulevard, Milwaukee
Knuth, Donald	4205 W. Peck Place, Milwaukee
Krause, Frederick J.	4484 N. 46th Street, Milwaukee
Krause, Marion	4484 N. 46th Street, Milwaukee
Krechel, Al	4514 W. Congress, Milwaukee
Krueger, Elmer E.	4125 W. Hampton Avenue, Milwaukee
Miller, Milton H.	4150 N. Toronto Street, Milwaukee
Pohland, Waldemar E.	4550 N. Sherman Boulevard, Milwaukee
Reid, Lunette E.	4557 N. 46th Street, Milwaukee
Robar, Audrey H.	4237 N. 40th Street, Milwaukee
Steinbach, Wm. E.	4701 N. 51st Boulevard, Milwaukee
Stumpf, Charles H.	4307 N. 54th Street, Milwaukee
Wagner, Robert G.	4338 N. 51st Boulevard, Milwaukee
Weiermann, Glenn O.	5141 N. 65th Street, Milwaukee
West, Lowell G.	4354 N. 52nd Street, Milwaukee
Zautke, Herbert	4424 N. 41st Street, Milwaukee
Zautke, Rose	4424 N. 41st Street, Milwaukee

Appendix D

MATERIALS SUBMITTED PRIOR TO THE PUBLIC HEARING AND RESPONSES THERETO

Milwaukee Metropolitan Sewerage District
735 North Water Street Milwaukee, Wisconsin 53202
414·278·3958

September 22, 1982

Southeastern Wisconsin Regional
Planning Commission
Post Office Box 769
Waukesha, Wisconsin 53187

Attention: Kurt W. Bauer
Executive Director

Re: SEWRPC Lincoln Creek Flood Control Plan:
Public Hearing of September 23, 1982

Dear Mr. Bauer:

Enclosed herein are the comments of the Milwaukee Metropolitan Sewerage District concerning the Flood Control Plan for Lincoln Creek. This Plan was referenced in your newsletter, Vol. 22, No. 3, May-June 1982.

The recommended plan identifies the Milwaukee Metropolitan Sewerage District as having implementation responsibilities in regard to the replacement of culverts and the construction of bridges for railroads crossing Lincoln Creek. State law imposes no such mandatory obligation on the District. There is an important legal distinction to be made. It is one thing to grant authority to the District to engage in certain watercourse corrections if it is deemed best in the discretion of the Commission and consistent with the public good and that, in turn, may lead to replaced culverts and to requiring railroads to reconstruct their bridges so as to comport to the hydrological necessities of a water body. It is quite another thing to identify the Milwaukee Metropolitan Sewerage District as having a mandatory obligation to replace culverts and construct railroad bridges over a creek for the purposes of facilitating creek repairs.

Historically, it has been the responsibility of the railroads in the State of Wisconsin to maintain their bridges in such a fashion as to provide an adequate waterway for a stream or river passing under their tracks. Consistent with that responsibility, the District and the railroads have engaged in protracted litigation which resulted in clarification of where the District's responsibility for bridge reconstruction or replacement will lie. The District would view, with grave concern, any attempt on the part of SEWRPC to change the historical responsibilities of the railroads for maintaining a proper and adequate waterway under its tracks.

As to other improvement responsibilities that have been identified in the recommended plan and for which a responsibility has been allocated to the District, we believe it incumbent upon SEWRPC to identify the permissive and nonmandatory nature of the various statutory grants of authority to the District. It would be unfortunate and undesireable from the District's perspective for SEWRPC to pre-empt the field of discretion for other municipalities that may desire to exercise their authority to do the same work as is contained within the recommended improvements.

The provision of the recommended plan that identifies the District as having approval responsibility for improvement designs is an appropriate identification of the proper agency with the responsibility.

If I can be of further assistance, do not hesitite to contact either me, or my staff. Sylvester Hejlik of our Engineering Department staff can serve as a ready contact for you. His number is 225-2133.

Very truly yours,

Harold P Cahill

Harold P. Cahill, Jr.
Executive Director

HPC/ek

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WAUKESHA

September 27, 1982

Mr. Harold P. Cahill, Jr.
Executive Director
Milwaukee Metropolitan Sewerage District
735 N. Water Street
Milwaukee, Wisconsin 53202

Dear Mr. Cahill:

This is to acknowledge receipt of your letter of September 22, 1982, transmitting the comments of the Milwaukee Metropolitan Sewerage District on the draft flood control plan for Lincoln Creek as that plan was presented for public hearing on September 23, 1982, and as documented in SEWRPC Newsletter Vol. 22, No. 3, May-June 1982. Your letter was introduced into, and made a part of, the record of the public hearing on the draft plan.

The comments of the District as set forth in your letter are well taken, and we have directed the Commission staff to make appropriate changes reflecting those comments in the draft of the planning report setting forth the findings and recommendations of the Lincoln Creek flood control study. We will informally review the changes with your staff to make sure they are acceptable to the District. In this manner, we trust that the concerns addressed in your letter will be fully met and the plan will be acceptable to the District.

We very much appreciate the District's review of, and comments on, the preliminary plan.

Sincerely,

Kurt W. Bauer
Executive Director

KWB/ms

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Appendix E

MATERIALS SUBMITTED AFTER THE PUBLIC HEARING AND RESPONSES THERETO

11-6-82
4309 N. 39th St.
Milwaukee WI
53216

Kurt W. Bauer, Exec. Dir.
S.E. Wisconsin Regional Planning Commission
Old Courthouse
P.O. Box 769
Waukesha, WI 53187-1607

RECEIVED
NOV 1 0 1982
SEWRPC

Dear Mr. Bauer:

I am writing in response to the flood control plan for the Lincoln Creek, as summarized in the Newletter of your agency, Vol. 22, No. 3. I am strongly opposed to the proposed project for several reasons.

First, the benefit-cost ratios outlined in the plan are below 1.0 at a realistic interest rate. The benefit-cost ratios drop even further if storm-sewer outlet work is included (p. 30 of plan summary). The standard answer I have received to this ~~con~~ objection is that all the benefits are not really included (loss of work, etc.). I am unwilling to accept this rationale. All the costs are not included either (e.g., loss of mature trees and the park-like atmosphere along the lower Lincoln Creek). Furthermore, when government agencies are generally short on money, it seems imprudent to carry out a public works project with such questionable benefit-cost ratios. Some simple calculations show that the project proposed to spend $7181 per structure ~~in the~~ subject to inundation in a 100 yr. flood event. (1490 structures ~~[illegible]~~ and $10.7 million). Doesn't that seem ridiculous? A 100 yr. flood event seems unlikely to cause $7000 damage per structure.

A second major objection to the proposed plan is that nowhere does it mention the dramatic change that will take place in vegetation and usefulness to residents of the Lincoln Creek between 32nd St. and Hampton Ave. (near 60th St.). This section of the creek is currently a semi-natural area with many mature trees and thick brush. ~~[illegible]~~ This section of the Lincoln Creek is currently one of very few semi-natural areas remaining in the City of Milwaukee. Its recreational value to the nearby residents is completely ignored in the report. It is an excellent place for a peaceful walk where a person can forget the hustle and bustle of the city. This section of the creek is also a haven for birds and small animals. There are waterfowl that reside in the creek as well as a few muskrats. The proposed flood control project will completely eliminate the recreational value of the creek between 35th St. and Sherman Ave., because the channel deepening and widening will leave too little space for replacing any trees. Also, cement-lining of the channel will make the creek unusable for waterfowl and muskrats. The section of the creek between Sherman and Hampton Ave. (near 60th) is also likely to provide ~~little~~ few attractions to birds or people after the proposed work.

Third, there is no mention in the report of the effects of the project on the water quality of either the Lincoln Creek itself or of the Milwaukee River. Certainly turning the Lincoln Creek into a cement-lined drainage ditch cannot help further the goal of fishable and swimmable waterways. If it will, such information has been omitted from the report. The Lincoln Creek appears to me (from reading the report & looking at topo maps) to be a spring-fed creek. Cement-lining the full length of the creek is likely to raise the temperature of the water at its entry to the Milwaukee River. It is clear that cement-lining will eliminate the possibility of ever rehabilitating the creek to the point where it will provide fishing or swimming, and that it may also contribute to problems in rehabilitating the Milwaukee R. These issues should be considered in the plan.

If possible, I would like to receive a complete copy of the plan, including information on how cost and benefit dollar amounts were derived.

Thank you very much for your assistance. I hope my comments above will be considered as the planning commission revises the flood control plan.

Sincerely,

[signature]

Colleen F. Surber

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WAUKESHA

November 10, 1982

Ms. Colleen F. Surber
4309 N. 39th Street
Milwaukee, Wisconsin 53216

Dear Ms. Surber:

This is to acknowledge receipt of your letter of November 6, 1982, in which you express your concerns over, and opposition to, the Lincoln Creek flood control plan which this Commission has prepared for the City of Milwaukee and the Milwaukee Metropolitan Sewerage District. Although the record of the public hearing, which was held on the proposed plan on September 23, 1982, has long been closed, we will--because of the clear and concise manner in which it illuminates some of the key issues involved--append your letter to that record. The record of the hearing, together with your letter, will be published as an appendix to the final planning report.

Please be advised that we very much appreciate and share the concerns raised in your letter. The Lincoln Creek flood control plan had to address two important but conflicting objectives--flood damage abatement and the maintenance of an environmental corridor along Lincoln Creek. The Commission staff very reluctantly, and only as a last resort, recommended channel improvements as the only practicable way of resolving the flood damage problems which do exist along Lincoln Creek.

While it is true, and the report clearly points out the fact, that the flood control project would have a benefit-cost ratio of less than one when the storm sewer outlet-related channel work is taken into account, it is not uncommon for public agencies to undertake public works projects having benefit-cost ratios of less than one, given other intangible--but nevertheless very real--benefits that may be involved, including protection of the public health and safety. The ultimate judgment and decision in this matter have to be made by the elected public officials to whom the plan report is addressed, and who are charged by law with the responsibility for making judgments and decisions of this sort which require a compromise between conflicting objectives.

We know that this response will provide you with little comfort; and for this, we apologize. We will provide to you a copy of the published report as soon as it is available from the printer.

Sincerely,

Kurt W. Bauer
Executive Director

KWB/ms

RECEIVED

NOV 16 1982

SEWRPC

City of Milwaukee

Department of City Development

William Ryan Drew
Commissioner
Jon L. Wellhoefer
Deputy Commissioner

Housing Authority
Redevelopment Authority
City Plan Commission
Historic Preservation Commission

File Reference:
DCD:TM:smr:115

November 11, 1982

Mr. Phil Evenson,
Assistant Director
Southeastern Wisconsin Regional
Planning Commission
P. O. Box 769
Waukesha, WI 53186

Dear Mr. Evenson:

The enclosed letter requests information concerning the Lincoln Creek Flood Control Plan. Some of the information requested is quite technical. As the author of the plan, your agency is better qualified than we to provide the information requested.

Thank you for your assistance in this matter.

Sincerely,

William Ryan Drew
Commissioner

Enclosure

734 North 9th Street, Milwaukee, Wisconsin. Phone (414) 278-2690
Mailing Address: P.O. Box 324, Milwaukee, Wisconsin 53201

BY WRD
TO Miller
DATE 11/9/82
☑ ACTION
☐ INFORMATION
☐ PREPARE REPLY
☐ SEE ME
☐ FILE
REMARKS Simons
JD, JLW

4309 N. 39th St.
Milwaukee, WI
53216

11-4-82

Mr. Tom Miller, Senior Planner
Department of City Development
200 E. Wells St.
Milwaukee, WI 53202

Dear Mr. Miller:

Alderman Kalwitz suggested that I contact you if I needed further information regarding the flood control plan for Lincoln Creek. I have read the plan summary published in the Southeastern Wisc. Regional Planning Commission newsletter. I am interested in obtaining further information about the benefits estimated in the report. Most of the estimated benefits are apparently reductions in flood damages, including basement flooding and first-floor inundation. If possible I would like to see the documents pertaining to these estimated benefits. Perhaps xeroxed pages out of the draft report would do. I am also interested in knowing whether any comparison was made with flood-related incidents outside the Lincoln Creek flood plain area. That is, how does the frequency of reported flood-related incidents (mentioned on p. 4 of the plan summary) compare with flood-related incident report frequency outside the Lincoln Creek area? This comparison seems

to me to be critical to establishing that the
flood-related incidents in the Lincoln Creek area
are due to problems with ~~B~~ the Lincoln Creek
rather than some other variable(s) that is constant
over the city.

Second, I am interested in knowing what
type of revegetation is planned for the section
of the creek between 32nd and Hampton Ave (near 60th).
This section currently has alot of trees and
brush and functions as a semi-natural area
for birds and other wildlife. After the planned
work, will there be space left to restore this
section? This section currently supports many birds,
including waterfowl and a few muskrats, and the usual
squirrels and rabbits. If this semi-natural area is
removed from the neighborhood, will any new park
area be purchased to replace it? (This latter ~~part~~
question may be better directed to Mr. Kalwitz.)

~~I appreciate your~~

Third, did the draft plan consider the issue
of how the work on the Lincoln Creek will influence
its water quality, and the water quality of the Milwaukee
River? I notice that the peak discharge is estimated to
be increased by 75% (quite a dramatic increase).
Normally, when the carrying capacity of a creek is
increased by channelization, there is also a

change in water quality. Usually there is an increase in the amount of sediment carried in the stream. I would like to see any information that may have been collected on water quality issues related to the Lincoln Creek.

Thank you very much for your help with the above issues. I am very difficult to reach by telephone (due to odd work hours), so it will be most convenient if you answer in writing. I am enclosing a copy of a reply to an inquiry I made through Mr. Kalwitz approximately 2 weeks ago so that you will not repeat any of that information.

Again, thanks alot.

Sincerely,

Colleen F. Surber
4309 N. 39th St.
Milwaukee, WI
53216

cc: John R. Kalwitz
Alderman

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November 18, 1982

Ms. Colleen F. Surber
4309 N. 39th Street
Milwaukee, Wisconsin 53216

Dear Ms. Surber:

Your letter of November 4, 1982, addressed to Mr. Thomas H. Miller, Senior Planner, City of Milwaukee Department of City Development, and requesting information regarding the Lincoln Creek flood control plan, has been referred to this office for reply. Accordingly, this letter is intended to respond to the questions posed in your letter of November 4, 1982, and, as such, is further intended to supplement the information provided to you in our letter of November 10, 1982, written in direct response to your letter of November 6, 1982.

As noted in your letter, the benefits attendant to the proposed Lincoln Creek flood control works are, in accordance with good engineering practice, expressed in terms of potential reductions in direct flood damages. A description of the benefits expected from the various flood control alternatives, as well as the methods used to calculate these benefits is provided on the attached pages 57 through 90, of the preliminary draft of the Lincoln Creek flood control plan report. The approach used provides a conservatively low estimate of the project benefits since no indirect damages are considered, as is the practice of other agencies including the U.S. Army, Corps of Engineers.

Also please be advised that the flood frequency analyses made for the Lincoln Creek watershed under the flood control study have been both implicitly and explicitly compared to and correlated with such events for other watersheds in the Southeastern Wisconsin Region. The flood events are directly related to rainfall within the Region for which a record of over 37 years in length exists. The frequency and magnitude of the flood flows, however, are also related to the specific hydrologic and hydraulic conditions of each watershed; that is, to the size and shape, topography, soils, land use and degree of urbanization, type of drainage system, and certain other factors which determine the frequency and magnitude of flooding. A discussion of this issue is included in Chapter III of the preliminary draft of the Lincoln Creek flood control plan report, a copy of which chapter is attached hereto. To further assist you in your investigations, the following information on peak rates of runoff for various watersheds in the Region is provided. As may be expected, the peak rates of runoff vary with a number of factors as noted above--particularly land use.

Watershed	Drainage Area (Sq Miles)	Peak Rate of Discharge for 100-Year Recurrence Interval Flood (cfs) (Planned Land Use)	Peak Rate of Discharge Per Square Mile of Drainage Area (cfs)
Fox River	942	9,400	10.0
Milwaukee River	688	26,700	38.8
Root River	197	6,700	34.0
Menomonee River	137	19,600	143.0
Pike River	52	4,100	78.8
Kinnickinnic River	25	7,400	296.0
Lincoln Creek	19	8,000	421.0

With respect to the type of vegetation which may be planned for the reach of the Creek between N. 32nd Street and W. Hampton Avenue near N. 60th Street, please be advised that the plan recommends that this entire reach be channelized. Between N. 35th Street and N. 47th Street, there will be little room within the available right of way to provide any substantial amount of replacement vegetation other than the turf-lined upper portions of the channel. In other reaches, such as that between N. 47th Street and N. Hampton Avenue near N. 60th Street, there should be room to permit the improved channel to be constructed without total removal of the existing vegetation. Accordingly, some of the existing vegetation could be left in place along this reach, and additional vegetation provided. Such revegetation could be made similar to that which now exists, or could include improved types of vegetation.

With respect to impacts on water quality, please be advised that since the flood control plan deals strictly with recommendations regarding the modification of the channel system within Lincoln Creek, no negative impacts on water quality are expected. Rather, it is anticipated that because the channel would be properly lined to prevent erosion, there may, in fact, be some improvements in water quality downstream. In response to your request for information concerning the water quality management needs in the Lincoln Creek and the Milwaukee River watersheds, we are providing to you herewith a copy of selected information taken from the regional water quality management plan indicating the need for both nonpoint and point source pollution abatement measures to achieve desired water use objectives for the Milwaukee River watershed in general, including the Lincoln Creek watershed.

We trust this letter adequately responds to the questions raised in your letter of November 4, 1982.

Should you require any further information, or should you desire to discuss the Lincoln Creek flood control plan directly with the Commission staff, please do not hesitate to write or call.

Sincerely,

Kurt W. Bauer
Executive Director

KWB/ib
Enclosures

cc: Mr. Thomas H. Miller
Ald. John R. Kalwitz
Supr. James A. Krivitz

Milwaukee WI
53216

Kurt W. Bauer
Exec. Director
S.E.W. Regional Planning Comm.

11-26-82

Dear Mr. Bauer:

Thank you for including my letter to you in the record of the public hearing regarding the Lincoln Creek flood control proposal.

Thank you for sending me copies of Chapters III, VII and VIII of the proposed plan. However, I was quite disappointed to discover that much of the technical information was deleted from the copy I received. Specifically, the following pages were not included: 59, 62, 64, 65, 67, 70, 72, 77, 79, 81, 83, 87. These pages apparently contain Figures 9-12, Table 11, and Maps 9-13. I would appreciate it if you would provide me with copies of these pages.

I am most interested at this time in the damage estimate methods. It is of interest to me that although the report mentions the fact that the Sewerage Engineering Division of the City of Milwaukee has collected flood-related reports from property owners (1960-1975), no mention is made of the use of these data in estimating flood damage.

A second concern is in whether the flood-control project would significantly reduce the types of problems reported by property owners. A glance at Map 5 on p.9 of the plan summary shows that many of the reported problems are not simply due to the Lincoln Creek overflowing its banks. It appears to me that Wahl Creek (which is already channelized its full length) must contribute to some of these problems, since ~~the~~ one blue-shaded area ~~is~~ covers the Wahl Creek area. Also, the blue-shaded patch lying mostly south of Capitol Dr. cannot conceivably be directly related to bank overflows of the Lincoln Creek. Therefore, I am still interested in knowing whether any comparison ~~of floo~~ was made of the relative frequency of flood-related incidents reported ~~&~~ in the Lincoln Creek area with reports from another area of the city. These 1500 flood-related incident reports are touted as evidence that there is a constant and serious flood problem. In the absence of a comparison, I fail to see their relevance to the proposed project. This issue, I trust you now see, is separate from the comparison of peak discharges for various watersheds in S.E. Wisconsin (information which you gave me in your letter of Nov. 18).

Returning to the damage estimate procedures, the section in Chapter VII is not clear (of course, I am lacking the damage cost curves in Figure 9). The report does not state over what period of time, or for floods of what year-intervals, the costs were estimated. For example, the estimated ~~cost~~ total cost of a 100-year interval event on Lower Lincoln Creek is $14.4 million (year 2000 land use); prorated over 100 years, it would ~~be~~ cost approximately $144,000 per year. The report estimates $617,000 annual flood costs, so I must not understand how the costs were calculated. ($617,000 is more than 4 times the annual cost of a 100 yr event.)

Perhaps Figure 9 will clarify this matter. If not, I would appreciate some further clarification.

I hope you will be able to provide me with the above information. I do not mean to nag you, but I take the recreational value of the Lincoln Creek in its current state quite seriously. Since the flood plan does not mention this issue except casually, I feel it deserves a detailed critique and I intend to carry out such a critique. I am grateful to you for your assistance thus far.

Sincerely,

Colleen F. Surber

Colleen F. Surber
4309 N. 39th St.
Milwaukee, WI
53216

COPY

SOUTHEASTERN WISCONSIN REGIONAL PLANNING COMMISSION

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December 6, 1982

Ms. Colleen F. Surber
4309 N. 39th Street
Milwaukee, Wisconsin 53216

Dear Ms. Surber:

This is to acknowledge receipt of your letter of November 26, 1982, requesting additional information on the Lincoln Creek flood control plan, as well as certain pages from the Lincoln Creek flood control report which were not included with the text of the report previously sent to you.

The pages which contain the figures and maps referenced in your letter are not presently available in a readily and cheaply reproducible form. Accordingly, you will have to await publication of the report to receive the requested pages. Publication of the report should be completed early next year. At that time we will provide to you a printed copy of the report which will contain all of the figures and maps you require.

You also requested additional information on the methods used to estimate flood damages. The method used to estimate costs of flood damages consisted of the following steps. First, the areas which could be expected to be inundated under both existing and under planned land use conditions were determined for several recurrence interval flood events including the 100-year, 50-year, and 10-year recurrence interval events and including a storm approximating the lowest recurrence interval event for which flood damages may be expected to occur--as small as a one-year recurrence interval event along certain stream reaches. Based upon the number and type of structure expected to be flooded and the expected depth of flooding, estimates were made of the damages associated with each of the aforementioned storm events using depth-damage curves such as the one shown on the enclosed figure. Following this calculation of the damages attendant to individual storm events of a specified recurrence interval, the damage costs associated with all storm events expected to cause damage were then estimated by integrating the data. Damages on an annual average basis were then computed using the probability of each event occurring in any given year and the associated cost of that event.

In your letter you question the amount of the average annual damages in the Lower Lincoln Creek watershed, estimated in the report to approximate $617,000. You correctly note that the estimated damage costs associated with a 100-year recurrence interval event--$14,400,000--when averaged over the 100-year period only result in average annual damages of $144,000. However, as described in the previous paragraph, the average annual cost of flood damage must be calculated using the damages associated with all floods weighted by the probability of the recurrence in any year rather than by use of the 100-year recurrence interval flood only. Thus, in calculating the average annual flood damages, the average annual damages resulting from all recurrence interval events must be added to the average annual damages associated with a 100-year recurrence interval event. For example, the estimated damages associated with a 50-year recurrence interval event would be divided by 50 and added as a component of the average annual cost. Similarly, the cost associated with a two-year recurrence interval event would be divided by two and added as a component. In this manner, all of the flooding events which may be expected to occur are accounted for in the estimate of damages.

The methodology used to estimate flood damages for the Lincoln Creek flood control plan is well developed and widely accepted and applied in flood control planning and engineering. The enclosed excerpt from one of the Commission comprehensive watershed plan reports describes the methodology in more detail.

You also question how the flooding and drainage problem reported in the watershed were used in the analysis. The areas noted to have flooding and drainage problems in the Lincoln Creek watershed as documented by the City Engineer of the City of Milwaukee were used only to help identify and verify those areas which have actually experienced flooding caused directly by Lincoln Creek. Those areas were not used directly to determine the monetary flood damages and, therefore, flood control project benefits. As you indicate in your letter, some of the problems documented by the City Engineer were caused by direct overland flooding of Lincoln Creek; while others were caused by local stormwater drainage or sanitary sewerage system backup or a combination of both. It should be noted that the flood damage estimate given in the report considered only the direct damages caused by overland flooding of Lincoln Creek and did not consider costs associated with damages due to stormwater drainage or sanitary sewerage system backup. If these damages had been included--as would have been the case if the work were done by some other agencies--the benefit cost ratio of the recommended plan would have been much higher. Indeed, the flood damage estimate given in the report is a conservatively low figure, and is considered by some to be substantially understated.

You also questioned whether or not the recommended flood control plan will resolve all of the reported problems identified by the City. Only those problems which are the result of direct overland flooding will be fully resolved by the flood control recommendations in the plan. The recommended flood control measures will not resolve local drainage problems. However, the recommended measures are necessary to the eventual resolution of those problems, and will make the full resolution of those problems possible, by providing a suitable outlet for the local stormwater drainage systems.

We trust this letter adequately responds to the questions raised in your letter of November 26, 1982. Should you require any further information, or should you desire to discuss the Lincoln Creek flood control plan directly with the Commission staff, please do not hesitate to write or call.

Sincerely,

Kurt W. Bauer
Executive Director

KWB/ib

cc: Mr. Thomas H. Miller, DCD
Mr. John R. Kalwitz, Alderman
Mr. James A. Krivitz, Supervisor

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NEWSPAPER ARTICLES AND NOTICES PERTAINING TO THE PUBLIC HEARING

Flood-control plan will be presented

The Department of City Development has scheduled a public meeting at 7:30 p.m. on Sept. 23 to present the finding of a Lincoln Creek Flood Control Plan prepared by the Southeastern Wisconsin Regional Planning Commission.

The meeting will be held in the auditorium of Custer High School, 5075 N. Sherman Blvd.

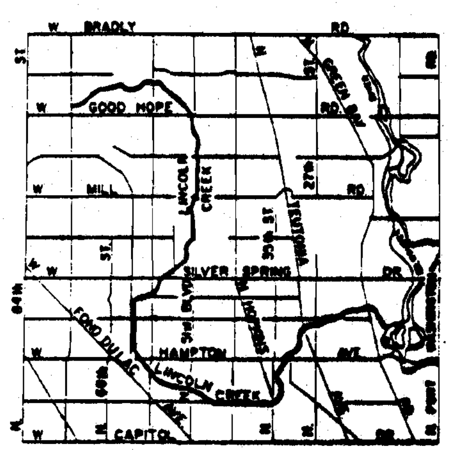
For more information call DCD at 278-2956.

THE MILWAUKEE JOURNAL

Monday, September 13,

Public Meeting

Lincoln Creek Flood Control Plan



MILWAUKEE JOURNAL

Wednesday, September 15, 1982

The Southeastern Wisconsin Regional Planning Commission with financial assistance from the City of Milwaukee has prepared a flood control plan for Lincoln Creek. A public meeting has been scheduled for the purpose of describing this plan to interested persons.

Date: Sept. 23, 1982
Time: 7:30 p.m.
Location: Custer High School Auditorium
5075 N. Sherman Blvd.

For more information:
City of Milwaukee
Department of City Development
Phone: 278-2956