COMMUNITY ASSISTANCE
PLANNING REPORT NO. 261

FLOOD MITIGATION PLAN FOR THE CITY OF MILWAUKEE

MILWAUKEE COUNTY WISCONSIN

CITY OF MILWAUKEE DEPARTMENT OF PUBLIC WORKS

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NUMBER 261

FLOOD MITIGATION PLAN FOR THE CITY OF MILWAUKEE MILWAUKEE COUNTY, WISCONSIN

Prepared by the

City of Milwaukee Department of Public Works

Southeastern Wisconsin Regional Planning Commission

October 2000

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Chapter I

INTRODUCTION AND BACKGROUND

Based upon an October 1999 agreement, the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the City of Milwaukee Department of Public Works agreed to cooperatively prepare a flood mitigation plan for the City. In addition to setting forth updated and refined flood mitigation recommendations for the City and for the five watersheds that lie partly within the City, the plan is designed to set forth current information regarding the status of flooding problems and planning for their mitigation, as well as plan implementation efforts, including public involvement activities undertaken as a part of flood mitigation planning, within and for the City and the five watersheds. The plan was prepared by City staff and Regional Planning Commission staff and was coordinated with related activities of the Wisconsin Department of Natural Resources (WDNR), the Milwaukee Metropolitan Sewerage District (MMSD), other concerned units and agencies of government, and the Southeastern Municipal Executives (SEME) group. Major flood mitigation actions identified are the result of the ongoing MMSD watercourse management program which was carried out for the MMSD planning area, including all of the City of Milwaukee. In preparing the plan, the City involved all appropriate City departments as needed. In addition, the Milwaukee County Sheriff's Department, Division of Emergency Management, was contacted and has been involved in ongoing cooperative flood mitigation planning. Additionally, the development of detailed system plans as described involved the coordination of many agencies and units of government, including, but not limited to, the Milwaukee Metropolitan Sewerage District, the Wisconsin Department of Natural Resources, and the local units of government involved in the areas with flooding problems.

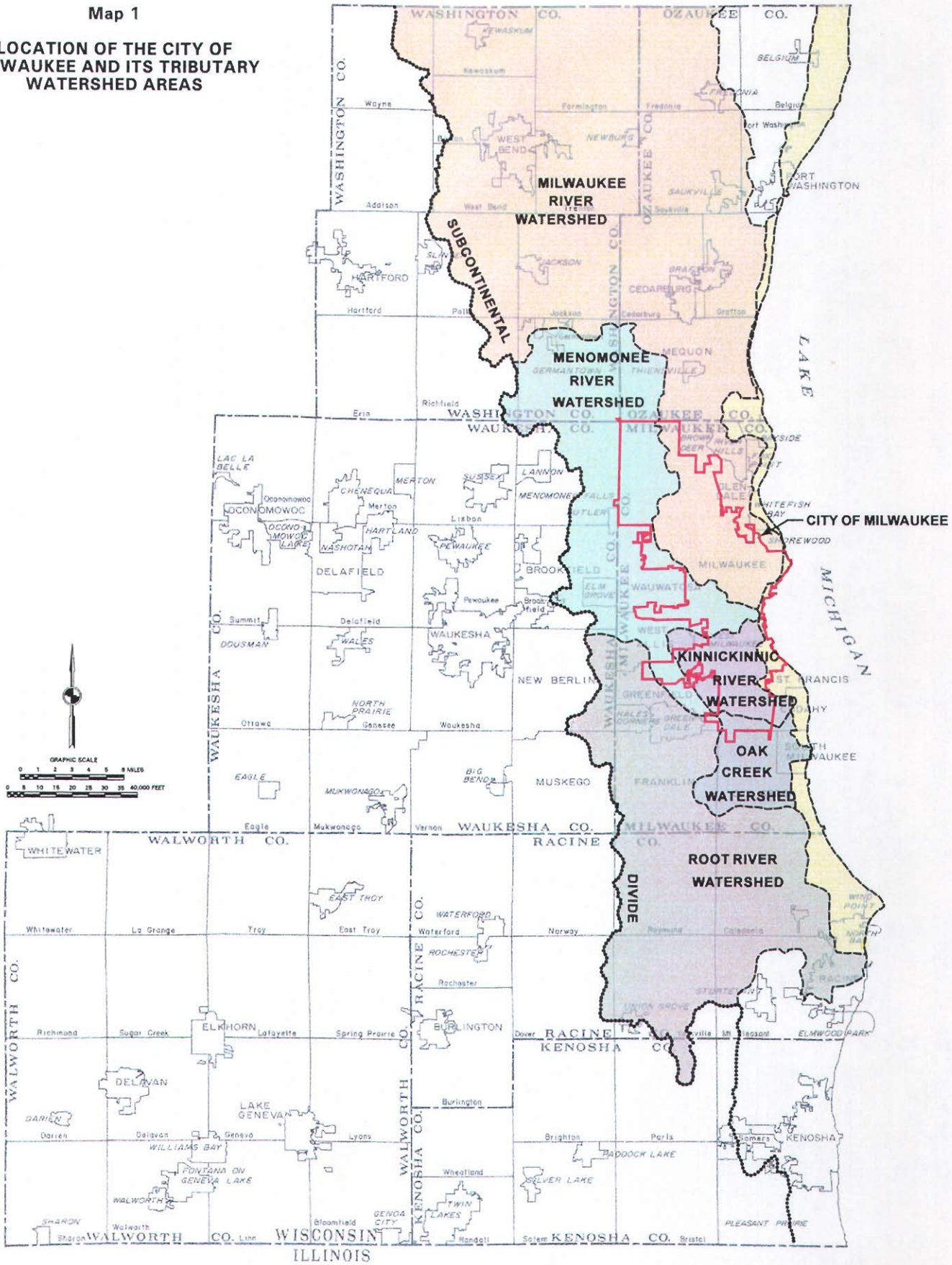
The preparation of the plan is an important step in minimizing flood damages in the City and is a condition of the City's receiving grant funding administered by the Wisconsin Department of Military Affairs, Division of Emergency Management, under the Hazard Mitigation Grant Program in conjunction with the flooding which occurred in the City on August 6, 1998. Funding for this plan was provided in part through a Flood Mitigation Assistance Planning Grant from the Federal Emergency Management Agency (FEMA).

STUDY AREA

The study area encompassed by the plan includes 1) a primary study area coterminous with the corporate boundaries of the City of Milwaukee which includes portions of the five watersheds—the Kinnickinnic River, Menomonee River, Milwaukee River, Oak Creek, and Root River watersheds—that lie within the City and 2) a secondary study area encompassing those portions of the five watersheds that lie outside the City (see Map 1). The primary study area encompasses a total of about 97 square miles, or about 9 percent of the overall study area. The secondary study area encompasses a total of about 981 square miles, or the remaining approximately 91 percent of the overall study area.

Map 1

LOCATION OF THE CITY OF MILWAUKEE AND ITS TRIBUTARY WATERSHED AREAS



Source: SEWRPC.

NEED FOR THE PLAN

Floodwaters can directly damage buildings and other structures in numerous ways. The most common types of damage include hydrostatic pressure leading to the collapse of building foundations, basement slab heaving, and loss of mortar; erosion of foundations and soil; heaving of sidewalks and slabs; saturation of insulation; wood rot; deterioration of masonry and concrete, including soluble salt damage and freezing and thawing damage; damage to metal structural components, including fasteners, exposed metals, and embedded iron; damage to interior finishes, including drywall, plaster, wood floors and trim, interior paint, wallpaper, and floor coverings; exterior paint problems; and damage to utilities, appliances, equipment, merchandise, and personal belongings. Businesses damaged by floodwater also suffer direct economic losses of varying types, including loss of production and commerce arising from being forced to suspend operations as a result of the flooding and its aftermath. In addition to direct flood damages, indirect damages, such as the cost of temporary evacuation or relocation and lost wages, as well as intangible damages, such as psychological stress and health hazards, can occur.

A number of major flooding events, including many that have caused extensive damage, have been recorded within the primary and secondary planning areas since their settlement by Europeans in the 19th century. Over the past 15 years, these events have included the following:

- The event of August 6, 1986, when 6.84 inches of rain fell in 24 hours at General Mitchell International Airport in the City of Milwaukee, the single-day record rainfall at the airport's recording station. The most intense precipitation from the storm involved occurred within a band oriented from northwest to southeast across Milwaukee County. The rainfall recorded at the airport had a recurrence interval of about 300 years and the resultant flood peak of 10,600 cubic feet per second on the Kinnickinnic River at S. 11th Street in the City is estimated to have had a recurrence interval greater than 500 years. The attendant flooding, which included widespread flooding in the Mitchell International Airport area and closed the airport, caused great damage, including severe damage along the Kinnickinnic River between S. 6th Street and S. 16th Street in the City.

- The event of June 20-21, 1997, when a period of moderate rainfall followed by intense thunderstorms centered in northern Milwaukee County resulted in at least four inches of rain across the County, with much of the County receiving about six inches of rain. More than nine inches of rain was recorded in the Village of Brown Deer. Severe localized damage occurred in Brown Deer, the City of West Allis, and the Lincoln Creek area of the City of Milwaukee. Flooding also occurred along the Menomonee River in the Cities of Milwaukee and Wauwatosa. Sewer backup flooding was reported in the Kinnickinnic River watershed, but no damage resulting from overbank flooding along waterways in that watershed was reported.

- The event of July 2, 1997, a "follow-up" storm to the June 20-21, 1997, storm event, involved as much as four inches of rain, but resulted in little additional property damage.

- The event of August 6, 1998, in which over six inches of rain in northwestern Milwaukee County and eastern Waukesha County resulted in significant property damage due to overbank flooding along the Menomonee River and Lincoln Creek.

- The event of July 2, 2000, in which as much as 6.5 inches of rain fell on portions of eastern Waukesha and southern Milwaukee Counties, including 4.42 inches recorded at General Mitchell International Airport on the far south side of the City of Milwaukee. Storms associated with this event produced one tornado and resulted in significant property damage due to high winds and flooding, mainly in communities south of the City of Milwaukee. Reported damages in the City of Milwaukee were mainly limited to basement flooding due to either sewer backups or inoperable sump pumps caused by power outages.

Presidential Disaster Declarations due to flooding were issued in all four years noted above. Each of these declarations included communities in Milwaukee County. Federal and State disaster assistance to the City of Milwaukee included $2.5 million for the 1997 floods and $227,000 for the 1998 flood.

These recent flooding events demonstrate the continuing need for a comprehensive and cooperative strategy for mitigating existing flooding problems and for preventing future flooding in the City of Milwaukee. In the absence of adequate planning, existing flooding problems may be aggravated and new ones may be created. A systematic plan to address existing flooding problems and avoid the creation of new problems is therefore critical to the sound development of the City.

SCOPE AND PURPOSE OF PLAN

This plan is intended to set forth the most appropriate, feasible, and effective flood mitigation strategy for the City of Milwaukee. The planning process, which is also documented in this report, includes the following steps:

- Conduct of inventories and analyses of relevant basic data pertaining to the overall study area, including data on planned land use and related data; the surface-water system; existing applicable floodland management regulations and programs; historical flooding problems; and recent flood events and associated flooding problems.

- Identification of flood mitigation goals and objectives for the City.

- Analysis and assessment of flood problems in the City.

- Consideration of alternative flood mitigation strategies. Alternative strategies must be considered in the context of comprehensive water resource and other planning efforts, particularly recent floodland system planning efforts.

- Identification of potential funding sources for flood hazard mitigation efforts.

- Selection and description of a recommended flood mitigation plan for the City, including 1) documentation of public participation activities and coordination efforts undertaken with other concerned "stakeholders," including other units and agencies of government and concerned private-sector parties, undertaken as part of the planning process, 2) description of recommended plan implementation strategies, and 3) description of recommended plan monitoring strategies.

The Watershed as a Planning Unit

Planning for floodland- and stormwater-related problems can conceivably be carried out on the basis of a number of different geographic units, including areas defined by governmental jurisdictions, economic linkages, or watersheds. There are important reasons for utilizing the watershed as a water resources planning unit. These reasons include the following:

- Floodland management measures, flood control measures, and stormwater management facilities should form a single integrated system over a watershed. The streams and watercourses of a watershed must be capable of carrying present and future runoff loads generated by existing and probable future land use development patterns within the watershed. Therefore, flood control and stormwater management problems can best be considered on a watershed basis.

- Flood control and stormwater drainage problems are closely related to other land and water use problems. Consequently, floodland protection and water-related park and open space preservation can be best studied on a watershed basis.

- Changes in land use and transportation requirements ordinarily are not controlled by watershed factors, but nevertheless have major effects on watershed problems. Land use and transportation system patterns significantly affect the amount and spatial distribution of hydrologic loadings to be accommodated by water control facilities. In turn, the water control facilities and their effect on historical floodlands determine to a considerable extent the uses to which certain land areas can be put.

- Finally, the related physical problems of a watershed tend to create a community interest within the watershed around which floodland and stormwater management planning efforts can be organized.

For these reasons, the watershed is a logical unit for floodland management and related stormwater management planning, provided the relationships existing between the watershed and the surrounding region are recognized. Since its inception in 1960, the regional planning program in the Southeastern Wisconsin Region has embodied a recognition of the need to consider watersheds as rational planning units if workable solutions are to be found for interrelated land and water use problems, including flood mitigation. Accordingly, this flood mitigation plan has included consideration of the watersheds which lie within or partially within the City of Milwaukee in addition to the City itself.

Relationship of Flood Control Planning to Stormwater Management Planning
While the focus of the current planning effort is flood mitigation within the City of Milwaukee, it is imperative to note the importance of the relationship between flood control planning and stormwater management planning.

In both flood control and stormwater management planning, the important effect of land use development on flood flows and stages and on water quality conditions must be recognized. It is important to understand the differences between flood control and stormwater management planning. Flood control planning deals with the problems presented when peak streamflows exceed stream channel capabilities and floodwaters move outward from stream channels to occupy natural floodplains, particularly such floodplains occupied by flood-damage-prone development. Sound flood control measures for any given watershed include, first and foremost, the preservation of floodlands in essentially natural, open uses and, as may be found necessary, the provision of floodwater storage capacity above and beyond that provided by the remaining open floodlands to reduce peak flood flows along the stream channels; the removal of existing flood-damage-prone buildings and the floodproofing of other existing flood-damage-prone buildings; and, as a last resort, modifications to increase the flood storage and conveyance capacities of the streams and watercourses, including the replacement of hydraulic control structures, such as bridges, culverts, and dams, and the provision of floodwater storage areas.

Stormwater management planning deals with problems created by the inability of stormwater runoff to reach the major stream channels of a watershed without attendant local ponding; street, yard, and basement flooding; and surcharging of sanitary sewerage systems with attendant basement flooding. The proper preparation of stormwater management system plans requires the existence of agreed-upon flood control system plans. This is important because the flood elevations along the major stream channels will determine the configuration, sizing, and performance of the local drainage systems. In some cases, the design of a stormwater management system may require revisions in the flood control plan.

Both flood control and stormwater management system plans must consider the need for water pollution abatement measures to meet water use objectives and related water quality standards. At the watershed level, this requires the incorporation of areawide recommendations for the abatement of point sources of water pollution, such as sewage treatment plant discharges, and the reduction of nonpoint sources of water pollution.

Importantly, local stormwater management system planning must also be integrated with sanitary sewerage system planning in order to address the serious public health and safety problems caused by the surcharging of sanitary sewers during periods of excessive rainfall with attendant backup of sanitary sewage into basements of buildings, or the required bypassing of raw sanitary sewage to storm sewers, roadside swales and ditches, and natural swales and watercourses.

Other Hazards

Like other municipalities in Milwaukee County, the City of Milwaukee is vulnerable to a wide range of hazards besides flooding. Accordingly, as an integral part of their emergency management planning efforts, both the City and other municipalities in the County cooperate with Milwaukee County in analyzing such hazards and, as appropriate, planning for and responding to any disasters that may arise from those hazards.

A September 1998 hazard analysis prepared by Milwaukee County describes various types of disasters which have occurred in the County and/or which are likely to or which may otherwise happen in the County.[1] The analysis categorizes flooding among other natural hazards to which the County is vulnerable, including heat waves; droughts; thunderstorms; lightning; hail; tornadoes and downbursts; and winter storms. Although the threat to Wisconsin of another type of natural hazard, earthquakes, as a whole is not great, the analysis notes that ground shaking can be felt from earthquakes centered in Wisconsin or in adjacent states.

The Milwaukee County analysis also includes an examination of 1) health threats, including epidemics of contagious disease; the contamination of water and food by microorganisms; emergencies involving the spilling or unsafe release of hazardous materials into the environment; and violent crime, including child abuse and neglect; 2) technological and/or human-created hazards, including dam failures; incidents involving the spilling or unsafe release of hazardous materials; transportation accidents, including trucking, aircraft, rail, and maritime accidents, many of which may involve mass casualties and/or rescues; nuclear power plant and/or other nuclear-energy-related incidents, including both incidents which may involve the release of radioactive materials into the atmosphere from nuclear power plant accidents and incidents arising in the transportation or storage of radioactive materials; electrical power outages; and urban fires, defined as fires occurring in, around, or on a structure or a vehicle inside the limits of an incorporated village or city; and 3) national security threats, including chemical and biological warfare; nuclear attack; sabotage and terrorism; and civil disturbances, including terrorist attacks, riots, labor stoppages resulting in violence, demonstrations resulting in police intervention and arrests, and disturbances at mass spectator events or at correctional or other detention facilities. Milwaukee County developed an emergency operations program which sets forth an "all hazards" action plan for the County, including the City of Milwaukee. It should be noted that the hazards considered by the County and in the integrated emergency operation program, with the exception of flood hazards, are not geographic in nature. Accordingly, no mapping of the other hazard areas is needed.

In 2002, the City of Milwaukee developed a plan of work to prepare an all hazards mitigation plan for the City. That plan will integrate the flood mitigation measures being carried out by the City of Milwaukee, with measures designed for mitigating other natural hazards, where applicable. The City has applied to the Wisconsin Department of Military Affairs, Division of Emergency Management, for a hazard mitigation planning grant to partially fund this all hazards mitigation plan.

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[1]Hazard Analysis for the County of Milwaukee, Milwaukee County Sheriff, Division of Emergency Management, *September 1998.*

Chapter II

BASIC STUDY AREA INVENTORY AND ANALYSIS

Information on certain pertinent natural and built features and aspects of the study area is essential to sound flood mitigation planning. Accordingly, the collection and collation of definitive information regarding basic demographic characteristics, existing and planned land use, surface-water-system characteristics, environmentally sensitive areas, existing floodland management regulations and programs, historical flooding problems, and recent flood events constitute an important step in the planning process. The resulting information is essential to the planning process, since sound alternative plans cannot be formulated and evaluated without an in-depth knowledge of the relevant conditions in the study area.

POPULATION AND HOUSEHOLDS

Because of the direct relationships that exist between resident population levels and land use patterns, an inventory and analysis of the existing and anticipated 2020 resident population and household levels in the City of Milwaukee, the Kinnickinnic River watershed, the Menomonee River watershed, the portion of the Milwaukee River watershed within the Southeastern Wisconsin Region, the Oak Creek watershed, the Root River watershed, and the portion of the Lake Michigan direct drainage area within Milwaukee County was performed as part of the preparation of this flood mitigation plan for the City. As indicated in Table 1, the resident population of the City is anticipated to remain stable, with a modest increase from the 1995 level of about 616,000 persons to a 2020 level of about 637,000 persons, or by about 3.5 percent. Except for the Kinnickinnic River watershed, whose resident population is anticipated to remain stable between 1995 and 2020, the resident populations of the six drainage areas are all anticipated to increase during that time period. Between 1995 and 2020, the resident population of the Milwaukee County portion of the Lake Michigan direct drainage area is anticipated to increase by about 4.5 percent; the resident population of the Milwaukee River watershed within the Southeastern Wisconsin Region is anticipated to increase by about 6.9 percent; the resident population of the Menomonee River watershed is anticipated to increase by about 7.4 percent; the resident population of the Root River watershed is anticipated to increase by about 15.4 percent; and the resident population of the Oak Creek watershed is anticipated to increase by about 33.0 percent. The combined resident population of the six drainage areas is anticipated to increase by about 8.0 percent during that time period.

The anticipated rate of growth in the number of households within the City of Milwaukee between 1995 and 2020 is anticipated to increase by about 7.7 percent between 1995 and 2020. During that same time period, the number of households in the Kinnickinnic River watershed is anticipated to increase by about 2.2 percent and the number of households in the Milwaukee County portion of the Lake Michigan direct drainage area is anticipated to increase by about 5.3 percent. The numbers of households in the Menomonee River watershed, the Milwaukee River watershed within the Southeastern Wisconsin Region, the Root River watershed, and the Oak Creek

Table 1

POPULATION AND HOUSEHOLD LEVELS WITHIN THE CITY OF MILWAUKEE AND OF SELECTED DRAINAGE AREAS: 1995 AND 2020[a]

Area	Population			Number of Households		
	Existing 1995	Planned 2020	1995-2020 Change	Existing 1995	Planned 2020	1995-2020 Change
City of Milwaukee	615,624	637,474	21,850	237,570	255,880	18,310
Watershed Areas						
Kinnickinnic River Watershed	150,366	148,899	-1,467	60,383	61,712	1,329
Menomonee River Watershed	324,954	349,157	24,203	127,988	142,698	14,710
Milwaukee River Watershed (portion within Southeastern Wisconsin Region)	480,494	513,597	33,103	182,550	205,655	23,105
Oak Creek Watershed	46,018	61,182	15,164	18,232	23,784	5,552
Root River Watershed	162,827	187,839	25,012	60,444	73,243	12,799
Lake Michigan Direct Drainage Area (Milwaukee County portion)	66,171	69,167	2,996	27,152	28,604	1,452
Total for Six Drainage Areas	1,230,830	1,329,841	99,011	476,749	535,696	58,947

[a]*For the purposes of this table, municipal and drainage-area boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

Source: SEWRPC.

watershed are anticipated to increase by, respectively, about 11.5 percent, 12.7 percent, 21.2 percent, and 30.5 percent. The number of households in the six drainage areas combined is anticipated to increase between 1995 and 2020 by about 12.4 percent.

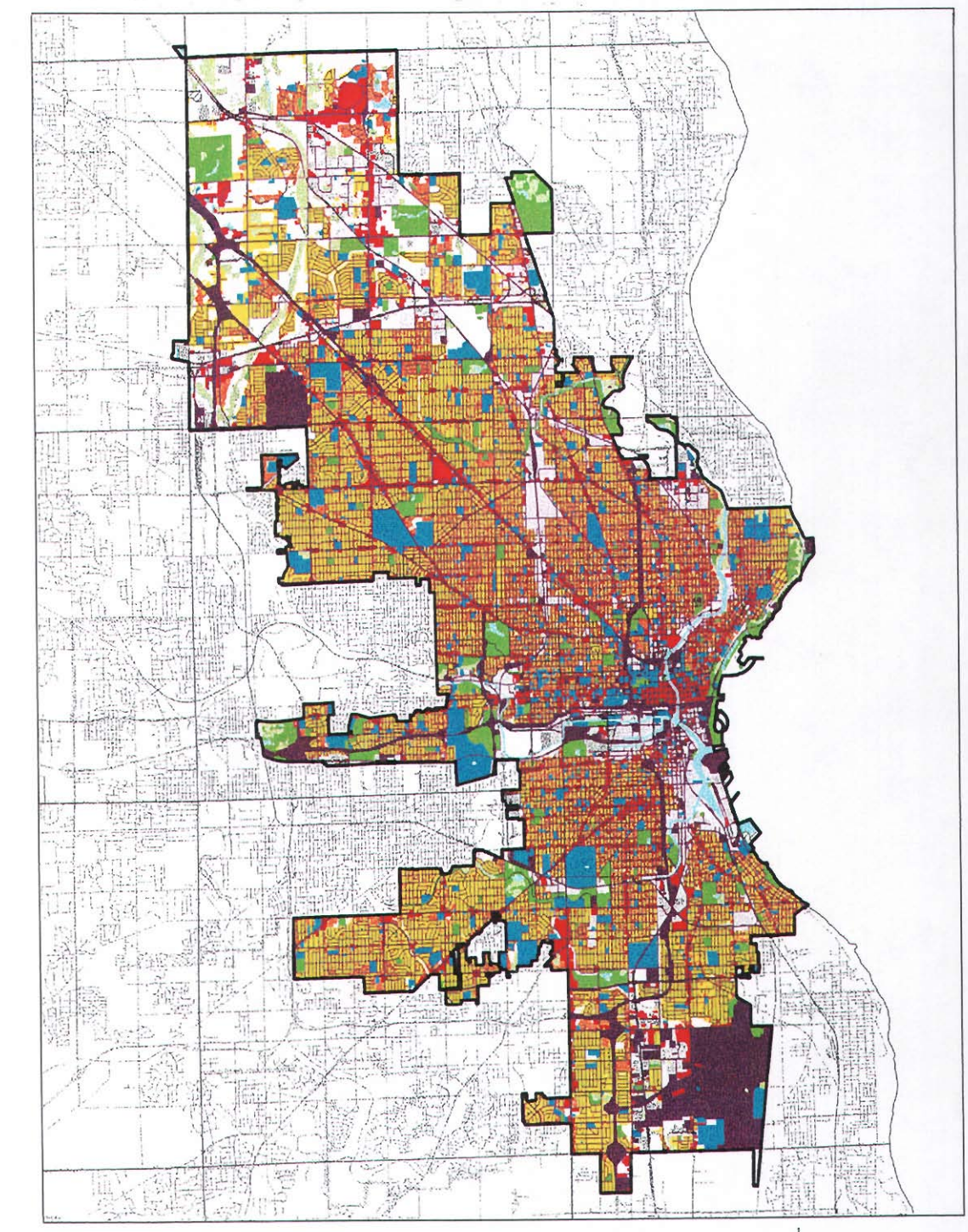
LAND USE

The existing 1995 land use pattern within the City of Milwaukee is graphically set forth on Map 2. The existing 1995 land use pattern for the six drainage areas that lie partly within the City of Milwaukee is graphically set forth on Map 3. The areal extent of existing 1995 and planned 2020 land uses in 1) the City of Milwaukee and 2) each of the six drainage areas that lie partly within the City of Milwaukee are set forth, respectively, in Tables 2 through 8.

As indicated in Table 2, residential land uses comprise the largest area within a given land use category in the City under both 1995 and planned 2020 conditions, encompassing about 34 percent of the total area of the City in 1995 and planned to encompass about 36 percent of the total area of the City in 2020. Lands in transportation, communication, and utility uses encompass the second-largest area within a given land use category in the City under both sets of conditions, encompassing about 28 percent of the total area of the City under actual 1995 conditions and about 29 percent under planned 2020 conditions. Extractive, landfill, and other open non-agricultural lands, which encompass about 8 percent of the total area of the City and thus comprise the third-largest area within a given land use category in the City under actual 1995 conditions, are envisioned to encompass about 5 percent of the total area of the City and thus comprise the seventh-largest area within a given land use category under planned 2020 conditions. Industrial lands, which comprise the fifth-largest area within a given land use category under actual 1995 conditions, are envisioned to comprise the third-largest area within a given land use category under planned 2020 conditions, in both cases encompassing about 7 percent of the total area of the City. It is envisioned that more than three square miles of lands currently in agricultural or open uses, encompassing about 4 percent of the total area of the City, will be converted to urban uses between 1995 and 2020. About 45 percent of the lands envisioned for such conversion are planned to be converted to residential uses, with most of the remainder envisioned to be converted to transportation, communication and utility, industrial, and recreational uses.

Map 2

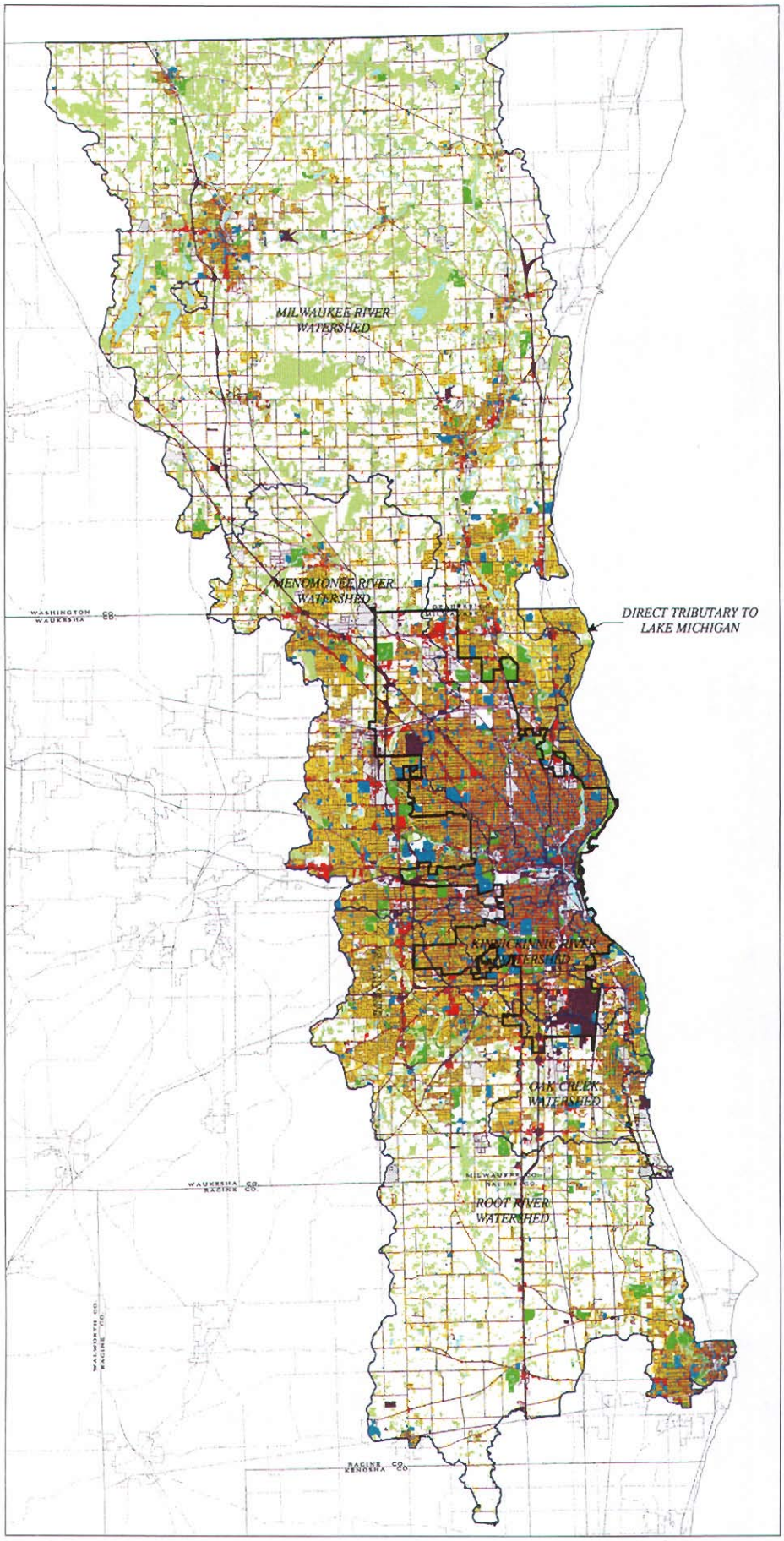
EXISTING LAND USE IN THE CITY OF MILWAUKEE: 1995



Source: SEWRPC.

Map 3

EXISTING LAND USE IN THE CITY OF MILWAUKEE AND ITS TRIBUTARY WATERSHEDS: 1995



LEGEND

- Single-family residential
- Multi-family residential
- Commercial
- Industrial
- Transportation, communications, and utilities
- Government and institutional
- Recreation
- Surface water
- Wetlands and woodlands
- Agricultural, unused, and other open lands
- Extractive and landfill
- City of Milwaukee boundary
- Watershed boundary

GRAPHIC SCALE

0 23000 46000 FEET

Source: SEWRPC.

Table 2

LAND USE IN THE CITY OF MILWAUKEE BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	0	0	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	363	683	320
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	3,795	4,168	373
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	16,944	17,242	298
Residential Subtotal	21,102	22,093	991
Commercial	3,435	3,591	156
Industrial	4,062	4,437	375
Transportation, Communication, and Utilities[b]	17,076	17,553	477
Governmental and Institutional	4,195	4,195	0
Recreational	3,351	3,576	225
Agricultural	1,062	676	-386
Open Lands[c]	5,150	3,312	-1,838
Wetlands	782	782	0
Woodlands	643	643	0
Surface Water	616	616	0
Total	61,474	61,474	0

[a]*For the purposes of this table, municipal boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

SURFACE-WATER SYSTEM

The City of Milwaukee lies entirely east of a major subcontinental divide that roughly bisects the Southeastern Wisconsin Region. The entire City is therefore tributary to the Great Lakes-St. Lawrence River drainage system. Except for those portions of the City that lie either 1) within the Milwaukee County portion of the Lake Michigan direct drainage area or 2) within the Oak Creek and Root River watersheds, all drainage within the City ultimately enters Lake Michigan at the mouth of the Milwaukee River. Within the Oak Creek and Root River watersheds, drainage from the City proceeds out of the City in southward and southeastward directions.

Map 4 illustrates significant streams and lakes within the boundaries of the six drainage areas that lie partly within the City of Milwaukee.

ENVIRONMENTALLY SENSITIVE AREAS AND OPEN SPACE PRESERVATION

Many of the natural resource base elements of the City of Milwaukee occur in linear concentrations on the landscape. One of the most important tasks completed under the regional planning program for Southeastern Wisconsin has been the identification and delineation of these linear areas, or corridors. The most important elements of the natural resource base and closely related features, including wetlands, woodlands, prairies, wildlife habitat, major lakes, rivers, and streams and associated shorelands and floodlands, and historic, scenic,

Table 3

LAND USE IN THE KINNICKINNIC RIVER WATERSHED BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	0	0	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	131	134	3
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	1,184	1,227	43
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	4,473	4,483	10
Residential Subtotal	5,788	5,844	56
Commercial	920	949	29
Industrial	1,145	1,243	98
Transportation, Communication, and Utilities[b]	5,268	5,268	0
Governmental and Institutional	1,255	1,271	16
Recreational	716	716	0
Agricultural	110	0	-110
Open Lands[c]	927	838	-89
Wetlands	49	49	0
Woodlands	92	92	0
Surface Water	140	140	0
Total	16,410	16,410	0

[a]For the purposes of this table, watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.

[b]Off-street parking included with associated land use.

[c]Includes extractive lands, landfills, and other open lands.

Source: SEWRPC.

and recreational sites, when combined, result in an essentially linear pattern referred to by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) as environmental corridors. Primary environmental corridors include a wide variety of important natural resource and related elements and are, by definition, at least 400 acres in size, two miles long, and 200 feet wide. Secondary environmental corridors generally connect with the primary environmental corridors and are at least 100 acres in size and one mile in length. In addition, smaller concentrations of natural resource base elements that are separated physically from the environmental corridors by intensive urban or agricultural land uses have also been identified. These areas, which are at least five acres in size, are referred to as isolated natural resource areas.

In any consideration of environmental corridors and important natural features, it is important to note that the preservation of such features can assist in the attenuation of flood flows. The drainage of wetlands, which are included in the corridors and natural resource areas, may destroy natural filtration and floodwater storage areas. In addition, the intrusion of intensive urban land uses into such areas may result in the creation of serious and costly problems, such as failing foundations for pavements and structures, wet basements, excessive operation of sump pumps, excessive clearwater infiltration into sanitary sewerage systems, and poor drainage. Similarly, destruction of ground cover may result in soil erosion, stream siltation, more rapid runoff, and increased flooding, as well as the destruction of wildlife habitat.

Although the effects of any one of these environmental changes may not in and of itself be overwhelming, the combined effects must eventually lead to a serious deterioration of the underlying and sustaining natural resource

Table 4

LAND USE IN THE MENOMONEE RIVER WATERSHED BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	226	226	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	10,622	12,897	2,275
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	8,040	8,428	388
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	6,479	6,607	128
Residential Subtotal	25,367	28,158	2,791
Commercial	3,076	3,581	505
Industrial	3,949	4,496	547
Transportation, Communication, and Utilities[b]	13,224	13,625	401
Governmental and Institutional	3,708	3,817	109
Recreational	3,311	3,484	173
Agricultural	17,194	15,837	-1,357
Open Lands[c]	7,248	4,079	-3,169
Wetlands	6,656	6,656	0
Woodlands	2,140	2,140	0
Surface Water	509	509	0
Total	86,382	86,382	0

[a]*For the purposes of this table, watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

base and of the overall quality of the environment for life. The need to maintain the integrity of the remaining environmental corridors and isolated natural resource areas in the City of Milwaukee should thus be apparent.

Because environmental corridors and floodplain areas are generally linear in nature, many such areas in the greater Milwaukee area are located partly within the City of Milwaukee and partly outside the City's boundaries. Any viable approach to planning for these lands and other environmentally sensitive areas located partly or wholly within the City of Milwaukee must therefore encompass an area larger than the City alone. Such areas within the City of Milwaukee have therefore been encompassed within planning efforts undertaken by and for Milwaukee County, which has taken an active, primary role in preserving the environmental corridors and isolated natural resource areas within the City of Milwaukee as an integral part of the County's park and open space planning program. This program is set forth in the County's current park and open space plan,[1] completed by the Regional Planning Commission in 1991 and adopted by Milwaukee County in 1992. Milwaukee County, has primary responsibility for parks and related open space sites located within the County, including such sites located within the City of Milwaukee.

[1]*SEWRPC Community Assistance Planning Report No. 132,* A Park and Open Space Plan for Milwaukee County, *November 1991.*

Table 5

LAND USE IN THE PORTION OF THE MILWAUKEE RIVER WATERSHED WITHIN THE SOUTHEASTERN WISCONSIN REGION BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	1,888	1,888	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	16,464	18,082	1,618
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	9,746	11,020	1,274
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	9,746	9,946	200
Residential Subtotal	37,844	40,936	3,092
Commercial	3,587	4,011	424
Industrial	3,468	4,900	1,432
Transportation, Communication, and Utilities[b]	20,705	21,718	1,013
Governmental and Institutional	3,915	3,915	0
Recreational	5,323	5,650	327
Agricultural	128,009	126,956	-1,053
Open Lands[c]	16,411	11,176	-5,235
Wetlands	34,327	34,327	0
Woodlands	17,948	17,948	0
Surface Water	5,441	5,441	0
Total	276,978	276,978	0

[a]*For the purposes of this table, watershed-area boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

Under full implementation of the park and open space plan for Milwaukee County, the important natural resource features in the County, including such features within the City of Milwaukee, would be protected and preserved for resource preservation and other open space purposes. As noted in the park and open space plan report, the primary environmental corridors in Milwaukee County are located primarily along the Lake Michigan shoreline; along the main stems of the Milwaukee River, the Menomonee and Little Menomonee Rivers, the Root River, and Underwood Creek; and along the lower reaches of Oak Creek and Honey Creek. Under the plan, these lands would be preserved in essentially natural, open space uses for resource preservation and limited outdoor recreation uses.

Under the park and open space plan, it has been recommended that Milwaukee County continue to acquire primary environmental corridor lands, as well as certain floodlands that have been used for agricultural purposes, as part of the County's system of parkways. As a part of this recommendation, certain floodlands presently in agricultural use adjacent to primary environmental corridors are proposed for eventual restoration and inclusion as primary environmental corridor. As shown on Map 5, a total of about 10,300 acres would be located within the primary environmental corridor areas in Milwaukee County.

Under the plan, it is recommended that all primary environmental corridor lands be preserved in essentially natural, open space uses through a combination of public ownership and public land use controls. The plan

Table 6

LAND USE IN THE OAK CREEK WATERSHED BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	0	0	0
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	1,261	1,993	732
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	2,319	2,604	285
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	794	815	21
Residential Subtotal	4,374	5,412	1,038
Commercial	556	732	176
Industrial	825	1,317	492
Transportation, Communication, and Utilities[b]	3,015	3,332	317
Governmental and Institutional	613	613	0
Recreational	543	606	63
Agricultural	4,012	3,307	-705
Open Lands[c]	2,344	963	-1,381
Wetlands	656	656	0
Woodlands	791	791	0
Surface Water	24	24	0
Total	17,753	17,753	0

[a]*For the purposes of this table, watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

recommends that a total of about 8,200 acres, or about 80 percent of the planned primary environmental corridor lands in the County be preserved and protected through ownership by a public agency or private conservation organization. An additional 990 acres, or about 10 percent of the planned primary environmental corridor areas in Milwaukee County, are surface waters. The remaining 1,170 acres, or about 10 percent of the planned primary environmental corridors in the County, are held in private ownership. These corridor lands, under the plan, have been proposed to be protected and preserved in natural uses through public land use regulation.

Secondary environmental corridors in Milwaukee County are located generally along small perennial and intermittent streams and drainageways. As shown on Map 5, a total of about 3,100 acres would be located in secondary environmental corridors. The plan recommends that a total of about 1,030 acres, or about 33 percent of the planned secondary environmental corridors in the County, be preserved and protected through ownership by a public agency. An additional 80 acres, or about 3 percent, of the planned secondary environmental corridor areas are surface waters. The remaining 1,990 acres, or about 64 percent of the planned secondary environmental corridors in the County, were held in private ownership and proposed to be preserved and protected in natural, open space uses through public land use regulation or acquired, as necessary, for urban stormwater detention areas, associated drainageways, or urban parks.

Isolated natural resource areas, which consist primarily of wetlands and woodlands, are scattered throughout Milwaukee County. As shown on Map 5, a total of about 2,280 acres would be located in isolated natural resource

Table 7

LAND USE IN THE ROOT RIVER WATERSHED BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	40	66	26
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	12,051	13,565	1,514
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	7,272	8,027	755
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	1,555	1,580	25
Residential Subtotal	20,918	23,238	2,320
Commercial	1,683	1,886	203
Industrial	1,015	1,515	500
Transportation, Communication, and Utilities[b]	9,708	10,397	689
Governmental and Institutional	1,755	1,795	40
Recreational	3,003	3,036	33
Agricultural	67,226	66,566	-660
Open Lands[c]	7,553	4,428	-3,125
Wetlands	6,690	6,690	0
Woodlands	5,046	5,046	0
Surface Water	983	983	0
Total	125,580	125,580	0

[a]*For the purposes of this table, watershed boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

areas. The plan recommends that a total of about 440 acres, or about 19 percent of the planned isolated natural resource areas in the County, be protected through public ownership. An additional 110 acres, or 5 percent of the planned isolated natural resource areas in the County, are surface waters. The remaining 1,730 acres, or about 76 percent of the planned isolated natural resource areas in the County, are envisioned under the plan to be held in private ownership and preserved in natural, open space uses through public land use regulation and considered for public acquisition as necessary for urban park and open space use.

Floodland areas, while generally not well suited to urban development, often contain important elements of the natural resource base, such as wetlands and wildlife habitat areas, and therefore constitute important locations for open space lands, including parkways. Floodlands also provide storage for floodwaters and thereby decrease downstream flood discharges and flood stages. Thus, every effort should be made to discourage incompatible urban uses of floodlands while encouraging compatible natural, open, and parkway, including playfield, uses. Floodlands, excluding about 750 acres of surface water, encompassed about 9,650 acres, or about 6 percent of the area of the County at the time of the preparation of the County plan.

Under the County plan, it is recommended that floodlands within the County be preserved in essentially natural, open uses or, if such floodlands were used for agricultural purposes at the time of the preparation of the plan, that such floodlands be maintained in agricultural use. Of the total 9,650 acres of floodlands in Milwaukee County, about 6,580 acres, or about 68 percent, were recommended to be in public ownership. Under the plan, about 3,070

Table 8

LAND USE IN THE MILWAUKEE COUNTY PORTION OF THE LAKE MICHIGAN DIRECT DRAINAGE AREA BY ACREAGES: 1995 AND 2020[a]

Land Use Category	Existing 1995	Planned 2020	1995-2020 Change
Residential			
Suburban-Density (0.2-0.6 dwelling units per net residential acre)	230	251	21
Urban Low-Density (0.7-2.2 dwelling units per net residential acre)	1,002	1,010	8
Urban Medium-Density (2.3-6.9 dwelling units per net residential acre)	1,437	1,543	106
Urban High-Density (7.0-17.9 dwelling units per net residential acre)	1,855	1,897	42
Residential Subtotal	4,524	4,701	177
Commercial	276	318	42
Industrial	460	499	39
Transportation, Communication, and Utilities[b]	2,425	2,459	34
Governmental and Institutional	608	609	1
Recreational	769	864	95
Agricultural	481	473	-8
Open Lands[c]	1,848	1,468	-380
Wetlands	73	73	0
Woodlands	696	696	0
Surface Water	91	91	0
Total	12,251	12,251	0

[a]*For the purposes of this table, drainage-area boundaries have been approximated by whole U.S. Public Land Survey one-quarter section.*

[b]*Off-street parking included with associated land use.*

[c]*Includes extractive lands, landfills, and other open lands.*

Source: SEWRPC.

acres, or about 32 percent of the 9,650 acres of floodlands within the County, would remain in private ownership The Milwaukee County Board of Supervisors adopted the County park and open space plan subject to a modification concerning the acquisition of floodlands by the County. The modification provides that any of the land made available to Milwaukee County by the Milwaukee Metropolitan Sewerage District (MMSD) for flood control purposes shall be evaluated on a case-by-case basis.

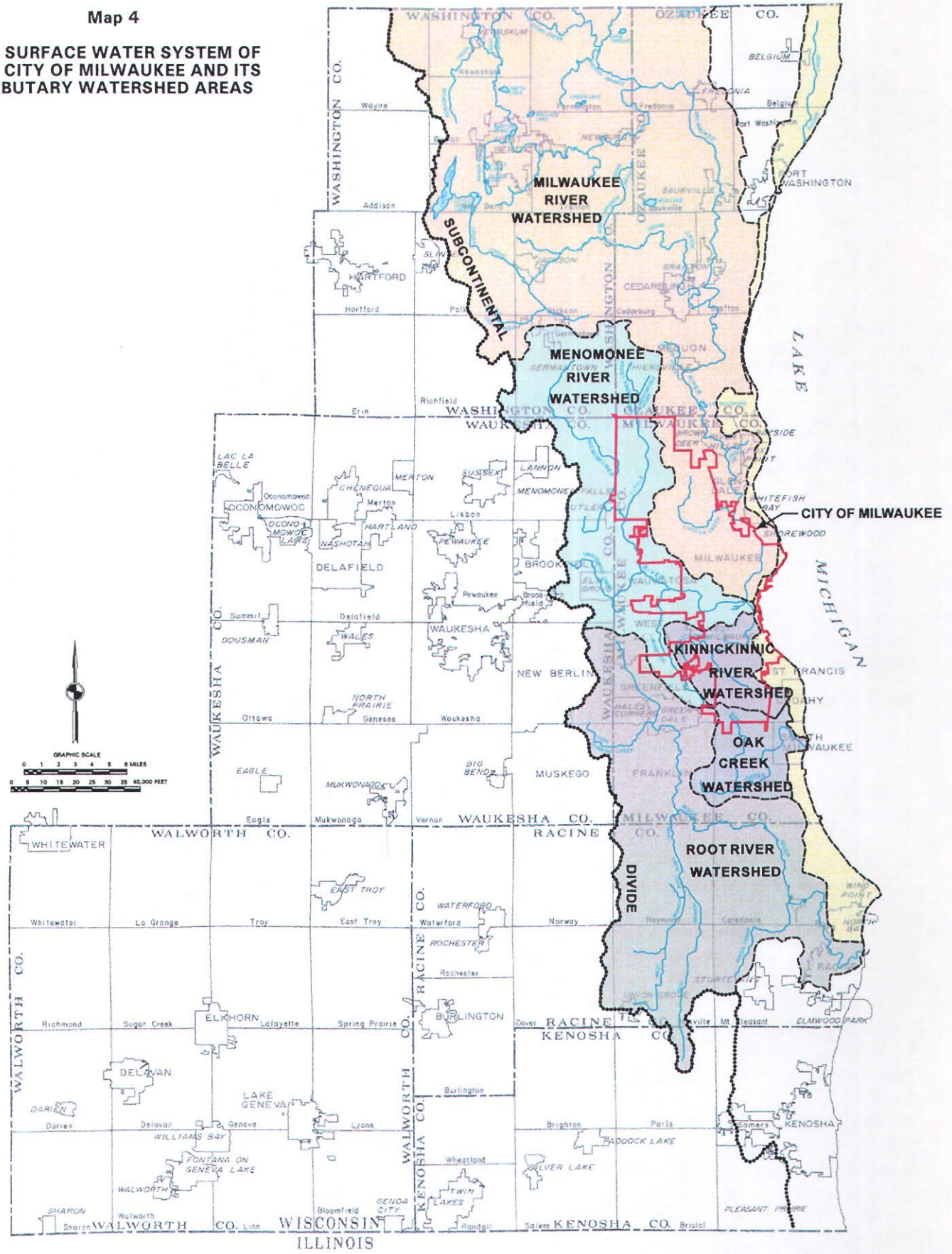
Map 5 graphically summarizes the recommendations of the adopted Milwaukee County park and open space plan. The open space, wetlands, and floodlands preservation recommendations set forth in this park and open space plan form an integral part of the flood mitigation plan for the City of Milwaukee.

FLOODLAND MANAGEMENT AND RELATED REGULATIONS AND PROGRAMS

Floodland management regulations and programs perform critical roles toward assuring that flood mitigation efforts are properly implemented. Pertinent regulations include the City of Milwaukee's floodplain zoning ordinance and stormwater management regulations. As noted in Chapter III of this report and as detailed in Chapters V and VII of this report, the Milwaukee Metropolitan Sewerage District is currently engaged in comprehensive, detailed flood management planning and plan implementation efforts. These work efforts by the MMSD include significant flood mitigation planning efforts for areas within the corporate limits of the City of Milwaukee. These latter efforts constitute current citywide flood mitigation planning program within the City.

Map 4

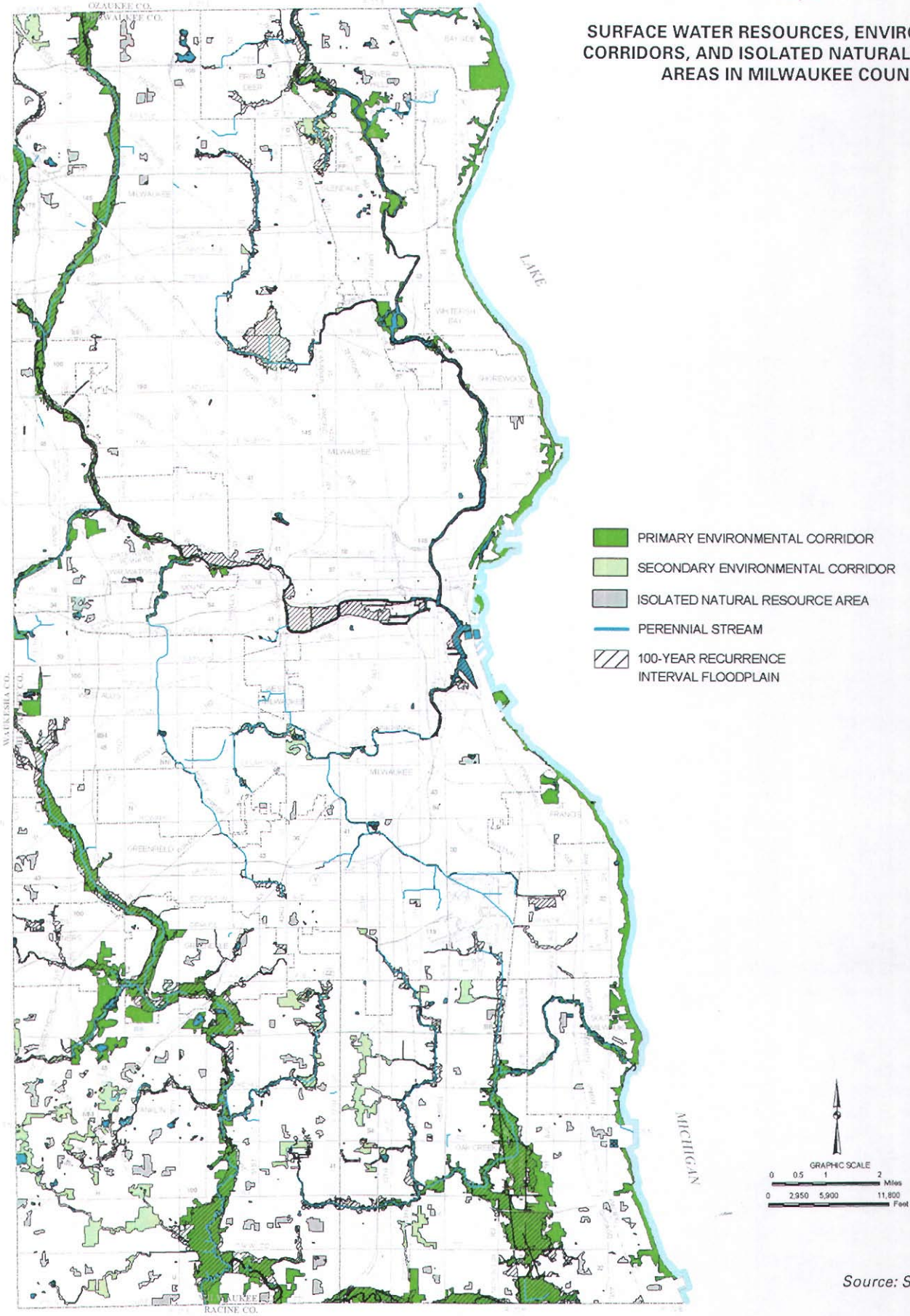
THE SURFACE WATER SYSTEM OF THE CITY OF MILWAUKEE AND ITS TRIBUTARY WATERSHED AREAS



Source: SEWRPC.

Map 5

SURFACE WATER RESOURCES, ENVIRONMENTAL CORRIDORS, AND ISOLATED NATURAL RESOURCE AREAS IN MILWAUKEE COUNTY



Source: SEWRPC.

Floodplain Zoning Ordinance

The City of Milwaukee has enacted a floodplain district zoning ordinance. This ordinance is intended largely to preserve floodwater conveyance and storage capacity of floodplain areas and to prevent the location of new flood-damage-prone development in flood hazard areas. Under the ordinance, designated floodplain areas within the City are divided into two districts: 1) a floodway district and 2) a flood fringe overlay district. Under the City's zoning code, a "floodway" is defined as "[a] designated portion of the regional flood that will safely convey the regulatory flood discharge with small, acceptable upstream and downstream stage increases, limited in Wisconsin to 0.1 feet unless special legal measures are provided. The floodway, which includes the channel, is that portion of the flood plain not suited for human habitation." The City zoning code defines a "regional flood" as "[a] flood determined to be representative of large floods known to have generally occurred in Wisconsin and which may be expected to occur on a particular stream because of like physical characteristics," and which has a flood frequency of once in every 100 years. The code defines a "flood fringe" as "[t]hat portion of the flood plain outside of the floodway which is covered by flood waters during the regional flood" and which is "generally associated with standing water rather than rapidly flowing water."

The City floodplain zoning district ordinance states its purpose as follows: "Flood plain districts are intended to identify flood prone areas in the city for the purpose of establishing corrective and preventive measures to reduce flood damage, and to alert the public to the hazard it may face. Development in the flood plain will vary, depending on whether it is in a floodway area or a flood fringe area. The floodway, with its deep, fast moving waters, is limited primarily to the development of open space uses that will not impede the flow of water during periodic flooding and increase flood heights upstream. The flood fringe, with its shallow, slow-moving waters, allows the development of most types of uses if adequate floodproofing measures are followed and if uses will not reduce flood storage areas during periodic flooding and increase flood heights upstream. Development which in itself or in combination with existing or future similar uses would increase the regional flood elevation by one tenth of a foot is not allowed. Calculations for this purpose are made by applying the principles of equal degree of hydraulic and hydrologic encroachment."

Under the ordinance, the following uses are permitted uses in designated floodway districts: 1) farming, truck gardening, and nurseries, but not structures; and 2) impoundments and wildlife preserves. In designated flood fringe overlay districts, the following uses are permitted uses: 1) uses permitted in floodway districts; 2) navigational structures; 3) water measurement and control facilities; 4) bridges; 5) marinas; 6) utility poles, towers, and underground conduits for transmission of electricity, telephone service, cable television service, natural gas, and similar products and services; 7) parks, playgrounds, and other recreational areas, except for campgrounds; 8) off-street surface parking and loading areas accessory to permitted uses in adjoining districts, but not sale or storage areas for new or used vehicles; 9) filling or dumping material in conjunction with the establishment of bulkheads or bridge approaches, as authorized by the WDNR; and 10) municipal water supply and sanitary sewerage systems, provided they are floodproofed and designed to eliminate or minimize infiltration of floodwater into the system. Under the ordinance, the second through the tenth use categories of permitted uses in flood fringe overlay districts are declared "special uses" in floodway districts. The City zoning code defines a "special use" as a use that is generally acceptable in a given zoning district but which, because of the use's characteristics and the characteristics of the zoning district in which it would be located, requires review on a case-by-case basis to determine whether, in any particular case, it should be permitted, conditionally permitted, or denied.

In addition, the following uses are permitted uses in flood fringe overlay districts, provided the City of Milwaukee Commissioner of Neighborhood Services (formerly known as the Commissioner of Building Inspection) has determined that the use or improvement in question will not impede drainage or cause ponding, will not increase flood-flow velocities, will not increase the regional flood elevation, will not retard the movement of floodwaters, and will not diminish floodplain storage capacity, and that all permitted structures or uses in question are erected so as not to catch or collect debris or be damaged by floodwater: 1) residence, business, and manufacturing uses, as permitted in the underlying zoning districts and in accordance with ordinance requirements relating to placing such uses on fill or, in cases where existing streets or sewer lines are at elevations making compliance with the fill requirements impractical, relating to floodproofing of, and emergency access during floods to, the structures

involved; and 2) accessory uses as permitted in the underlying zoning districts, provided any accessory structures meet ordinance requirements designed to mitigate or prevent danger and damage arising from flooding.

Under the ordinance, the following uses are prohibited uses in a floodway district: 1) dumping and filling not authorized by the WDNR, although incidental grading activities normally associated with the development of open space, outdoor recreation, yards, parking, or loading areas is permitted; 2) storage of material that is buoyant, flammable, explosive, or harmful to human, animal, or plant life; 3) solid waste disposal, soil absorption sanitary sewer systems, or construction of wells providing water for human consumption; and 4) all fill, structures, or other development that would impair floodwater conveyance by adversely increasing flood stages or velocities, or would itself be subject to flood damages. The third category of prohibited uses in floodway districts is also prohibited in flood fringe overlay districts.

The ordinance also provides for the removal from floodway districts and flood fringe overlay districts of residence, business, and manufacturing uses that meet City zoning code requirements relating to 1) the placement of such uses on fill and 2) the making of appropriate zoning district boundary amendments, with such amendments being subject to notice and petition requirements, to the approval of the WDNR, to the receipt of an official letter of map amendment from the Federal Emergency Management Agency, Federal Insurance Administration, and to restrictions on any resulting increase in the regional flood elevation.

Under the ordinance, development in floodway and flood fringe overlay districts may not adversely affect channels, floodways, or banks of any tributaries of the City's watercourses or land outside the floodplain. The ordinance bans the use of any structure or land or the erection, alteration, relocation, extension, or substantial improvement of any structure in a floodway or flood fringe overlay district prior to the issuance of a City permit. The ordinance also declares that permit applicants have the responsibility for securing all necessary required local, State, and/or Federal permits. The ordinance also provides that no river or stream in the City may be altered or relocated until the City Common Council grants a floodplain district boundary amendment in accord with the City zoning code.

Stormwater Management Regulations

The City of Milwaukee's stormwater management regulations are set forth in Chapter 120 of the City code of ordinances. The stated purposes of that chapter include the following: 1) the promotion of the public health, safety, and general welfare; 2) the establishment of procedures to control the adverse impacts associated with stormwater runoff; 3) assistance in the attainment and maintenance of water quality standards; 4) reduction of the effects of development on land and stream channel erosion; 5) maintenance of runoff characteristics after development as nearly as possible to predevelopment runoff characteristics; and 6) the minimization of damage to public and private property. The regulations generally prohibit any person from discharging, spilling, or dumping substances or materials which are not entirely composed of stormwater into receiving bodies of water, storm sewers, or drainage facilities, or onto driveways, sidewalks, parking lots, or other areas that drain into the drainage system. The term "drainage system," as used in the regulations, is defined as "the collection and conveyance of storm water runoff, snow melt runoff, surface water runoff or other drainage from the land" and is declared to include "all drainage facilities, watercourses, waterbodies and wetlands." Certain activities are declared exempt from the general prohibition unless they are found to have an adverse impact upon stormwater. The exempt activities include 1) discharges authorized by a WDNR permit, 2) discharges resulting from fire-fighting activities, 3) discharges in compliance with the City's construction site erosion control ordinance, and 4) discharges from uncontaminated groundwater, potable water sources, roof drains, foundation drains and sump pumps, air-conditioning condensation, springs, lawn watering, individual residential car washing, water-main and hydrant flushing, and swimming pools if the water has been dechlorinated. The regulations prohibit connecting any wastewater building sewer or drain to the drainage system.

The regulations also generally prohibit any person from proceeding with any residential, commercial, industrial, or institutional improvement or subdivision of property without having provided for appropriate stormwater measures that control or manage runoff from such development or redevelopment or future development of the subdivided property. Unless exempted or waived as provided in the regulations and as summarized below, any

such person must have a stormwater management plan prepared, submit the plan to the City for approval, and obtain such approval 1) before an existing drainage system is altered, rerouted, deepened, widened, enlarged, filled, or obstructed in preparation for improvement, 2) before or concurrent with the submittal and approval of an erosion and sediment control plan as specified in the City's construction site erosion control ordinance, or 3) before the improvement in question is commenced. The person involved is responsible for the implementation of the plan.

Under the regulations, the following development activities are exempt from the stormwater management plan requirements: 1) development occurring within a gross aggregate area of less than one acre which is not part of a larger common plan of development or sale; 2) agricultural activities not associated with development; 3) maintenance of, alteration of, use of, or improvement to an existing structure or construction activity that does not significantly change or affect the water quality and hydrologic conditions of the surface-water discharge; 4) maintenance activities undertaken by any municipal, State, or Federal governmental agency; 5) stormwater management measures to be undertaken by the City of Milwaukee on an outfall in a specific watershed when the City Engineer has determined that a stormwater management plan need not be prepared; and 6) subdivision of lands having a gross aggregate area of less than five acres. The stormwater management regulations also provide that requests to waive the stormwater management plan requirements shall be submitted to the City Engineer. Under the regulations, the City Engineer is responsible for coordinating a review by City agencies of any such waiver request and may grant a waiver if the development in question is not likely to 1) increase or decrease the rate or volume of stormwater runoff, 2) have an adverse impact on a wetland, watercourse, or receiving body of water; 3) contribute to the degradation of water quality; or 4) otherwise impair attainment of the objectives of the City stormwater management regulations.

The regulations also prescribe what must be contained in any City-required stormwater management plan, including certain general information as well as detailed descriptions of existing site conditions, proposed site alterations, predicted impacts from the proposed development on water quality and quantity, and best management practices proposed to be used for the protection of water quality. A City-required stormwater management plan, under the regulations, must also be accompanied by an irrevocable letter of credit, a certified check, or a surety bond to guarantee implementation and completion of the plan. The plan must also be accompanied by a second such guarantee to ensure that the facilities involved are maintained. This latter guarantee remains in effect until the facilities are recertified as required under the regulations.

The Milwaukee Metropolitan Sewerage District has adopted a comprehensive rule designed to minimize the potential to increase flood risk due to development or redevelopment in the Districts service area. The rule applies to the City of Milwaukee and the communities which lie upstream of the City in the tributary watershed areas. The rule was in effect as of January 1, 2002, and provides for community ordinances which require the management of the volume and peak rate of stormwater flows from new development and redevelopment in such a way that peak flows in a watershed do not increase downstream flooding. The rule provides for flexibility in choosing the means to comply with the rule. Options include limiting stormwater runoff from new development or redevelopment to established acceptable release rates or development of regional or multiple site approaches designed to meet the rule objective. This rule should be an important component of a strategy to minimize the creation of new or increased flooding problems.

Wetland and Floodplain Preservation Planning

As previously discussed in this chapter, Milwaukee County has developed, and is responsible for implementing, specific plans for preserving wetlands and floodplains within the City of Milwaukee under the County's park and open space planning program.

Other Related Regulations and Programs

The City of Milwaukee has enacted a construction site erosion control ordinance based on a State model ordinance.

The floodplains in the City of Milwaukee are currently delineated and mapped as documented in the Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) dated November 1987. Residents of the City are eligible to participate in the National Flood Insurance Program (NFIP). There are a number of completed activities which have modified the floodplain conditions in the City of Milwaukee. These include the removal of the North Avenue Dam, the completion of the Lincoln Creek flood control projects, the Menomonee River Valley Park flood control project, the Grantosa Creek detention basin, and the Southbranch Creek flood control project. In addition, other flood abatement projects are in the design stages. The City of Milwaukee Departments of Public Works and City Development are working cooperatively with the MMSD, the Milwaukee County Automated Mapping and Land Information System, and SEWRPC to develop updated hydrologic and hydraulic analyses and floodplain mapping to reflect current conditions. The City staff is then working to obtain necessary approvals from the Wisconsin Department of Natural Resources and FEMA, with the goal of having the resulting floodplains as the basis for the applicable flood insurance maps and floodplain zoning maps.

In addition to the regulations and programs noted above, the MMSD, as noted previously and as detailed in Chapters V and VII of this report, is currently engaged in comprehensive, detailed flood management planning efforts intended to update and implement its 1990 watercourse system plan. These work efforts by the MMSD include significant flood mitigation planning efforts for areas within the corporate limits of the City of Milwaukee. These latter efforts constitute the current citywide flood mitigation planning program within the City. In undertaking the updating and implementation of its watercourse system plan, the MMSD has recognized the importance of achieving consensus from all the major stakeholders involved regarding the goals and objectives of the planning effort as well as the need to obtain a final set of acceptable and implementable solutions for current flooding problems in each of the drainage areas involved.

Accordingly, for each watershed located partly within the City of Milwaukee where flooding problems exist, the MMSD has formed a stakeholder group to facilitate this aspect of plan development. The stakeholder groups include representatives of the City of Milwaukee and other concerned local units of government as well as the WDNR and SEWRPC, and, as appropriate within particular watersheds, other public and/or private agencies and organizations, including environmental and neighborhood organizations and concerned private businesses. Stakeholder meetings have been held throughout the MMSD's process of developing alternatives for flood management within each area involved in order to obtain feedback regarding proposed solutions to flooding problems. Stakeholder meetings have been held for each area involved since 1998 and continue to be held through the plan development process.

In some municipalities, the MMSD has also held community workshops to obtain community input regarding possible solutions to flooding problems in the context of what kind of community resource area residents—not just flood victims, but all residents involved—desire regarding their watercourse as a community resource. In some cases, the MMSD has held a number of special technical meetings with technical representatives from concerned communities as well as from the WDNR, SEWRPC, and Milwaukee County.

In addition to other meetings with representatives of the local communities involved and other agencies, the MMSD has participated in a series of meetings with the Southeastern Municipal Executives (SEME). These meetings, facilitated by SEWRPC, have focused on identifying common goals and intergovernmental efficiencies to produce a more effective set of solutions to flooding problems.

Throughout this public involvement process, potential solutions have been developed with input from major stakeholders. Various solutions and scenarios have been presented and feedback has been sought regarding their acceptability. The process has also considered and, as appropriate, incorporated the objectives of concerned local agencies and the authority and policy decisions made by the MMSD.

With regard to public informational and educational efforts applicable to flood mitigation in the City of Milwaukee, the Milwaukee County Sheriff's Department, Division of Emergency Management, has had prepared and distributes a booklet, *The Dry Facts: Protecting Your Home From Flood-Related Damage* (see Appendix A). This booklet sets forth a variety of potential self-help measures and other information useful to Milwaukee

County homeowners with regard to mitigating or preventing flood damage to residences and personal property inside residences. The booklet also provides basic information about flood warnings, as well as NFIP and various Federal and State aid programs that become available to flood victims upon the issuance of a Presidential declaration for the affected area. In addition, to the booklet, a corresponding videotape is available through the Milwaukee County Federated Library System. The Milwaukee County Sheriff's Department, Division of Emergency Management, also makes the videotape available upon telephone request.

HISTORICAL FLOODING PROBLEMS

As noted in Chapter I of this report, a number of major flooding events, including several that caused significant damage, have been recorded in the area now encompassed by the City of Milwaukee, as well as in the drainage areas partly encompassed within that area, since the areas involved were settled by Europeans in the 19th century. The earliest major flood event of record within any of the drainage areas that lie partly within the City for which any significant amount of information is available is that of March 1897, which involved inundation along an approximately 1.7-mile-long reach of the Menomonee River beginning just north of present-day W. Wisconsin Avenue in Milwaukee County and extending downstream into the Menomonee River industrial valley. The peak stage of the Menomonee River rose above the first and, in some cases, even the second, floors of some houses, and floodwaters completely surrounded the shop of the Chicago, Milwaukee & St. Paul Railroad in the Menomonee River industrial valley. Considerable economic loss was incurred. A March 1912 flood event in the Kinnickinnic River watershed, the earliest major flood of record within the watershed for which any significant amount of information is available, was caused by snowmelt. Damage caused by this flood was concentrated in the 0.77-mile-long reach of the Kinnickinnic River between present-day S. 6th Street and present-day S. 16th Street. Damage to homes along the reach involved totaled thousands of dollars, with floodwaters reported above the windowsills of some of the structures. Various outbuildings were demolished and carried away by the floodwaters. The absence of flood damage elsewhere in the watershed probably reflects the fact that urban growth in the watershed as of 1912 had encompassed only approximately the northeastern one-third of the watershed.

A June 1917 flood caused extensive damage in the lower Menomonee River watershed, particularly in the Menomonee River industrial valley. The Menomonee River floodplain below what is now the Wisconsin Avenue viaduct was subjected to very serious flooding that drove almost every resident there from the area. Several businesses with major facilities in the Menomonee River industrial valley, including the Chicago, Milwaukee, St. Paul & Pacific Railroad and The Falk Corporation, incurred significant flood damage. In addition, the flood event caused problems farther upstream along the Menomonee River and Honey Creek. Judging from historical accounts, there was also serious flooding in the Kinnickinnic River watershed, including flooding in an area encompassing several square blocks and occurring due to a stormwater drainage problem near the eastern edge of the watershed and immediately northwest of Humboldt Park. A portion of the roadway at the intersection of S. Howell Avenue and E. Oklahoma Avenue was also washed out. A January 1938 flood, while significant, is known to have affected only scattered areas along the lower Kinnickinnic River and along Wilson Park Creek. The Kinnickinnic River overflowed its banks near a railway bridge crossing over it at S. 18th Street extended, depositing large blocks of ice on the tracks, and flooded a railroad bridge located directly west of S. 20th Street. The latter structure was threatened by large blocks of ice pushed against the bridge pilings by floodwaters. Wilson Park Creek inundated a seven-block segment of W. Howard Avenue between S. 20th Street and S. 27th Street. Although this flood occurred in January, it was attributed to the occurrence of heavy rainfall.

Another major flood event in the Menomonee River watershed occurred in June 1940. This event apparently approached but did not equal the severity of the June 1917 flood, inundating and causing damage to areas primarily along the Menomonee River with scattered occurrences of flooding also reported along Honey Creek, Underwood Creek, and the Little Menomonee River. The S. 84th Street bridge over Honey Creek in the City of Milwaukee was washed out. Some of the reported problem areas were located west and north of the limits of urban development within the area as of 1940. The occurrence of reported flood problems outside of the urban area is attributable to the fact that the rural-area problems involved primarily damage to and the closing of river crossings and riverine-area roadways. The residential area known as the Valley Park neighborhood, located near the Menomonee River beneath the Wisconsin Avenue viaduct, once again suffered major flood damage, including

damage caused when basements were flooded by sewer backup and overland flow and some vehicles were inundated to window level. Farther upstream, high and rapidly moving floodwaters destroyed part of a brick building located at N. 46th Street and W. State Street in the City of Milwaukee. Near the confluence of the Menomonee and Little Menomonee Rivers in the City, rising floodwaters forced the closure of short segments of N. Mayfair Road (STH 100) and W. Hampton Avenue, both of which have since been rebuilt at higher grades in the area involved. While there were no further flood problems reported along the Menomonee River upstream of its confluence with the Little Menomonee River, road closings were reported along the latter at W. Silver Spring Drive and at W. Appleton Avenue (USH 41), both of which have also since been reconstructed at higher grades.

In late March and early April 1960, serious flooding occurred in the Kinnickinnic River and Menomonee River watersheds as the result of a snowmelt-rainfall event. The event caused widespread damage in the City of Milwaukee along the Kinnickinnic River and scattered problems in the City along Wilson Park Creek. The spatial distribution of riverine areas affected by the flood, when compared with historical urban growth patterns in the Milwaukee area, indicate a close correlation between the flood damage areas and the extent of urban development in the area as of 1960. While the damage resulting from previous major floods in the Kinnickinnic River watershed had been concentrated in the downstream one-third of the basin, the March-April 1960 flood caused problems along the Kinnickinnic River as far west as S. 43rd Street and along Wilson Park Creek as far south as General Mitchell Field (now General Mitchell International Airport). Flood inundation and damage, including flooding of basements of residential and commercial structures in the area and the inundation of a 0.75-mile-long section of Chicago & North Western Railway (now Union Pacific Railroad) trackage paralleling and lying approximately 1.5 blocks south of the Kinnickinnic River, occurred along and immediately south of the Kinnickinnic River reach bounded by S. 6th Street and S. 16th Street. Farther upstream along the Kinnickinnic River, between S. 16th Street and S. 20th Street, floodwaters overtopped the Chicago & North Western Railway trackage, sidewalks were washed out, and debris was deposited on lawns and streets. Still farther upstream, basement flooding was reported in homes along W. Manitoba Street between S. 31st Street and S. 35th Street. Collapsed basement walls were reported for two homes in this area. Upstream of S. 35th Street, the Kinnickinnic River overflowed its banks and inundated portions of Jackson Park. However, because of the compatible open space use of the floodplains there, no significant damage or disruption was reported there. Stormwater inundation occurred on the City of Milwaukee-City of West Milwaukee border along W. Lincoln Avenue, north of the Kinnickinnic River, between S. 37th Street and S. 43rd Street. Street flooding was reported and several buildings incurred damage as a result of basement flooding in that area. Scattered instances of localized flooding and stormwater inundation were also reported along Wilson Park Creek or tributaries to it.

The March-April 1960 flood event also caused widespread damage in low-lying areas along the Menomonee River in Milwaukee and Waukesha Counties and along Underwood Creek in Waukesha and Milwaukee Counties. In addition, serious flooding occurred along Honey Creek in the City of West Allis as a result of the flood event. In the City of Milwaukee, flood inundation and damage in the Menomonee River industrial valley were extensive; large areas were inundated and high monetary flood damages occurred. The U.S. Department of Agriculture, Soil Conservation Service (now the Natural Resources Conservation Service), estimated flood damages in the Menomonee River watershed for the March-April 1960 flood at about $2.9 million. Included among these estimated damages were damages to several houses in the vicinity of the W. Wisconsin Avenue viaduct and damages to industrial plants in the lower Menomonee River valley. The latter area was indicated as the predominant area of damage resulting from the flood event. In the valley, the Thiele Tanning Company experienced flooding to a depth of two feet and incurred extensive damage. At the plant of The Falk Corporation, the Menomonee River flowed onto its floodplain, entered the Falk property from the west end, and crested at an elevation four to seven feet above the grades of the land surrounding the buildings and the first floors within the buildings. Floodwaters completely surrounded the Falk facilities and, as a result of overland flow and sewer backup, the interior of the plant was flooded. Three weeks passed before even part of the plant was back in operation. The Falk Corporation thus incurred about $1.3 million in losses. As a result of these losses, extensive flood control measures were subsequently taken by the company, including the construction of a concrete floodwall along the west end of the property and a sheet pile floodwall along the Menomonee River on the south side of the Falk property and along the east edge of the grounds. These works, in combination with a concrete wall on the north that existed prior to the March-April 1960 flood, have prevented inundation of the Falk plant

and grounds in subsequent floods, one of which—the April 1973 flood—peaked about two feet higher at the Falk plant than did the March-April 1960 flood. The Chicago, Milwaukee, St. Paul & Pacific Railroad yards and engine shops located in the valley were also flooded; up to one foot of water was reported in the shops. After the March-April 1960 flood, the City of Milwaukee Sewerage Commission and the Metropolitan Sewerage Commission constructed a sheet pile floodwall along the east bank of the Menomonee River and at the west edge of the railway property, and also deepened and widened the River channel. The railway constructed a 3,000-foot-long earthen dike along the south limits of the railway property extending from the downstream terminus of the sheet pile floodwall to the upstream end of the Falk floodwall. The sheet pile floodwall and the earthen dike, in combination with the protection provided by similar flood control works at the Falk site, have prevented inundation of the railway yards during subsequent flood events, including the April 1973 flood.

No major damage was reported farther upstream in the residential area near the W. Wisconsin Avenue crossing of the Menomonee River. As noted above, this area was the site of extensive damage during earlier floods. Although scattered problems involving flooded basements, closed roadways, and stranded motorists were reported in the March-April 1960 flood event, those problems were minor compared with the damage caused by previous flood events in the area. The cessation of flood problems in the area was attributed primarily to the extensive channel improvements from N. 43rd Street to N. 45th Street, initiated in 1940, and to previously completed work on a section of the Menomonee River immediately downstream extending from N. 43rd Street to the present East-West Freeway. These modifications included channel straightening, widening, and lowering, and the placement of masonry sidewalls.

An August 1960 flood event caused extensive flooding along the Kinnickinnic River downstream of S. 43rd Street. The resulting damage in terms of areas affected was very similar to that experienced along the River as a result of the March-April 1960 event. The Kinnickinnic River overtopped the S. 12th Street bridge and damaged sidewalks that had been replaced as a result of the March-April 1960 flood. A portion of the flood flow from the Kinnickinnic River was diverted from the stream at W. Montana Street extended and flowed five blocks in an easterly direction along the Chicago & North Western Railway right-of-way to S. 12th Street, where the flow turned northward, moving about two blocks along S. 12th Street to rejoin the Kinnickinnic River. Considerable flood damage occurred in basements located along this route, including damage to appliances and other contents. Farther upstream, residential structures along W. Manitoba Avenue again experienced flood damage, again similar to the damage incurred in that area as a result of the March-April 1960 event. Numerous basements were flooded and at least one incident of basement wall collapse was reported. In addition, as in the March-April 1960 event, W. Lincoln Avenue between S. 37th Street and S. 43rd Street was inundated, and scattered instances of flooding or stormwater inundation were reported along Wilson Park Creek.

A September 1972 flood event caused by a relatively large quantity of rainfall occurring under high antecedent moisture conditions resulted in significant flood damage and disruption in the Kinnickinnic River watershed within the City of Milwaukee. Most of the damage and disruption involved was confined to the reach of the Kinnickinnic River between S. 6th Street and S. 16th Street in the City. The flood problems were restricted largely to this reach because of the considerable channel modifications that had been completed by this time within the watershed on the Kinnickinnic River, Wilson Park Creek, Lyons Park Creek, and other tributaries, thereby providing for the control of the relatively high flows that were experienced. Floodwaters overtopped the low point of the roadways of the 10 bridges that then crossed the Kinnickinnic River beginning with and including S. 7th Street and extending through S. 15th Street. Overland flooding occurred on both sides of the River between S. 6th Street and S. 15th Street, extending as much as about one city block away from the River. Because of secondary flooding, the areal extent of the effects of flooding undoubtedly extended outside the area affected by the overland flooding. In addition to damage to residential buildings, both structural damage and damage to contents were sustained by and in commercial buildings. Farther upstream, the City of Milwaukee Bureau of Engineers reported that floodwaters overtopped the S. 43rd Street bridge over the Kinnickinnic River in the City. However, except for the flood damage and disruption in the reach of the River from S. 6th Street to S. 16th Street, no other serious flood problems were reported in the Kinnickinnic River watershed as a result of the September 1972 flood event. Significantly, the area along and near the River between S. 16th Street and S. 43rd Street, which had experienced serious flood damage and disruption during previous major flood events, did not

incur any serious flood problems as a result of the September 1972 event, even though the flood flows generated by the earlier floods were probably of the same order of magnitude as that generated in the September 1972 flood. The absence of flood problems along the S. 16th Street-S. 43rd Street reach of the Kinnickinnic River probably reflects the effectiveness of the massive channel improvements made to the River in that reach between 1960 and 1965.

An April 1973 major flood event caused flood problems throughout most of the seven-county Southeastern Wisconsin Region, with certain areas, such as the Kinnickinnic River and Menomonee River watersheds, experiencing severe flood damages. The flooding that occurred was somewhat more serious than what would ordinarily be expected under the relatively moderate levels of rainfall involved because of the existence of very wet antecedent moisture conditions.

Measured by the spatial extent of the flood damage and disruption resulting from the event, the April 1973 flood, which within the Kinnickinnic River watershed had a recurrence interval of about 60 years, was not the most serious flood experienced in the Kinnickinnic River watershed, since the causative rainfall was less severe over that watershed than it was over other parts of Southeastern Wisconsin, such as the Menomonee River watershed. In addition, by this time, as noted above, considerable channel modifications had been completed within the Kinnickinnic River watershed on the Kinnickinnic River, Wilson Park Creek, Lyons Park Creek, and other tributaries, thereby again providing for the control of the relatively high flood flows that were experienced. Within the watershed, major damage and disruption attributed to the flood were confined to the S. 6th Street-S. 16th Street reach of the Kinnickinnic River in the City of Milwaukee, although damage also occurred at General Mitchell Field. Although major channel modifications had been completed throughout the aforementioned Kinnickinnic River reach in 1961, the modified channel in combination with the 13 stream crossings then in the reach did not have sufficient capacity to convey the 1973 flood flows within the channel banks. As a result, floodwaters overtopped the low point of the roadways of all 11 bridges then crossing the Kinnickinnic River beginning with and including S. 7th Street and extending through S. 15th Place. Accordingly, overland flooding occurred on both sides of the River between S. 6th Street and S. 16th Street, extending as much as 700 feet, or more than one city block, away from the River. The areal extent of the effect of flooding undoubtedly extended outside the area affected by the overland flooding in the form of secondary flooding. Many residential and commercial buildings in the area of overland flooding incurred both structural damage and damage to contents as a result of basement or first-floor flooding. Extensive monetary losses occurred in the case of some individual structures, including a $16,000 loss resulting from damage to the inventory of a pharmacy located less than one-half block from the Kinnickinnic River. In addition, an isolated incident of flood damage occurred at General Mitchell Field, where a concrete box drainage structure beneath a taxiway in the northwestern corner of the airport suffered serious damage as a result of high stormwater flows.

Except for the serious flood damage and disruption that occurred in the S. 6th Street-S. 16th Street reach of the Kinnickinnic River, no serious flood problems were reported in the Kinnickinnic River watershed as a result of the April 1973 flood event. Significantly, the area along and near the River between S. 16th Street and S. 43rd Street, which had experienced serious flood damage and disruption during the major flood events of 1912, 1917, 1938, and 1960, did not exhibit any flood problems as the result of the April 1973 flood event, even though the flood flows generated by the aforementioned earlier flood events were probably of the same order of magnitude as that of the April 1973 flood. As in the case of the September 1972 flood event, the absence of flood problems along the S. 16th Street-S. 43rd Street reach of the River in the April 1973 flood event probably reflects the effectiveness of the massive channel improvements made to the River in that reach between 1960 and 1965.

The April 1973 flood event, which illustrates the extreme sensitivity of rainfall-induced floods to antecedent moisture conditions in the Menomonee River watershed, was the most severe flood event recorded up to that time in that watershed in terms of damage and disruption. In that flood event, moderate rainfall volumes occurred over the entire watershed under very wet antecedent moisture conditions. Although the event caused flood problems throughout most of the urban area of the watershed, which at the time of the event encompassed about 54 percent of the total area of the watershed, the damage and disruption within the watershed arising from the event were most serious along Underwood Creek in the Village of Elm Grove and along the Menomonee River in the City of

Wauwatosa. In addition, significant damage and disruption and/or significant overland flooding occurred in the Cities of Mequon and Wauwatosa and the Villages of Germantown and Menomonee Falls as a result of the April 1973 flood event. However, the flood event had little impact on the other riverine-area communities in the watershed, including the City of Milwaukee. The general absence of significant flood problems in these communities in the April 1973 flood event is primarily attributable to the presence of structural flood control works that protected riverine-area residential, commercial, and industrial development. Thus, largely as a result of channel modifications and sheet steel floodwalls completed by the City of Milwaukee Sewerage Commission and the Metropolitan Sewerage Commission between 1962 and 1968 along the 1.5-mile reach of the Menomonee River from the Chicago, Milwaukee, St. Paul & Pacific Railroad yard in the Menomonee River industrial valley upstream to about N. 45th Street in the City of Milwaukee, the April 1973 flood there was confined to the channel area. Similarly, a sheet steel floodwall constructed along the Menomonee River by The Falk Corporation in 1962 prevented flooding at the company's location, even though the peak stage of the April 1973 flood was about two feet higher than that of the March-April 1960 flood, which caused The Falk Corporation to suffer extensive losses. It is important, however, to recognize that there were and are areas in the Menomonee River watershed that continue to experience localized stormwater problems.

Based on an analysis of streamflow records available for the Menomonee River at Wauwatosa since October 1961, the July 1964, September 1972, and April 1973 floods in the Menomonee River watershed had recurrence intervals of seven, nine, and 95 years, respectively.

An August 1986 storm event centered in a one- to four-mile-wide band extending northwesterly from the City of Oak Creek through General Mitchell International Airport to the northern portion of the City of Wauwatosa near Lawrence J. Timmerman Airport resulted in a storm total rainfall of 6.84 inches in 24 hours, the single-day record at the General Mitchell International Airport recording station. The rainfall recorded at the airport had a recurrence interval of about 500 years and the resultant flood peak of 10,600 cubic feet per second is estimated to have had a recurrence interval greater than 500 years. Widespread flooding occurred in the Mitchell International Airport area and closed the airport. The overall flooding attendant to the storm event caused great damage, including severe damage along the reach of the Kinnickinnic River between S. 6th Street and S. 16th Street in the City of Milwaukee. However, as detailed in Chapter IV of this report, the August 1986 rainfall event—an event virtually centered on the Kinnickinnic River watershed, and whose 24-hour rainfall was estimated to have a recurrence interval of about 300 years and whose heaviest three-hour rainfall was estimated to have a recurrence interval exceeding 500 years—caused an area of inundation along this reach of the River that was substantially smaller than the area along the same reach that was inundated in the April 1973 flood event. The substantial differences in the areas of inundation may be attributed to the proper performance of significant channel improvements implemented between the time from 1973 to 1986. A 100-year recurrence interval storm—a design storm—would have been contained within the limits of the improved channel. It is clear that the flood control improvements involved functioned as designed to significantly reduce flood damages in the August 1986 storm, and serve to eliminate damages from floods up to and including the 100-year recurrence interval flood.

In the August 1986 flood event, significant flooding impacts also occurred along Wilson Park Creek, located in the Kinnickinnic River watershed. Other areas that were significantly affected included the near northwestern portion of the City of Milwaukee, including the area along the Menomonee River and Woods Creek adjacent to Milwaukee County Stadium. Severe basement flooding due to sewer backup was experienced in numerous areas in the Menomonee River and Kinnickinnic River watersheds that are remote from streams.

With regard to the Milwaukee River watershed, the studies performed in the preparation of the initial comprehensive plan for the watershed adopted by SEWRPC in 1972,[2] as well as research performed under subsequent related planning efforts, indicated that up to and including 1971, five major flood events occurred

[2]*SEWRPC Planning Report No. 13,* A Comprehensive Plan for the Milwaukee River Watershed, *Volume One,* Inventory Findings and Forecasts, *December 1970, and Volume Two,* Alternative Plans and Recommended Plan, *October 1971.*

within the watershed since its settlement by Europeans: one in March 1918, one in August 1924, one in March 1929, one in March 1959, and one in March-April 1960. Although no significant widespread damage occurred as a result of these flood events in areas then or now located within the City of Milwaukee, the historical experience with flooding in the portion of the Milwaukee River watershed located within the City includes flooding along the 3.1-mile-long reach of the River extending from the site of the North Avenue Dam to the mouth of the River. The damages associated with such flooding have been relatively very minor in the reach involved, being limited to minor damage due to basement seepage in structures along the River and to the backup of sewers within the downtown area of the City. Some shallow inundation of low-lying street intersections located relatively close to the Milwaukee River reach involved has also occurred.

No historical flood damages are known to have occurred along the approximately three-mile-long reach of the Milwaukee River extending from the North Avenue Dam to Estabrook Park. The riverbanks along this reach are generally high, and a considerable proportion of the stream banks is devoted to park or other open space uses.

In the August 1924 flood event, portions of the 2.1-mile-long reach of the Milwaukee River extending from Estabrook Park to W. Silver Spring Drive experienced very high water levels, as evidenced by reported high-water marks. At the peak flood stage at the W. Silver Spring Drive crossing of the River, located in the present-day City of Glendale, the water level of the River was about 11 feet above normal stage and only about 2.4 feet below the crown of the road over the bridge. Much of the potential for damage in the reach involved was eliminated, however, by the implementation in 1937 of channel improvements between Lincoln Park and N. Port Washington Road. Basement flooding has also been experienced in the past along this reach of the River due to stormwater drainage problems not directly related to the flood stages of the Milwaukee River. Remedial measures were implemented by the City of Milwaukee to alleviate the surface-drainage problems that caused this basement flooding.

The Milwaukee River has experienced flood stages in the City of Milwaukee during approximately one-half of the 68 years of record from 1914 through 1981 kept at the Estabrook Park stream-gaging station. Floods of moderate severity occurred in 1959 and in 1960, with the 1959 flood having a 10-year recurrence interval and the 1960 flood being slightly larger. The aforementioned major flood events in the watershed that occurred in 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.

Flooding, in various degrees, has long commonly occurred adjacent to Lincoln Creek, which is tributary to the Milwaukee River and whose subwatershed is located largely within the City. Flooding along Lincoln Creek has increased proportionally to the conversion of land within its subwatershed from open, rural use to urban use. Subsequently, channel improvements and bridge replacements have been implemented to accommodate the increased flows. During the period from 1960 through 1981, the four largest flood events of record along Lincoln Creek occurred in 1964, 1968, 1972, and 1973. The major consequences of these and other runoff events along Lincoln Creek have been flooding of roadways and underpasses, first-floor flooding of buildings, and basement flooding caused by sewer backup. Over the period from 1960 through 1975, more than 1,300 separate flooding and water-related problems were reported to the City of Milwaukee by property owners in the Lincoln Creek area. The problems thus reported included first-floor inundation, yard flooding, and basement flooding, with the most common complaint being basement flooding. Studies and planning efforts completed subsequent to SEWRPC's preparation and adoption of its initial plan for the Milwaukee River watershed—including the SEWRPC study undertaken to develop the detailed flood control plan for Lincoln Creek[3] that was adopted by SEWRPC in 1983 as an amendment to its comprehensive plan for the Milwaukee River watershed—have identified the Lincoln Creek subwatershed area in the City of Milwaukee as a specific problem area, with over 1,600 structures currently located within the flood hazard area.

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[3]*SEWRPC Community Assistance Planning Report No. 13 (2nd Edition),* Flood Control Plan for Lincoln Creek, Milwaukee County, Wisconsin, *September 1982.*

Within the portion of the Oak Creek watershed that is located within the City of Milwaukee, historical flood damages have been limited to an area along the North Branch of Oak Creek located east of S. 13th Street and north of W. College Avenue. One commercial building, two industrial buildings, and one residential building are currently located within this area.

Neither any historical flood damages nor any current flood problem areas have been identified within the portions of the Root River watershed that are located within the City of Milwaukee. In the portion of the Lake Michigan direct drainage area that is located within the City, flooding problems are relatively minimal.

DESCRIPTION OF RECENT FLOOD EVENTS

As also noted in Chapter I of this report, major flooding occurred in 1997, 1998, and 2000 within the City of Milwaukee and some of the drainage areas that lie partly within its boundaries. These flood events, which are significant with regard to the current flood mitigation planning effort for the City, include the following:

- The event of June 20-21, 1997, when a period of moderate rainfall followed by intense thunderstorms centered in northern Milwaukee County resulted in at least four inches of rain across the County, with much of the County receiving at least six inches of rain. More than nine inches of rain was recorded in the Village of Brown Deer. Severe localized damage occurred in Brown Deer, the City of West Allis, and the Lincoln Creek area of the City of Milwaukee. The reach of Lincoln Creek between N. 37th Street and N. 60th Street in the City experienced significant flooding and stormwater drainage problems during the flood event. Of the total of 1,510 flooding complaints received by the City in the one-week period following the flood event, about 980, or 65 percent, occurred with regard to the Lincoln Creek subwatershed. Severe, direct overland flooding also occurred in several other areas, including areas along the Menomonee River in the Cities of Milwaukee and Wauwatosa. Sewer backup flooding was reported in the Kinnickinnic River watershed, but no damages resulting from overbank flooding along waterways in that watershed were reported. There were, however, numerous occurrences of stormwater drainage and sanitary sewer backup problems in communities located throughout the areas of heavy rainfall.

  Estimated flood damages during the June 1997 event were $78.0 million in Milwaukee County. Assistance received by the City of Milwaukee through the FEMA and State Hazard Mitigation and Public Assistance programs administered by the Wisconsin Department of Military Affairs Division of Emergency Management associated with this event totaled about $1,122,000 under the FEMA Hazard Mitigation program and $1,412,000 under the FEMA Public Assistance program.

- The event of July 2, 1997, a "follow-up" storm to the June 20-21, 1997, storm event, involved as much as four inches of rain, but resulted in little additional property damage.

- The event of August 6, 1998, in which over six inches of rain in northwestern Milwaukee County and eastern Waukesha County fell, resulting in severe, direct overland flooding in a second consecutive year along Lincoln Creek in the City of Milwaukee as well as along the Menomonee River in the City of Wauwatosa, Underwood Creek in the City of Brookfield and the Village of Elm Grove, and Southbranch Creek in the Village of Brown Deer. Significant property damage resulted from overbank flooding along Lincoln Creek and the Menomonee River. As in the 1986 and 1997 major storm events in the area, there were numerous occurrences of stormwater drainage and sanitary sewer backup problems in communities located throughout the areas of heavy rainfall.

  Estimated flood damages during the August 1998 event were $11.0 million in Milwaukee County. Assistance received by the City of Milwaukee through the FEMA and State Hazard Mitigation and Public Assistance programs associated with this event totaled about $227,000 under the FEMA Public Assistance program.

- The event of July 2, 2000, in which as much as 6.5 inches of rain fell on portions of eastern Waukesha and southern Milwaukee Counties, including 4.42 inches recorded at General Mitchell International Airport on the far south side of the City of Milwaukee. The storm associated with this event produced one tornado in southern Milwaukee County about three-fourths of a mile northwest of 27th Street and Ryan Road in the City of Franklin. The tornado moved east/northeast through the City of Oak Creek and into neighboring Racine County. In addition to damage from the tornado, significant damages due to flooding also occurred. The most severe flooding occurred in the communities south of Milwaukee, including the Cities of Franklin and Oak Creek and the Villages of Greendale and Hales Corners. In the City of Milwaukee, reported damages occurred mainly in the Kinnickinnic River and Oak Creek watersheds, with damages mostly limited to basement flooding due to either sewer backup or inoperable sump pumps cause by power outages.

  Estimated flood damages during the July 2000 event were $6.8 million in Milwaukee County.

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Chapter III

FLOOD MITIGATION GOALS AND OBJECTIVES

INTRODUCTION

Planning may be defined as a rational process for formulating and meeting goals and objectives. Consequently, the formulation of goals and objectives is an essential task which must be undertaken before plans can be prepared. This chapter sets forth a set of flood mitigation goals and objectives for use in the design and evaluation of alternative flood mitigation plans for the City of Milwaukee and the five watersheds that each lie partly within its boundaries, and in the selection of a recommended plan from among those alternatives.

In formulating and setting forth goals and objectives, their differing natures and purposes must be kept in mind. Goals are general guidelines that explain what a community desires to achieve. Based upon the selected goals, a community can then develop the specific objectives needed to attain the goals. Objectives define strategies for meeting the selected goals and are more specific than goals.

In the selection of goals and objectives and their application to the preparation, testing, and evaluation of plan alternatives, several basic considerations must be recognized. First, it must be recognized that any proposals for flood mitigation must constitute integral parts of a total system. It is not possible from an application of the goals and objectives alone to assure such system integration, since the goals and objectives cannot be used to determine the effect of any given individual proposed facility or other proposal on the system as a whole, nor on the environment within which the system must operate. Such determination requires the use of quantitative planning and engineering techniques developed for those purposes. Second, it must be recognized that it is unlikely that any one plan proposal will fully meet all applicable goals and objectives; the extent to which each applicable goal and/or objective is met, exceeded, or violated must serve as the measure of the ability of each alternative plan proposal to achieve the applicable goal(s) and/or objective(s). Third, it must be recognized that there may be certain cases where certain goals and/or objectives may conflict, and that such conflicts may require resolution through compromise, such compromise being an essential aspect of any planning or design effort. Finally, it should be recognized that goals and objectives may, in some cases, be specific to a particular watershed or subwatershed area. Accordingly, certain citywide goals and objectives may be refined as detailed floodland and stormwater management plans are prepared for each specific subarea of the City and its related watershed(s) or subwatershed(s).

RELATIONSHIP OF FLOOD MITIGATION GOALS AND OBJECTIVES TO COMMUNITY DEVELOPMENT AND PARK AND OPEN SPACE OBJECTIVES

As described in Chapter II, Milwaukee County has prepared and adopted a park and open space plan[1] to guide the County in preserving and developing recreational and other open space uses throughout the County, including the City of Milwaukee. As park and open space planning and floodland management planning are carried out in Milwaukee County and the City of Milwaukee and in the related watersheds, an integration and coordination of the goals and objectives has taken place. In addition, land use planning goals and objectives are integrated and coordinated with floodland management planning. This is accomplished at the watershed level by developing comprehensive watershed plans which include floodland management, land use, park and open space, and water quality planning in one integrated planning program. These watershed plans form a potential framework for subwatershed-level planning programs. As an example, the comprehensive watershed planning objectives, principles, and standards for the comprehensive plan for the Menomonee River watershed[2] include six specific objectives and supporting standards related to land use and park and open space use, as well as objectives and standards relating to flood control. A copy of the objectives, principles, and standards used for development of the comprehensive plan for the Menomonee River watershed is included in Appendix B of this report. Similar objectives, principles, and standards are included in the comprehensive plans for the Kinnickinnic and Milwaukee Rivers and Oak Creek watersheds.

FLOOD MITIGATION GOALS AND OBJECTIVES FOR THE CITY OF MILWAUKEE

A series of goals and objectives has been developed to guide the current flood mitigation planning effort for the City of Milwaukee. These goals and the objectives related to them are set forth below.

GOAL NO. 1

The reduction and, to the maximum extent practicable, the prevention of future loss of lives and/or property due to flooding within the City of Milwaukee through the most appropriate, feasible, and effective means available.

OBJECTIVES

1. The enforcement of existing and, as appropriate, the adoption of new development regulations to reduce risks to life and property in floodprone areas.

2. The development and maintenance of up-to-date inventories and maps to identify areas and structures at risk of flooding.

3. The implementation and, as necessary, the development of public education and information programs and funding assistance programs for property owners wishing to floodproof their structures.

4. The development and implementation of an acquisition/relocation program to purchase and remove or relocate structures located in floodprone areas.

5. The establishment, as appropriate, of open space parks and recreational areas in floodprone areas.

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[1] *SEWRPC Community Assistance Planning Report No. 132,* A Park and Open Space Plan for Milwaukee County, *November 1991.*

[2] *SEWRPC Planning Report No. 26,* A Comprehensive Plan for the Menomonee River Watershed, *Volume One,* Inventory Findings and Forecasts, *October 1976, and Volume Two,* Alternative Plans and Recommended Plan, *October 1976.*

6. The provision, maintenance, development, and implementation, as appropriate, of stormwater and floodlands management facilities, modifications to minimize or prevent damage from inundation events up to and including the 100-year recurrence interval flood event.

7. The development and maintenance of an up-to-date, adequate emergency action plan which identifies flood warning capabilities, escape routes, and rescue and relief capabilities.

GOAL NO. 2

The promotion of the long-term economic prosperity of the City of Milwaukee by the elimination or mitigation of conditions that leave the City and its residents vulnerable to economic loss as a result of flooding.

OBJECTIVES

1. The promotion of commercial and industrial development which avoids floodprone areas and limits the possibility of business interruptions resulting from flooding.

2. The promotion, where appropriate, of private acquisition by conservation organizations of floodprone areas for use as community parks and recreation areas.

3. The protection of property values by the elimination of blight in floodprone areas.

4. The development and implementation of floodland management plans which resolve existing and avoid creation of additional flood-related problems.

GOAL NO. 3

The improvement of water quality in the City of Milwaukee.

OBJECTIVES

1. The development and implementation of floodland management plans which control erosion in floodplain areas.

2. The development of stormwater management plans which identify and, as appropriate, mitigate nonpoint pollution sources.

3. The development and implementation of a continuing public information and education program regarding floodplain development and nonpoint source pollution abatement.

RELEVANT GOALS OF OTHER PLANNING EFFORTS

The above goals and objectives, as well as the current flood mitigation planning effort for the City of Milwaukee, must be treated in the context of historical and current related planning efforts undertaken for the area by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) and the Milwaukee Metropolitan Sewerage District (MMSD). Each of the plans involved sets forth a series of goals that are relevant to the current flood mitigation planning effort for the City.

SEWRPC Watershed Plans

As part of its continuing planning program for the seven-county Southeastern Wisconsin Region, SEWRPC has prepared and adopted comprehensive plans for the five watersheds that lie partly within the City of Milwaukee. Each of the five plans sets forth a series of detailed water control facility development objectives, as well as related land use and park and open space objectives. In these plans, the Commission defines an "objective" as "a goal or end toward the attainment of which plans and policies are directed." Each objective is 1) supported by a

stated fundamental, primary, or generally accepted planning principle that supports the objective and asserts its inherent validity and 2) accompanied by a set of quantifiable planning standards that can be used to evaluate the relative or absolute ability of alternative plan designs to meet the stated development objective. The principles and standards serve to facilitate quantitative application of the objectives during plan design, testing, and evaluation.

An objective common to all five watershed plans envisions "[a]n integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses" within each watershed. An example of the comprehensive watershed planning objectives and supporting principles and standards is included in Appendix B.

Plans Prepared for MMSD

In 1990, SEWRPC prepared a comprehensive stormwater drainage and flood control system plan for the MMSD. In preparing this plan, SEWRPC formulated and used a series of objectives, principles, and standards similar to those used in preparing the five watershed plans. In the system plan prepared for the MMSD, the following water control facility development objectives, or goals, were set forth: 1) the development of an integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern within the District boundaries and promote the implementation of the adopted land use plans for the watersheds in the District, meeting the anticipated runoff loadings generated by the existing and proposed land uses, and 2) the development of an integrated system of flood control and stormwater management facilities designed to minimize the negative impacts on fish and other aquatic life and to support the water use objectives set forth in the regional water quality management plan.

The proposed 1990 system plan for the MMSD reflected recommendations set forth in a 1986 stormwater drainage and flood control policy plan identifying the streams and other watercourses for which it was recommended that the District assume responsibility for flood control. The policy plan, also prepared for the MMSD by SEWRPC, was adopted by the District, by Milwaukee County, and the City of Milwaukee, as well as the Cities of Franklin, Greenfield, Oak Creek, Wauwatosa, and West Allis and the Villages of Brown Deer, River Hills, and Shorewood. The 1986 policy plan was also adopted conditionally by the Cities of Brookfield, Mequon, Muskego, and New Berlin and the Villages of Butler, Elm Grove, Menomonee Falls, and Thiensville. The 1990 system plan prepared by SEWRPC served as a major basis for the District's own 1990 watercourse system plan.

Current Plan Update Effort by MMSD

As noted in Chapter I of this report, the MMSD is currently engaged in its own detailed flood management planning efforts. The MMSD's current planning efforts, which are intended to update the District's 1990 watercourse system plan and policy plan, are integral to the current flood mitigation planning effort for the City of Milwaukee. The MMSD states its objective with regard to its current planning effort as follows: "The objective of the System Plan Update is to develop cost-effective, feasible, and implementable flood control management alternatives that minimize structure damages for major flooding events."

In seeking to address flooding problems along the watercourses under MMSD jurisdiction, the District has adopted an approach through which it seeks to do the following:

- Develop a thorough understanding of the frequency and extent of damaging floods in the system watercourses.
- Achieve a consensus among involved stakeholders regarding the goals and objectives of the completed plan.
- Identify jurisdictional and agency responsibility issues for various aspects of implementation of the updated plan.

- Conduct the hydrologic and hydraulic analyses necessary to identify causes of flooding, the extent of damages, and potential solutions.

- Develop solutions in the context of a comprehensive watercourse management plan that are acceptable to all of the involved stakeholders.

As part of the current effort, the MMSD refined its 1986 policy plan in order to define specific policy issues, such as the relationship between stormwater management and flood control, funding responsibilities, project prioritization, and allocation of responsibilities for flood control measures between the MMSD and the local units of government.

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Chapter IV

ANALYSIS OF FLOOD PROBLEMS

In order to evaluate various potential flood mitigation alternatives for the City of Milwaukee and select the most effective and feasible flood mitigation strategies, the existing flooding problems in the City must first be analyzed. Accordingly, this chapter summarizes the extent and severity of the flooding problems within the City of Milwaukee and the potential for these problems to increase in the future, and sets forth recent analyses of such problems as developed under detailed floodland management system plans which have been prepared under an areawide system planning program incorporating the City.

ANALYSIS DATA AND PROCEDURES

The most recent analyses of flooding problems incorporates basic data developed by the Milwaukee Metropolitan Sewerage District (MMSD) under a system-level Phase 1 watercourse management plan and to the extent practicable, subsequent plan implementation programs and projects. These analyses represent a refinement of earlier system planning programs. As part of the Phase 1 management plan, all structures within the identified 100-year recurrence interval floodplain within the City of Milwaukee were mapped using available large-scale topographic mapping and, in some cases, field data where available. This structure identification is being refined as subsequent detailed planning and preliminary design steps are carried out.

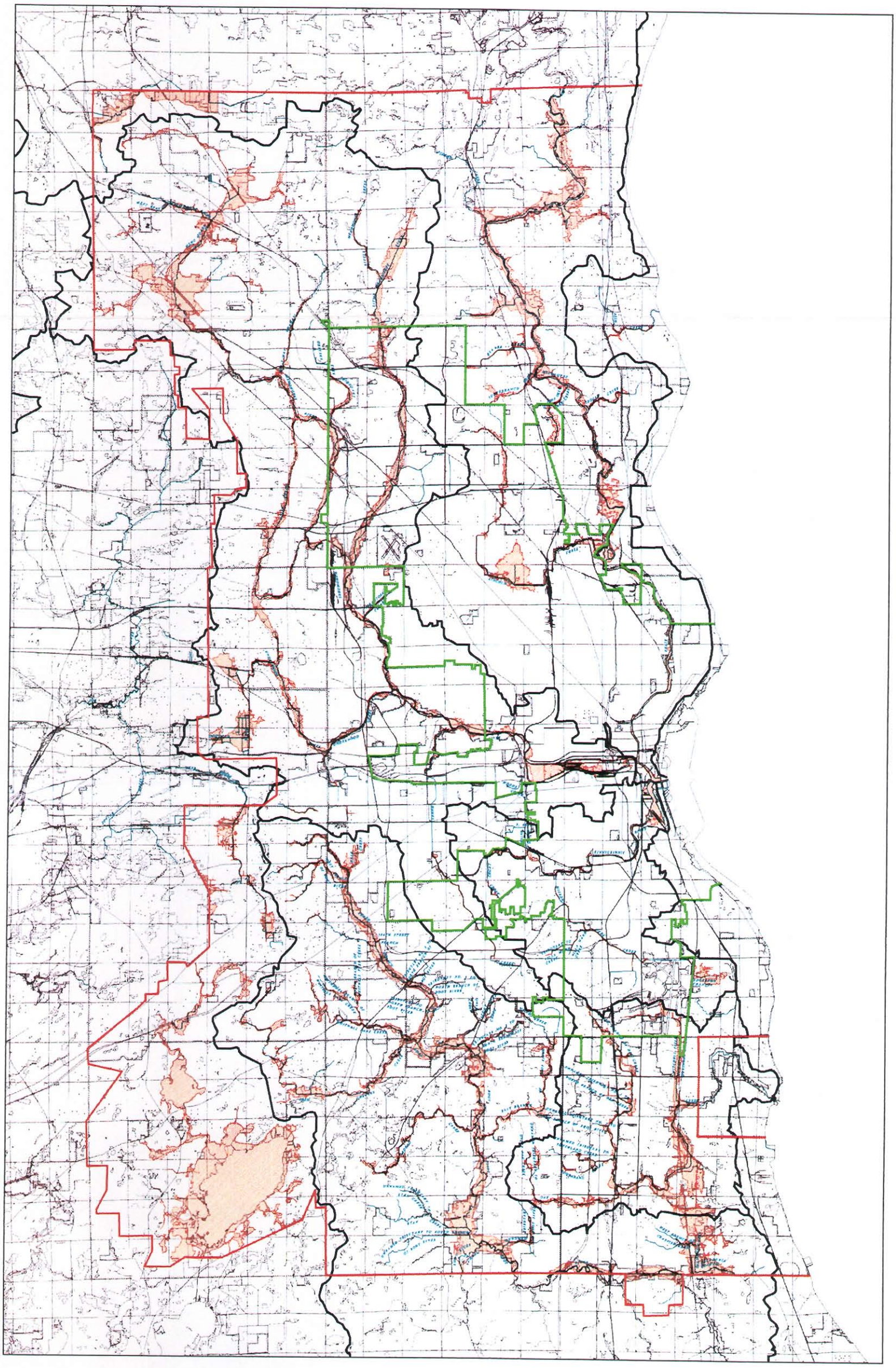
Similarly, the approximate depths of flooding, generalized estimates of property values, and potential flood damages were developed for all floodprone structures in the City as part of the system-level management plan. The property values used at the system planning level were typically based upon generalized values of $140,000 for single-family residential buildings, $160,000 for two-family residential buildings, $250,000 to $600,000 for multi-family residential buildings, and $200,000 to $1.0 million for institutional, commercial, and industrial buildings, except in certain instances where assessment data was readily available. Systems-level alternative and recommended plans were then developed using the flood depth and damage data so developed. As more-detailed project planning and design is carried out, these data are being refined by field survey and by obtaining assessed and market property values in cases where property acquisition are considered a viable option. As part of this step in the flood mitigation program, the recommended plans developed at the systems-level are being refined and detailed as this process is ongoing under the Milwaukee Metropolitan Sewerage District flood mitigation program. All of the basic data noted above as applied to the City of Milwaukee, is incorporated into the following section of this report.

CITY OF MILWAUKEE FLOODING PROBLEM AND COMMUNITY IMPACTS DESCRIPTION

The floodplain areas, as well as the subwatershed boundaries, within the City of Milwaukee are shown on Map 6. These areas are generally located along the major stream system throughout the City. The floodplains have been

Map 6

MAPPED FLOODPLAIN AREAS IN THE CITY OF MILWAUKEE: 1999



STUDY AREA BOUNDARY
CITY OF MILWAUKEE CORPORATE LIMIT
FLOODPLAIN (100-YEAR RECURRENCE INTERVAL)
PERENNIAL STREAM
INTERMITTENT STREAM
WATERSHED BOUNDARY

GRAPHIC SCALE
0 1 2 MILES
0 4000 8000 12,000 FEET

Source: SEWRPC.

delineated for a total of about 61 miles of stream within the City. Most of the floodplain areas for which detailed studies are available have been mapped on large-scale topographic mapping prepared at a scale of one inch equals 100 feet with a contour interval of two feet. Flood flows and stages are currently readily available for about 58 miles of the total stream reaches involved, while the floodplain for about three miles of stream is delineated by approximate methods under the Federal Flood Insurance Study for the City. Under the Milwaukee County Automated Mapping and Land Information Program, updated digital large-scale topographic maps for the entire City were recently prepared.

As of 2000, a total of 1,838 structures were identified as being located within the 100-year recurrence interval flood hazard areas of the City of Milwaukee. The areas where flooding of structures has been identified are shown on Map 7. There were 1,784 residential, 51 business and commercial, and three other structures involved. The location of the 207 structures which are considered to be repetitive- or substantial-loss structures are shown on Map 8. Repetitive-loss properties are those that have two or more flood insurance claims of at least $1,000 each. There are 168 single-family structures, 36 two- and four-family structures, and three other structures so classified in the City of Milwaukee. In addition, FEMA has also identified a subset of properties meeting one of three criteria: 1) four or more losses of $1,000 or more; 2) two or more losses in a 10-year period that, in aggregate, equal or exceed the current value of the insured property; and 3) three or more losses that, in aggregate, equal or exceed the current value of the insured property. In 1999, FEMA issued guidance stating that emphasis should be given to properties in this subset and that they are a high priority for mitigation measures. There are three properties in the City of Milwaukee that fall into this subset, as shown on Map 8. A listing and selected information on each of the repetitive, or substantial, loss structures is included in Report W2RCRLDT, as compiled by the Federal Emergency Management Agency (FEMA) under the National Flood Insurance Program, and is available in the City of Milwaukee Department of Public Works files. Selected information on each floodprone area is organized by watershed in this chapter and in the alternative and recommended mitigation plan elements presented in Chapters V and VII.

As of mid-2002, the MMSD had completed, or was nearing completion on, flood control projects for Lincoln Creek, Southbranch Creek, the Valley Park neighborhood of the Menomonee River, and the headwaters of Grantosa Creek. As a result of those projects, a total of 1,785 of the 1,838 structures identified will be protected from flooding up to, and including, the 100-year recurrence interval event. This includes 205 of the 207 repetitive-loss structures, including the three structures that are considered high priority by FEMA. Details of those projects are discussed in Chapters V and VII. In addition, the MMSD has continued with more-detailed planning and preliminary design for the other watercourses under its jurisdiction. This subsequent work has included obtaining field survey elevation data for potentially floodprone structures. Based upon the most recent analyses, as of mid-2002, the number of structures still remaining in the flood hazard areas of the City of Milwaukee is 70. Detailed information for these structures, including type and estimated depth of flooding, is listed in Appendix C.

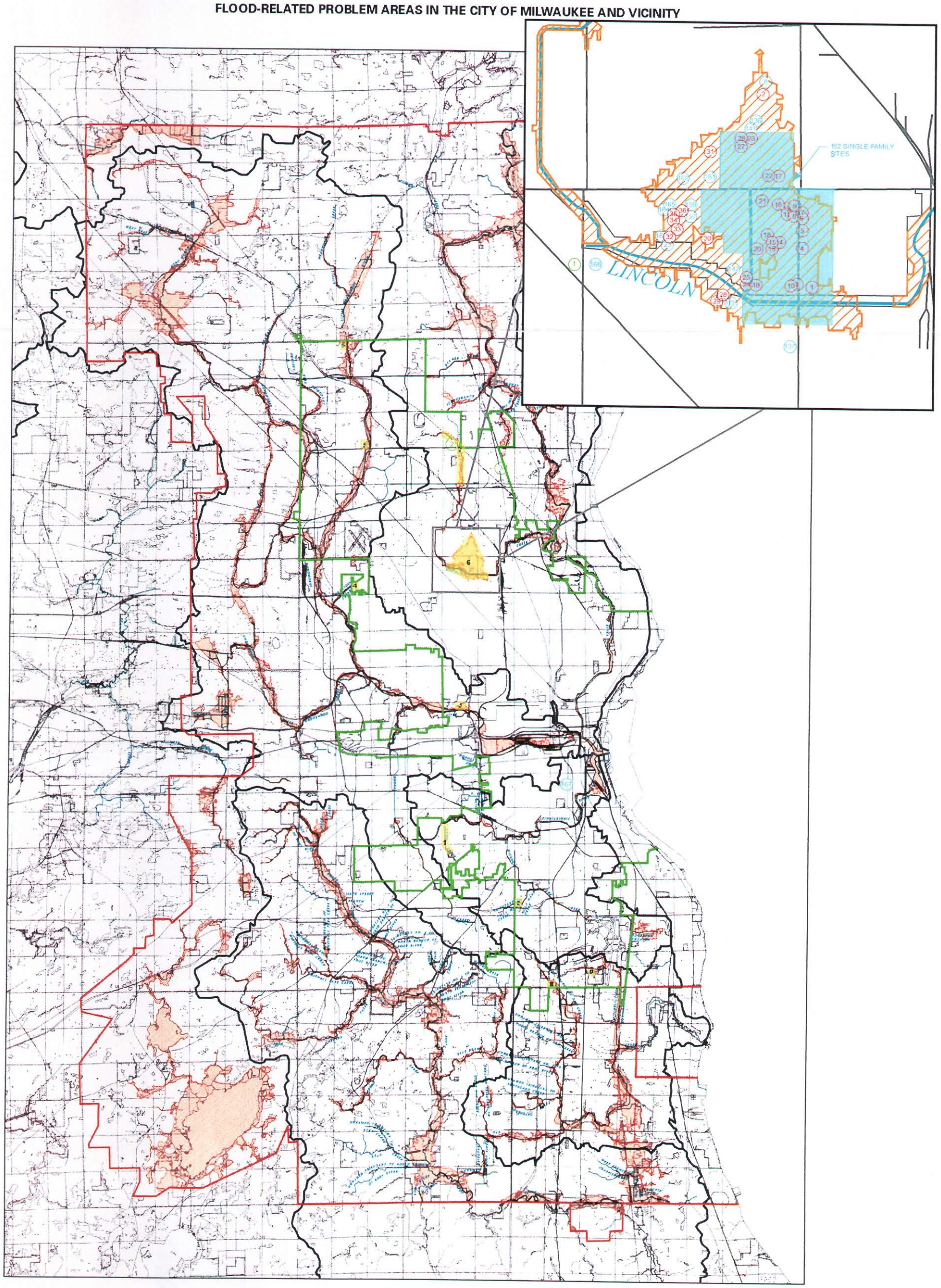
In addition to the structures which lie within the floodplain, there are other areas within the City which experience flooding and stormwater drainage problems. The problems generally include frequent street flooding and backup of stormwater at culverts and other structures causing yard and parking area flooding.

Map 9 shows the location of selected types of critical community facilities including fire and police stations, hospitals, and community administration facilities within the City. None of these facilities are located within the flood hazard areas. However, because of the need for access to and from these facilities, the flood mitigation plan includes their location and shows the relationship to the flood hazard areas. There are no schools, nursing homes, or other critical facilities located within the flood hazard areas within the City.

As described in Chapter II of this report, two recent flood events occurring on June 20-21, 1997, and August 6, 1998, resulted in unusual problems within the City due to a combination of extremely high flood flows, power outages and associated sump pump failures, and sanitary sewer capacity problems. A description of these two events is included in Chapter II of this report.

Map 7

FLOOD-RELATED PROBLEM AREAS IN THE CITY OF MILWAUKEE AND VICINITY



STUDY AREA BOUNDARY

CITY OF MILWAUKEE CORPORATE LIMIT

FLOODPLAIN (100-YEAR RECURRENCE INTERVAL)

PERENNIAL STREAM

INTERMITTENT STREAM

WATERSHED BOUNDARY

Source: SEWRPC.

FLOOD-RELATED PROBLEM AREAS

1 LYONS PARK CREEK
2 VILLA MANN TRIBUTARY
3 MENOMONEE RIVER
4 GRANTOSA CREEK
5 LITTLE MENOMONEE RIVER
6 LOWER LINCOLN CREEK
7 UPPER LINCOLN CREEK
8 NORTH BRANCH OF OAK CREEK
9 MITCHELL FIELD DRAINAGE DITCH

(2) NONRESIDENTIAL SITE

(34) TWO- TO FOUR-FAMILY SITE

(137) SINGLE-FAMILY SITE

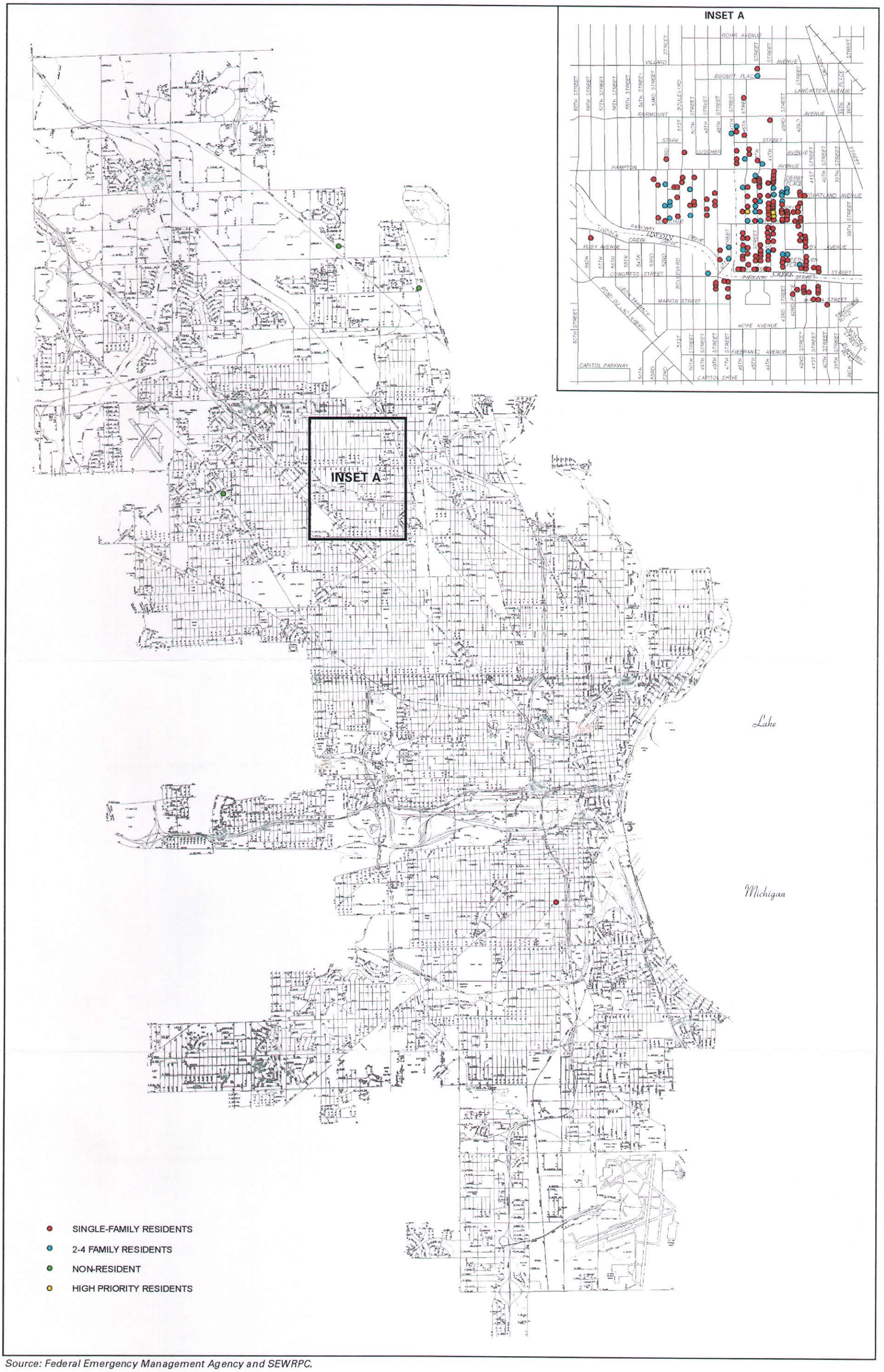
GRAPHIC SCALE

0 1 2 MILES

0 4000 8000 12,000 FEET

Map 8

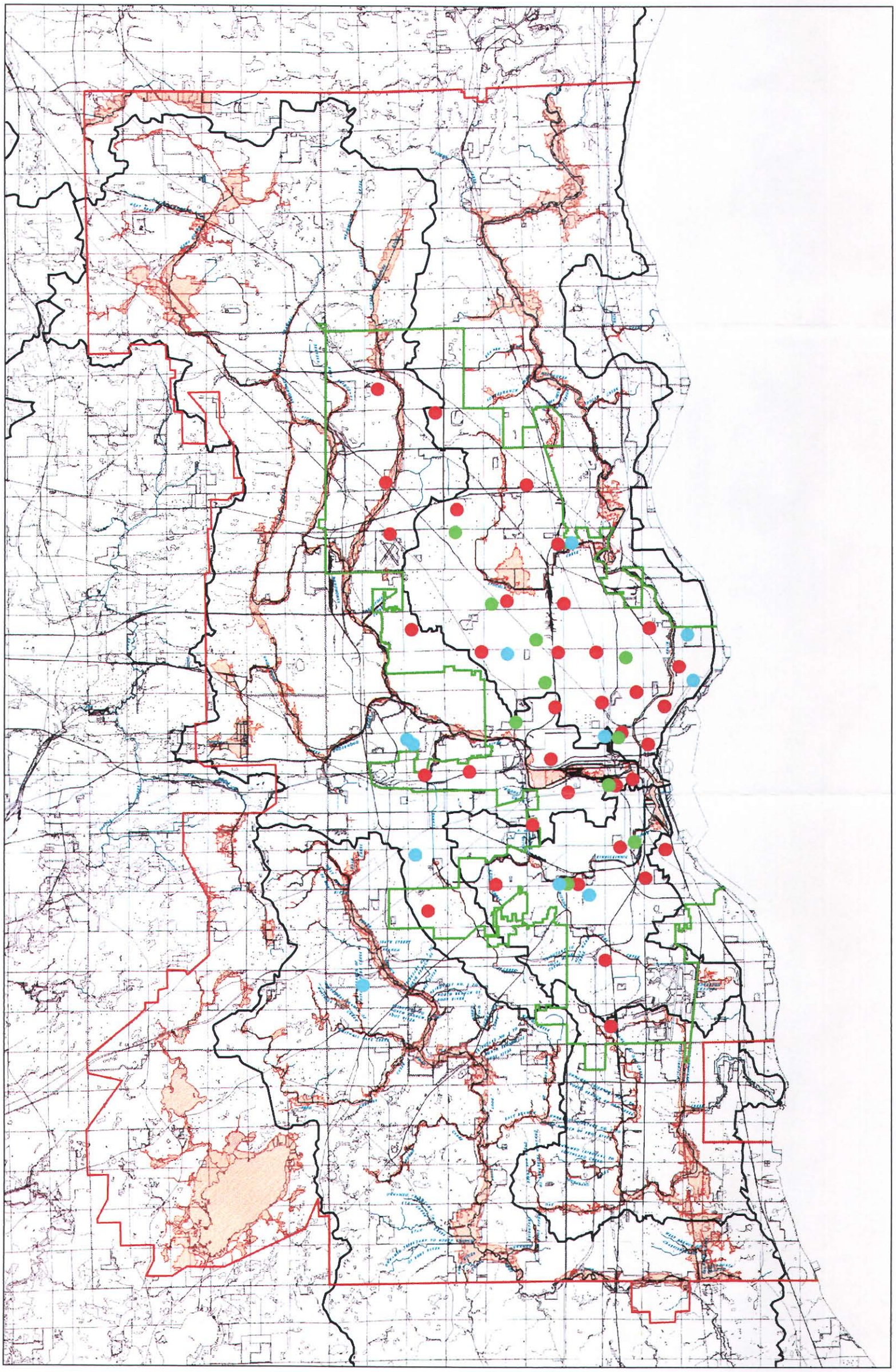
REPETITIVE-LOSS STRUCTURES IN THE CITY OF MILWAUKEE



Source: Federal Emergency Management Agency and SEWRPC.

Map 9

LOCATION OF CRITICAL COMMUNITY FACILITIES IN RELATION TO FLOODPLAINS IN THE CITY OF MILWAUKEE



STUDY AREA BOUNDARY
CITY OF MILWAUKEE CORPORATE LIMIT
FLOODPLAIN (100-YEAR RECURRENCE INTERVAL)
PERENNIAL STREAM
INTERMITTENT STREAM
WATERSHED BOUNDARY

FIRE STATION
POLICE STATION
HOSPITAL

GRAPHIC SCALE
0 1 2 MILES
0 4000 8000 12,000 FEET

Source: SEWRPC.

A review of the extent and severity of flooding conditions within the City of Milwaukee indicates that there is a significant community impact primarily as a result of the damages caused by flooding of buildings, primarily basements, and disruption of the transportation system during extreme flooding events. Most importantly, the contribution of overland flooding to the problem of basement sanitary sewer backup is a major community concern related to public health and safety. As an example, flooding of streets and buildings, primarily basements, was reported in the City as a result of the June 20-21 and July 2, 1997, August 6, 1998, and July 2, 2000, storms. Several types of structure flooding occurred. One major source of basement flooding problems was surcharging of sanitary sewers and resultant backups into basements. Another source of basement flooding was sump pump failure due to electrical power outages. Those two problems are interrelated. If sump pumps cannot operate and the volume of clearwater collected by a building's foundation drain system exceeds the capacity of the sump crock, water will overflow from the crock into the basement. That clearwater then flows into the basement floor drain, which is connected to the sanitary sewer. Excessive flows of such clearwater into the sanitary sewers can quickly exceed the capacity of those relatively small-diameter sewers, leading to surcharging and backup of a combination of sanitary sewage and clearwater into basements connected to the surcharged sewers. Additional sources of clearwater inflow to sanitary sewers were through: 1) flooding of basements due to surface runoff, 2) excessive amounts of water collecting in streets or roadside swales and entering sanitary sewer manholes through unsealed lids and frames, and 3) sanitary sewer manhole lids which were disturbed. The location of the reported flooding and stormwater-related problems within the City of Milwaukee for the June 20-21 and July 2, 1997, and August 6, 1998, storm events is shown on Map 10. The location of reported flooding and stormwater-related problems in the City of Milwaukee for the July 2, 2000, storm event is shown on Map 11. As can be noted from review of Maps 10 and 11, during the 1997 events a majority of the identified problems were located within or near the floodplain areas within the Lincoln Creek area with other problem areas being scattered throughout the City. The reported problems during the 1998 event were focused mostly in Menomonee River, Grantosa Creek, and Lincoln Creek areas with some scattered problems throughout the City. The reported problems during the 2000 event are focused mainly on the City's far south side.

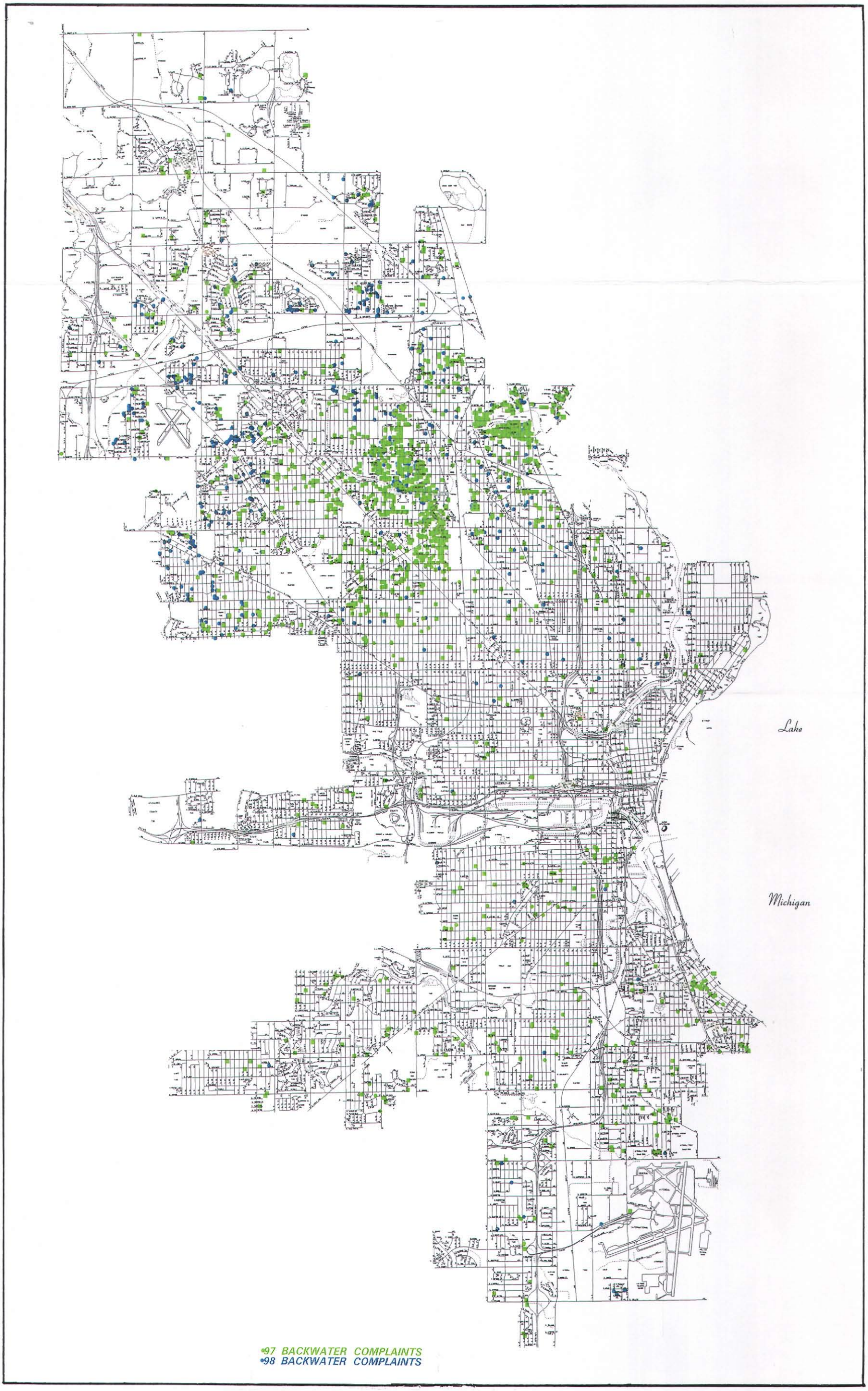
The flooding impacts on the City's infrastructure and the need to prepare for major evacuations and other emergency actions are not considered to be a major concern given the nature and the severity of the overland flooding problems. However, the Milwaukee County emergency operations planning program does have provisions for carrying out the latter if it would be needed. Furthermore, significant flood-related impacts on the community economy and businesses are of an infrequent and short-term nature. The major impact on City operations which are relatively frequent involve posting and closure of selected roadway locations where floodwaters frequently overtop bridges and culverts and cause short-term roadway flooding.

POTENTIAL FUTURE CHANGES IN FLOODPLAIN BOUNDARIES AND PROBLEMS

As described in Chapter II of this report, the City of Milwaukee and communities in the tributary areas currently have in place land use controls and planning programs to preserve nearly all of the remaining environmentally sensitive areas, including wetlands and floodplains. Furthermore, development within the City itself is approaching "buildout" conditions with new development expected to be largely limited to infilling and isolated open space parcels outside of the environmentally sensitive areas. The City has an adopted stormwater management ordinance which requires sound stormwater management practices for new development and redevelopment sites which will limit any increases in future stormwater runoff peak rates of flow. Accordingly, there is not expected to be any significant changes in the flood flows and hydrologic characteristics of the stream system resulting from future land use changes in the City. Detailed analyses conducted under the recently completed stormwater and floodland management plan for the Milwaukee Metropolitan Sewerage District (MMSD) and the Southeastern Wisconsin Regional Planning Commission (SEWRPC) comprehensive watershed plans for the watershed tributary to the City of Milwaukee have documented the potential extent of increases in future flood flows within the City of Milwaukee. The most recent hydrologic modeling conducted by consultants to the MMSD and by SEWRPC indicates that potential increases in flood flows due to increased development are generally less than 2 percent for the major streams in the City of Milwaukee with some higher increases noted in selected reaches where problems are not expected to occur. Those changes were calculated assuming that no

Map 10

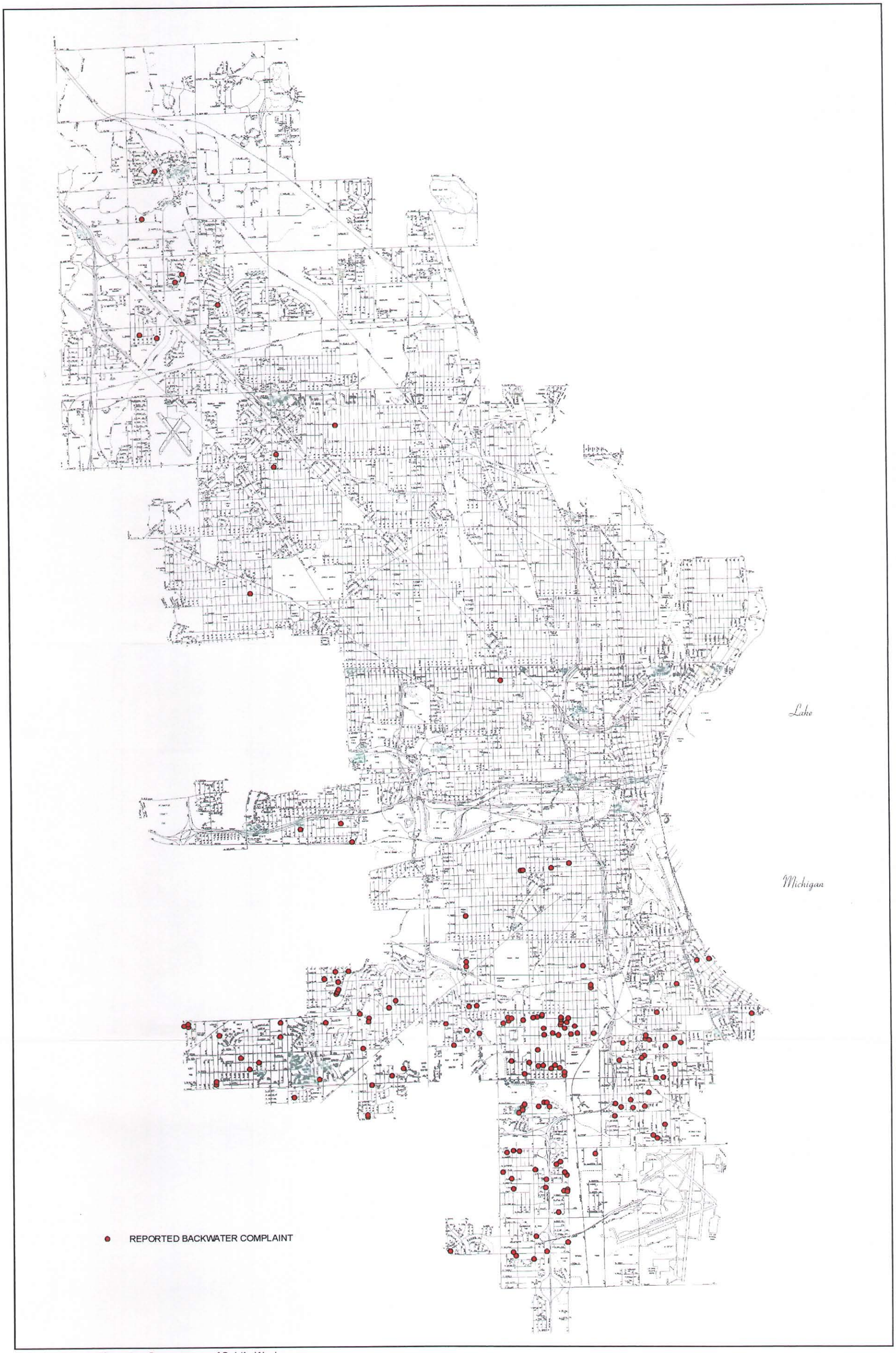
REPORTED FLOODING, STORMWATER, AND SANITARY SEWER BACKUP PROBLEMS IN THE CITY OF MILWAUKEE: 1997 AND 1998



Source: City of Milwaukee Department of Public Works.

Map 11

REPORTED FLOODING, STORMWATER, AND SANITARY SEWER BACKUP PROBLEMS IN THE CITY OF MILWAUKEE: JULY 2, 2000



Source: City of Milwaukee Department of Public Works.

systemwide effective stormwater detention measures would be put in place. However, as noted below, most of the communities do have requirements for stormwater detention. Accordingly, the future increased flows will be even less than calculated by the recent modeling.

With regard to the impact of development beyond the City of Milwaukee limits, however, nearly all of the developing communities lying upstream of the City, have recently prepared, or have under preparation, detailed stormwater management plans and/or stormwater-related ordinances designed to minimize any negative downstream impacts on flood flows and stages. In addition, most of the developed and developing communities in the tributary subwatersheds are currently involved in the Wisconsin Department of Natural Resources (WDNR) stormwater permitting program as set forth under Chapter NR 216 of the *Wisconsin Administrative Code*. This program will eventually lead to the development of additional stormwater management practices.

In addition to the above and as described in Chapter II of this report, the City of Milwaukee's current floodplain zoning regulations are designed to prevent the development of any new floodprone development, as well as to prevent any floodplain encroachment that would cause changes in the existing flood flows or stages.

Based upon the above, it can be concluded that the extent and severity of the flooding problem within the City will not become significantly more severe in the future. However, this conclusion is based upon the assumption of, and highlights the importance of, carrying out and implementing current floodplain and related land use regulations and existing and ongoing stormwater management plans and regulations.

SUMMARY OF STORMWATER AND FLOODLAND MANAGEMENT PLAN FLOOD PROBLEM ANALYSES

The identification, analysis, and recommendation of possible methods of abating or mitigating recent and current flooding problems in the City have been the subject of various planning efforts in recent decades, either with regard to the City as a whole or to various portions of it. The most significant and recent analyses of flood problems in the City are those which have been and which are being conducted as part of the detailed flood management planning efforts in which the MMSD is currently engaged with private consultants. As noted in Chapter III of this report, the MMSD's current planning efforts are intended to update its 1990 watercourse system plan.

The current MMSD planning effort builds upon previous flood mitigation planning efforts undertaken for the watersheds and watercourses that lie partly or wholly within the City of Milwaukee, most notably those undertaken by the MMSD itself and by SEWRPC for each of the watersheds lying partly within the City. The MMSD's flood mitigation planning efforts, like SEWRPC's similar efforts, use the watershed as the basic geographic unit for planning. Because the alternative and recommended flood mitigation plans are developed on a watershed or subwatershed basis, this section describes the problems on the same basis.

In addition to encompassing portions of the five watersheds that fall partly within the City of Milwaukee, the City encompasses lands along the Lake Michigan shoreline that drain directly into the Lake. Flooding problems within this shoreline area within the City of Milwaukee are relatively minimal due to the presence and placement of existing shoreline protection and other structures there. Accordingly, although the MMSD's current watercourse system plan update efforts include the Lake Michigan tributary drainage area within the MMSD planning area and treat that drainage area as a watershed, this chapter summarizes only the recent flood problem analyses undertaken by the MMSD and others for the five other watersheds involved.

Map 7 graphically sets forth the locations of flood problems identified within the City of Milwaukee under the MMSD's current watercourse system plan update efforts. Where available, the flood damage estimates set forth below were obtained as part of that planning effort. For those areas for which the MMSD has not completed revised damage estimates, the numbers presented are taken from earlier planning efforts.

Kinnickinnic River Watershed

The recommendations set forth in the flood control element of the comprehensive plan for the Kinnickinnic River watershed prepared by SEWRPC and adopted in 1979 by it, by Milwaukee County, and by the City of Milwaukee, endorsed in 1979 by the U.S. Department of Agriculture, Soil Conservation Service (now known as the Natural Resources Conservation Service) and the State Board of Soil and Water Conservation Districts, and amended by SEWRPC in 1987, have been largely implemented by the MMSD. The channel enclosure and realignment along the Edgerton Channel, the major channel modifications along Wilson Park Creek, and the bridge removals and replacements, the channel reconstruction, and dike and floodwall construction along the Kinnickinnic River recommended under the plan have all been implemented. Channel modifications have been implemented along the majority of the length of the perennial streams in the watershed. The Kinnickinnic River main stem has been modified along about 77 percent of its total length.

The demonstrated performance of the modified Kinnickinnic River channel in particular shows the effectiveness of the actions taken by the MMSD and other agencies toward implementation of the flood control plan element of the 1979 plan for the watershed. A channelization project to eliminate the most severe flooding in the watershed, along the Kinnickinnic River between S. 6th Street and S. 16th Street, was completed in 1985. An April 21, 1973, flood, estimated to have a recurrence interval of 60 years, resulted in widespread inundation and damage in this area. Subsequent to the completion of the recommended flood control measures for the area, the intensive rainfall event of August 6, 1986—an event virtually centered on the Kinnickinnic River watershed, and whose 24-hour rainfall was estimated to have a recurrence interval of about 300 years and whose heaviest three-hour rainfall was estimated to have a recurrence interval exceeding 500 years—caused an area of inundation along the same reach that was substantially smaller than the area inundated in the April 1973 storm. Map 12 sets forth a graphic comparison of the areal extent of overland flooding along the Kinnickinnic River between S. 6th Street and S. 16th Street in the 1973 event with the areal extent of the overland flooding along that reach in the 1986 event. The significant areal difference may be attributed to the proper performance of the channel improvements. It is clear that the flood control improvements functioned as designed to significantly reduce flood damages in the August 1986 storm, and serve to eliminate damages from floods up to and including the 100-year recurrence interval flood.

In the MMSD's current effort to update its 1990 watercourse system plan, the analysis conducted to predict watercourse system flows and water levels in the Kinnickinnic River watershed utilized a set of computer tools to evaluate a range of rainfall events and land use conditions. These tools were used to represent the watershed in terms of land use, slope, river geometry, bridges, wetlands, and other natural and built storage areas. The analysis involved two distinct computer-modeling tasks. The hydrologic analysis used software developed by the U.S. Environmental Protection Agency called Hydrological Simulation Program-Fortran (HSPF) and predicted streamflows based on 58 years of rainfall and two sets of land use conditions—existing land use conditions and expected 2020 land use conditions. Streamflows were developed for the 1 percent probability event (the "100-year event") for both sets of land use conditions. The hydraulic analysis used software developed by the U.S. Army Corps of Engineers called Hydrologic Engineering Center-River Analysis System (HEC-RAS) and determined maximum flood elevations based on the streamflows developed from the hydrologic analysis.

Estimates of 100-year flows were produced for key locations throughout the watershed. The results of the analysis show that peak flows along the Kinnickinnic River under expected 2020 land use conditions are expected to remain constant or increase only very slightly over current peak-flow levels. As previously noted, the watershed is currently 95 percent developed and, accordingly, significant or widespread future flow increases are not expected. However, peak flows from a one-square-mile area east of General Mitchell International Airport, outside the City of Milwaukee, are predicted to increase by nearly 30 percent by the year 2020.

Water-surface elevations were projected along the major watercourses under MMSD jurisdiction in the watershed. Under the analysis, no structures were predicted to be damaged along the main stem of the Kinnickinnic River under expected 2020 land use conditions. As noted above, much of the River's main stem has been channelized and lined with concrete to reduce flooding risk in areas that were historically prone to flooding. The main stem of

Map 12

AREAL EXTENT OF OVERLAND FLOODING ALONG THE KINNICKINNIC RIVER BETWEEN S. 6TH STREET AND S. 16TH STREET IN THE CITY OF MILWAUKEE: APRIL 1973 AND AUGUST 1986

Source: SEWRPC.

the River between S. 6th Street and S. 16th Street was designed to operate under complex and potentially unstable supercritical flow conditions. Even after implementation of the modifications completed in this reach as of 1985, which included the removal of nine roadway bridges over the River and the replacement of four others, the four existing roadway bridges over this reach are key components with regard to the hydraulic performance of the reach. The clearance between the bottoms of these bridges and the predicted water-surface elevations is minimal and could be nonexistent under certain hydraulic conditions. Under such conditions, the water-surface elevations could increase dramatically, potentially flooding adjacent structures. The potential for damage and possible structural improvements in this reach were recommended to be evaluated in the MMSD's advanced stage of its current planning effort. In 2002, the findings of that evaluation indicated that sufficient clearance would exist for floods up to, and including, the 100-year recurrence interval event. Therefore, no further structural improvements are recommended for this reach.

Several significant erosion, sedimentation, and local storm sewer outfall damage problems have been identified at the upstream end of the Kinnickinnic River, in the Cities of Milwaukee and West Allis. These problems are currently being addressed by a $1 million streambank and shoreline protection project which the U.S. Army Corps of Engineers has agreed to undertake with cooperation from the MMSD and Milwaukee County. The project is being undertaken to repair significant streambank erosion and damage to public infrastructure that have occurred along the River between W. Forest Home Avenue and S. 60th Street. The Corps will provide about 65 percent of the project cost, with the MMSD providing the remaining 35 percent. The study and design stages of the project have been completed, with construction scheduled for 2003.

In its analysis of flooding problems in the Kinnickinnic River watershed, the MMSD has identified several problem areas along the tributaries of the watershed. No structures along the main stem of the Kinnickinnic River are predicted to suffer flood damage, but limited structure flooding is predicted along certain tributaries under expected 2020 land use conditions and the 100-year flood event. The analysis also projected water-surface elevations along the major watercourses in the watershed that are under MMSD jurisdiction. The water-surface elevations predicted for the 100-year flood event under expected 2020 land use conditions were compared to structure-water-entry elevations for adjacent development to estimate the damages that would occur from this type of event.

Damages from the 100-year event are predicted only along three tributary streams in the Kinnickinnic River watershed under expected 2020 land use conditions and were originally estimated at about $1.2 million, of which about $0.8 million are in the City of Milwaukee. Two of the three general areas of predicted structure damage from such an event are located wholly or partly within the City of Milwaukee—one in the Lyons Park Creek subwatershed, located wholly within the City, and one in the Villa Mann Creek and Villa Mann Creek Tributary subwatershed, located partly in the City of Milwaukee and partly in the City of Greenfield. A total of 25 structures, 21 residential and four commercial, in the two areas would be expected to be flooded during the 100-year event.

In the Lyons Park Creek subwatershed, 22 problems were identified on Lyons Park Creek at three stream crossings, one at S. 57th Street, one at W Stack Avenue, and one at W. Cleveland Avenue, involving the flooding of 20 residential structures and two commercial structures.

On the Villa Mann Creek and the Villa Mann Creek Tributary, one problem area was identified in the vicinity of S. 27th Street and W. Bottsford Avenue, where the Villa Mann Creek Tributary enters enclosed box culverts that extend 1,350 feet east to the confluence with Villa Mann Creek. Three structures, one residential and two commercial, were identified as being vulnerable to flood damage during the 1 percent probability event. One of the three structures, a hotel, is located within the City of Milwaukee, east of S. 27th Street; the remaining two structures are located within the City of Greenfield, west of S. 27th Street.

The remaining flooding problem area identified within the Kinnickinnic River watershed in the MMSD's current planning effort involves one industrial structure located in the Village of West Milwaukee near the 43rd Street Ditch, upstream of the portion of the 43rd Street Ditch subwatershed located in the City of Milwaukee. The

MMSD's planning effort has also identified three additional issues pertaining to the 43rd Street Ditch as warranting investigation in the advanced stage of the planning effort: 1) reported erosion of the channel banks, potential sedimentation at the bottom of the ditch, and overgrowth of woody vegetation in the ditch; 2) significant potential for redevelopment in the area that could require improvements to the ditch or offer opportunity for stormwater detention; and 3) long-range plans by the City of West Allis to increase the capacity of the primary sewer drain that acts as the "headwaters" for the ditch.

No flooding problems were identified on Wilson Park Creek. As in the case of the Kinnickinnic River main stem, areas of Wilson Park Creek that were previously susceptible to flooding have been modified by widening and deepening.

Menomonee River Watershed

Following its initial preparation and its 1977 adoption by SEWRPC, the watershed plan for the Menomonee River watershed was adopted or endorsed by Milwaukee, Ozaukee, Washington, and Waukesha Counties, the City of West Allis, and several concerned State and Federal agencies, and in 1979 and 1987 was amended by SEWRPC. While significant progress toward implementation of the land use element of the watershed plan has been achieved with respect to 1) the preservation of the wetlands and floodlands lying within the primary environmental corridors located along the major stream channels of the watershed and 2) the location and density of new urban development within the watershed undertaken since 1977, the structural flood control measures recommended under the plan have not been implemented. However, recent new development in the Menomonee Valley industrial area in the City of Milwaukee has been placed on fill at elevations that will provide for flood protection.

In the MMSD's current effort to update its 1990 watercourse system plan, the analysis conducted to predict watercourse system flows and water levels in the Menomonee River watershed utilized a set of computer tools to evaluate a range of rainfall events and land use conditions. These tools were used to represent the watershed in terms of land use, slope, river geometry, bridges, wetlands, and other natural and built storage areas. The analysis involved two distinct computer-modeling tasks. The hydrologic analysis used the HSPF software and predicted streamflows based on 58 years of rainfall storm input and several sets of land use conditions. Streamflows were developed for the 1 percent recurrence interval event (the "100-year event") for existing land use conditions, expected 2020 land use conditions, and "ultimate" conditions. The hydraulic analysis, which used the HEC-RAS software, determined maximum flood elevations based on the streamflows developed from the hydrologic analysis. The HSPF and HEC-RAS computer models were calibrated and verified using recent rainfall, flow, and flood-stage data for the watershed.

Estimates of 100-year flows were produced for key locations throughout the watershed. The results of the analysis show that flow contributions are made by all the watercourses and tributaries in the watershed, with major flow inputs from the Menomonee River main stem upstream of Underwood Creek and from Underwood and Honey Creeks. These major flow inputs contribute significantly to observed flooding problems in the Hart Park area in the City of Wauwatosa and the Valley Park area in the City of Milwaukee.

As previously discussed, flows are not expected to increase significantly within the City of Milwaukee portion of the watershed where major damages would occur. Increases of 15 to 20 percent in the 100-year event discharge is anticipated along that portion of the main stem in the City of Milwaukee where it parallels the border between Milwaukee and Waukesha Counties. No structural flood problems are identified along this reach, however. The analysis also projected estimated water-surface elevations along the major watercourses in the watershed. The water-surface elevations predicted for the 100-year flood event under expected 2020 land use conditions were compared to structure-water-entry elevations for adjacent development to estimate the damages that would occur from this type of event.

Damages in Milwaukee County from the 100-year event are predicted to be concentrated along the Lower Wauwatosa and Valley Park neighborhood reach of the Menomonee River under expected 2020 land use conditions. Damages along the watercourses under MMSD jurisdiction within the Milwaukee County portion of

the watershed arising from this event are estimated to total about $10.6 million, with damages within the City of Milwaukee estimated to total about $5.6 million. In addition to the predicted damages in the Lower Wauwatosa and Valley Park neighborhood reach of the Menomonee River, damage occurring as a result of the 100-year flood event under expected 2020 land use conditions is also predicted to occur along several tributaries in the watershed, as described below.

The problems and damages associated with the main stem of the Menomonee River within Milwaukee County are the result of a combination of development constructed at a relatively low elevation compared to the River; limited capacities of certain roadway crossings; and years of development without any form of runoff control. In addition to these flooding problems, significant erosion and sedimentation was observed along a number of reaches of the watercourses.

The initial MMSD analysis found that a total of 256 structures along the main stem of the Menomonee River could be expected to suffer damage arising from the 100-year flood event under expected 2020 land use conditions, with the damages mainly located in the Hart Park area of the City of Wauwatosa, the west central portion of the City of Milwaukee, and the Valley Park neighborhood in the City of Milwaukee. Of these 256 structures, 162 are located within the City of Milwaukee. Refined analyses made under the MMSD advanced planning stage have updated the number of structures in the City of Milwaukee to 183—152 residential and 31 commercial and industrial. Furthermore, in 2001, the MMSD completed work on a levee system for the Valley Park neighborhood. As a result, 139 of the 183 structures, all residential, are now protected from floods up to, and including, the 100-year recurrence interval event.

The portion of the Little Menomonee River subwatershed included within MMSD boundaries is also located entirely within the City of Milwaukee. This portion of the subwatershed was evaluated to identify flooding problems and potential solutions to observed flooding problems. The portion of the subwatershed located in Ozaukee County is currently being analyzed as part of a separate analysis of flooding problems along the main stem of the Menomonee River and its tributaries outside of Milwaukee County. The local communities involved have offered to cooperate with the MMSD to examine this portion of the watershed in order to help develop a comprehensive watershed plan for the Menomonee River. Within the portion of the Little Menomonee River subwatershed located in the City of Milwaukee, one residential structure was identified as being potentially subject to damage arising from the 100-year event on the Little Menomonee River under expected 2020 land use conditions. The structure presents an isolated problem that does not cost-effectively lend itself to structural solutions.

To determine if any potential flooding solutions on Grantosa Creek would complement or enhance potential solutions on the main stem of the Menomonee River, the MMSD conducted a preliminary analysis of Grantosa Creek, whose drainage area includes portions of the Cities of Milwaukee and Wauwatosa. This preliminary analysis identified seven structures vulnerable to damage arising from the 100-year flood event on Grantosa Creek under expected 2020 land use conditions. Three of these structures were located in the City of Milwaukee. In 2001, the MMSD completed work on a 58 acre-foot dry detention basin at Timmerman Airport at the headwater of Grantosa Creek. As part of the advanced planning carried out by the MMSD, analyses were also carried out to determine if any residual flooding would occur once the detention basin was completed. That analysis included field-surveying structure elevations and concluded that four structures, all in the City of Wauwatosa, would continue to be subject to flooding. No structures were identified in the City of Milwaukee.

With regard to the significant existing flooding problems in the Underwood Creek subwatershed, SEWRPC has developed a plan to address problems lying in the City of Brookfield and Village of Elm Grove. Although a small portion of this subwatershed lies within the City of Milwaukee, no flooding problem areas lying within both the subwatershed and the City were identified by the MMSD. A recommendation for the subwatershed developed under the SEWRPC effort, envisioning storage, an overflow channel, and floodproofing or acquisition of various structures, is designed specifically to cause no increases in downstream flood flows and stages. The MMSD has continued an ongoing coordination process with SEWRPC in the development of its potential solutions for

flooding problems along Underwood Creek, with the intent of integrating the final solution into the MMSD-selected alternative for mitigating flooding problems along the main stem of the Menomonee River.

The Honey Creek subwatershed, which extends south from the main stem of the Menomonee River and contributes major flows to the River, was analyzed to determine if any potential solutions to its flooding problems might be combined with or contribute to potential solutions to flooding problems on the main stem of the Menomonee River. However, a review of potential complementing solutions did not yield any integrated solutions that appeared feasible. Eight structures, all located in the City of Greenfield, were identified as being vulnerable to damage arising from the 100-year event under expected 2020 land use conditions on Honey Creek. There are no flooding problems located along this stream in the City of Milwaukee.

No flooding problems were identified in the Woods Creek subwatershed, and thus no structural alternatives were considered for that subwatershed.

Milwaukee River Watershed

Following its initial preparation and its 1972 adoption by SEWRPC, the watershed plan for the Milwaukee River watershed was adopted or endorsed by Milwaukee, Ozaukee, Sheboygan, and Washington Counties, the Milwaukee County Park Commission, the City of Milwaukee and the City of Milwaukee Board of Harbor Commissioners, the Villages of Newburg, River Hills, and Saukville, the Town of Fredonia, and several concerned State and Federal agencies, and was amended by SEWRPC in 1979, 1983, and 1987. The 1983 amendment set forth a detailed flood control plan for Lincoln Creek. The MMSD has also had private consultants prepare three further flood control planning studies for Lincoln Creek, completed, respectively, in 1987, 1993, and 1996.

The 1990 system plan prepared for the MMSD by SEWRPC reflected recommendations set forth in a 1986 stormwater drainage and flood control policy plan identifying the streams and other watercourses for which it was recommended that the MMSD assume responsibility for flood control. This policy plan, also prepared for the MMSD by SEWRPC, was adopted by the MMSD, by Milwaukee County, and by the City of Milwaukee. As detailed in Chapter III of this report, other municipalities in the Milwaukee area have also adopted the 1986 policy plan, some doing so conditionally. While the policy plan did not place the main stem of the Milwaukee River within the jurisdiction and responsibility of the MMSD, the plan did, however, include within that jurisdiction and responsibility all or portions of the Beaver Creek, Brown Deer Park Creek, Indian Creek, Lincoln Creek, and Southbranch Creek tributaries of the Milwaukee River.

With respect to the flood control element of SEWRPC's Milwaukee River watershed plan, the 1990 system plan prepared for the MMSD by SEWRPC, in addition to setting forth refinements to the plan for Lincoln Creek, extended flood control analyses and recommendations to four major tributaries of the Milwaukee River in Milwaukee County: Beaver Creek, Brown Deer Creek, Indian Creek, and Southbranch Creek. The Indian Creek subwatershed is located entirely outside the City of Milwaukee. No significant damages have been identified for Brown Deer Park Creek. Damages along Beaver Creek are also minor and are located downstream of the City of Milwaukee in the Village of Brown Deer. Consequently, these three tributaries are not discussed further.

Relevant studies and planning efforts conducted since the completion and adoption of the 1972 plan for the Milwaukee River watershed have highlighted specific problem areas on the tributaries to the River. Most significantly with regard to the MMSD's current flood mitigation planning effort, the most severe flooding problem areas identified in the watershed in these studies and efforts include the Lincoln Creek subwatershed area in the City of Milwaukee, where 1,642 structures were located in the flood hazard area, and the Southbranch Creek subwatershed area located predominantly in the Village of Brown Deer, where about 22 structures were located within the flood hazard area. A portion of the Southbranch Creek subwatershed that experiences flooding problems does lie within the City of Milwaukee. That reach, however, is located upstream of the MMSD jurisdiction and has not, to date, been analyzed in detail. Those problems are mainly due to drainage and sanitary sewer backup.

A detailed plan for Southbranch Creek, prepared for the MMSD in 1998 by a private consultant, presents alternatives that are considered a refinement of the recommendations set forth in the 1990 system plan prepared for the MMSD by SEWRPC. The recommended plan for Southbranch Creek was completed in 2001 by the MMSD, resulting in protection of identified floodprone structures up to the 100-year recurrence interval event.

In addition, detailed design work was also undertaken by the MMSD toward implementing the recommended Lincoln Creek project. That project represents a refinement of the alternatives developed under the 1990 system plan prepared for the MMSD by SEWRPC, except that the current project includes an additional component providing for the removal of existing channel lining along two reaches of the stream. In mid-2002, that project was essentially completed. As a result, all 1,642 structures identified as being in the Lincoln Creek floodplain are now protected from floods up to, and including, the 100-year recurrence interval event.

Oak Creek Watershed

Following its preparation and its 1986 adoption by SEWRPC, the watershed plan for the Oak Creek watershed was adopted by the Milwaukee County Board of Supervisors, the MMSD, and the City of Milwaukee, as well as by the Cities of Cudahy, Franklin, and South Milwaukee. The plan has also been adopted or endorsed by several concerned State and Federal agencies. The Cities of Greenfield and Oak Creek did not act to adopt the plan.

Relatively little has been done with respect to implementing the flood control recommendations set forth in the plan. However, the City of Oak Creek, during 1997 and 1998, initiated steps to update its comprehensive floodplain zoning and began the preparation of a citywide stormwater management plan. With regard to zoning, the City has worked cooperatively with SEWRPC to update its floodplain maps for the Oak Creek watershed with the intention of using the updated mapping as the basis for the purposes of updating the floodplain zoning. Significant progress toward implementation of the land use element of the watershed plan has been achieved, however, both with respect to preservation of the wetlands and floodlands lying within the primary environmental corridors located along the major stream channels of the watershed and with respect to the location and density of new urban development undertaken within the watershed since 1986, the year SEWRPC adopted the plan. The plan has not been amended since its completion and adoption.

The 1990 stormwater drainage and flood control system plan prepared for the MMSD by SEWRPC, basically reaffirmed the flood control recommendations set forth in the adopted Oak Creek watershed plan. As noted above, the 1990 system plan reflected recommendations contained in a 1986 policy plan identifying the streams and watercourses for which the MMSD was recommended to assume responsibility for flood control.

In the MMSD's current effort to update its 1990 watercourse system plan, the analysis conducted to predict watercourse system flows and stages in the Oak Creek watershed utilized a set of computer tools to evaluate a range of rainfall events and land use conditions. These tools were used to represent the watershed in terms of land use, slope, river geometry, bridges, wetlands, and other natural and built storage areas. The analysis involved two distinct computer-modeling tasks. The hydrologic analysis used the HSPF software and predicted streamflows based on 58 years of rainfall and two sets of land use conditions 1) existing land use conditions and 2) expected 2020 land use conditions without any uniform or effective detention associated with the new development. Streamflows were developed for the 1 percent recurrence interval event (often called the "100-year event") for both sets of land use conditions. The hydraulic analysis used the HEC-RAS software and determined maximum flood elevations based on the streamflows developed from the hydrologic analysis.

The results of the flow analysis show that flows in the watershed generally increase by as much as 50 percent under the envisioned year 2020 land use conditions. The use of the 2020 land use condition without detention criteria is a conservative approach that produces somewhat conservative results. However, this approach is consistent with systemwide planning efforts by both the MMSD and SEWRPC. The analysis results thus far show the need to preserve existing natural storage in the Oak Creek watershed.

Damages along watercourses under MMSD jurisdiction within the Oak Creek are estimated at about $1.5 million for a 100-year flood event, of which about $500,000 would occur in the City of Milwaukee. The MMSD's initial

Phase 1 system planning analysis identified two areas located both within the City of Milwaukee and within the Oak Creek watershed as flood problem areas under expected 2020 land use conditions without any storage to accommodate new development: 1) an area in the vicinity of the intersection of S. 13th Street and W. College Avenue where four structures—one commercial, two industrial, and one residential—are expected to suffer damage arising from the 1 percent recurrence interval rainfall event along the Upper North Branch of Oak Creek and 2) an area in the southern portion of General Mitchell International Airport where three governmental structures are expected to suffer damage arising from the 1 percent recurrence interval rainfall event along the Mitchell Field Drainage Ditch. The airport's main north-south runway would be overtopped during a 1 percent recurrence interval storm.

The individual flooding problems identified in the Oak Creek watershed are limited in number and are scattered throughout the watershed. The causes of these problems are generally related to the limited capacity of the Creek combined with the relatively low elevations of the structures vulnerable to flood damage—elevations that are conducive to the flooding of those structures. The limited nature of the problems, with only a few structures within each identified flood problem area, also limits the cost-effectiveness of major structural solutions that would reduce flows or provide additional capacity. The widespread geographic distribution of the problems does not offer the opportunity for regional or watershedwide structural solutions to effectively reduce flood damages. The conditions involved indicate that the most cost-effective methods of flood mitigation within the watershed would be localized and structure-specific, as opposed to methods involving regional flood control storage facilities or major channel modifications.

A number of local storm sewers have been identified in the watershed as being "low" relative to the invert of Oak Creek or its tributaries. High stages on Oak Creek during major rainfall events typically cause surcharging of these storm sewers, which may contribute to local drainage problems away from the Creek. Three such sewers have been identified in the vicinity of the identified flood problem area near S. 13th Street and W. College Avenue. The initial phase of the MMSD's current planning effort for the Oak Creek watershed did not include any investigation of the problems that may be associated with this condition or the potential solutions that may be appropriate, if significant problems exist. During the second, advanced planning stage, the MMSD has evaluated these low storm sewer problems, in addition to conducting field surveys of potential structure flooding. As a result of this evaluation, the number of structures identified as subject to flooding along the North Branch of Oak Creek,, has been revised to five—three industrial and two residential. Additional alternative means of alleviating this flooding were also evaluated, as presented in Chapter V.

Existing topography in the watershed is relatively flat. Filling of the existing natural storage areas, such as wetlands, lowlands, and floodplains, is recommended to be prohibited to prevent potential increases in flow within the watershed.

Root River Watershed

No significant flood problem areas within those portions of the Root River watershed located within the City of Milwaukee have been identified by either the MMSD or by SEWRPC in their respective planning efforts. No identified flood problem areas within the watershed are located directly upstream of those portions of the watershed located within the City. Therefore, although the Root River watershed has been included in whole or in part in recent and current flood control planning efforts, including efforts undertaken by the MMSD and SEWRPC, the watershed is outside the scope of this report.

Chapter V

ALTERNATIVE FLOOD MITIGATION STRATEGIES

Floodland management may be defined as the planning and implementation of a combination of measures intended to reconcile the floodwater conveyance and storage function of floodlands with the space needs and other socioeconomic needs of a resident population. Specific purposes of floodland management include elimination of loss of life, lessening of danger to human health and safety, minimization of monetary damage to private and public property, reduction in the cost of utilities and services, and minimization of disruption in community affairs. Floodland management also involves the avoidance of intensification of existing and creation of new flood hazards. A broader goal is the enhancement of the overall quality of life of residents of the area involved by protection of those environmental values—recreational, aesthetic, ecological, and cultural—normally associated with, and concentrated in, riverine areas.

The preparation of a flood mitigation plan for the City of Milwaukee involves the development of alternative plan elements, a comparative evaluation of those elements, and the synthesis of the most effective elements into an integrated plan. The evaluation of alternative plans was prepared as part of a system-level planning program using logical subwatershed areas as a planning area. Thus, in some cases, the alternatives consider flooding areas which cover areas beyond the City of Milwaukee, but within such subwatershed areas.

GENERAL DESCRIPTION OF POTENTIAL FLOOD MITIGATION STRATEGIES

Floodland management techniques may be broadly divided into two categories—structural measures and nonstructural measures. Structural measures include floodwater storage facilities such as reservoirs and impoundments; diversion facilities such as dikes and channels; floodwater containment facilities such as earthen dikes and concrete floodwalls; floodwater conveyance facilities, such as channel modifications; and bridge and culvert modifications or replacements. Nonstructural measures include reservation of floodlands for conservation, recreation, and other open space uses; floodland use regulations; land use controls outside the floodlands; structure floodproofing and elevation; structure removal; channel maintenance; community education programs; flood insurance; lending institution policies; real-estate-agent policies; community utility policies; and emergency programs. Structural measures tend to be more effective in achieving the objectives of floodland management in riverine areas that have already been urbanized, while nonstructural measures, being preventive, are generally more effective in riverine areas that have not yet been converted to flood-damage-prone development, even in cases where such areas have the potential for such development.

Table 9 lists the alternative structural and nonstructural floodland management measures that may potentially apply, individually or in combinations, to the stream network within the City of Milwaukee, and summarizes the function of each. Further information regarding 1) the functions, 2) the key factors or basic requirements used to determine if a given alternative applies to a particular riverine area or portion of a watershed, and 3) some of the

Table 9

ALTERNATIVE FLOODLAND MANAGEMENT MEASURES CONSIDERED IN PREPARING THE FLOOD MITIGATION PLAN FOR THE CITY OF MILWAUKEE

Alternative		Function(s)	Comments
Major Category	Name		
Structural	Storage	To detain floodwaters upstream of floodprone reaches for subsequent gradual release	May be accomplished by on-channel reservoirs or by off-channel or underground storage
	Diversion	To divert waters from a point upstream of the floodprone reaches and discharge to an acceptable receiving watercourse outside of the watershed, or to divert floodwaters around floodprone areas on a completely new alignment	May entail legal problems
	Dikes and floodwalls	To prevent the occurrence of overland flow from the channel to floodland structures and facilities	--
	Channel modification and enclosure	To convey flood flows through a river reach at significantly lower stages	May be accomplished by straightening, lowering, widening, and otherwise modifying a channel or by enclosure; includes construction of a new length of channel for the purpose of bypassing a reach of a natural stream. This option normally requires environmental enhancement measures as a component to mitigate any negative environmental impacts
	Bridge and culvert alteration or replacement	To reduce the backwater effect of bridges and culverts	May be accomplished by increasing the waterway opening or otherwise substantially altering the crossing or by replacing it
Nonstructural	Reservation of floodlands for recreational and related open space uses	To minimize flood damage by using floodlands for compatible recreational and related open space uses and also to retain floodwater storage and conveyance	May be accomplished through private development, such as development of a golf course, or by public acquisition of the land or by use of an easement
	Floodland regulations	To control the manner in which new urban development is carried out in the floodlands so as to assure that it does not aggravate upstream and downstream flood problems, or to control selected practices by which existing urban or rural lands are managed	May be accomplished through zoning, land subdivision control, sanitary, and building ordinances
	Control of land use outside of the floodlands	To control the manner in which urban development occurs outside of the floodlands so as to minimize the hydrologic impact on downstream floodlands	--
	Community education programs	To inform and educate citizens regarding personal and private actions by property owners and residents which 1) may adversely affect flood flows and stages or 2) could favorably affect or prevent changes in flood flows and stages in the watershed	May have relationship to aesthetic, recreational, urban utility, or water quality aspects of water resources management in the watershed

Table 9 (continued)

Alternative		Function(s)	Comments
Major Category	Name		
Nonstructural (continued)	Flood insurance	To minimize monetary loss or reduce monetary impact on structure owner	Premiums may be subsidized or actuarially determined
	Lending institution policies	To discourage acquisition or construction of floodprone structures by means of mortgage-granting procedures	--
	Real-estate-agent policies	To discourage acquisition or construction of floodprone structures by providing flood hazard information to prospective buyers	--
	Community utility policies	To discourage construction in floodprone areas by controlling the extension of utilities and services	--
	Emergency programs	To minimize the danger, damage, and disruption from impending flood events	May include installation of remote stage sensors and alarms, road closures, and evacuation of residents
	Structure floodproofing and elevation	To minimize damage to structures by applying a combination of protective measures and procedures on a structure-by-structure basis	--
	Structure removal	To eliminate damage to existing structures by removing them from floodprone areas	--
	Channel maintenance	To maintain integrity of flood-stage profiles; to permit unobstructed flow from storm sewers, drainage ditches, and drainage tiles; and to remove potentially troublesome buoyant material	Will not significantly reduce stages of major floods, except as those stages might be influenced by accumulation of buoyant material on the upstream side of bridge waterway openings

Source: SEWRPC.

more significant positive and negative features of each alternative potential flood mitigation strategy involved is set forth in the series of watershed plans prepared by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). In the evaluation of alternative measures, the comprehensive watershed planning program gives priority to those nonstructural measures, such as floodplain open space preservation and regulation, which are preventative in nature. Beyond that, each alternative to be considered must have been shown at the systems level of planning to be technically feasible and economically and environmentally sound. The determination of technical feasibility should be based upon analyses, preferably hydrologic and hydraulic simulation model studies such as those conducted for this plan. Those analyses should clearly indicate that the proposed project will achieve the reductions in peak flood flows or peak flood stages, or both, that are necessary to abate the flood damages concerned without exacerbating such problems either upstream or downstream of the proposed project.

The alternative should be shown to be economically sound by benefit-cost analysis. While such analysis applied in the classic manner would require that the benefit-cost ratio of a project be greater than one, it must be recognized that other objectives which cannot be directly quantified monetarily, such as providing adequate outlets for municipal stormwater sewers or abating public health and safety hazards resulting from the backup of sanitary sewers surcharged by floodwaters into basements of buildings, may make it politically desirable to construct a project having a benefit-cost ratio of less than one.

The alternatives should be shown at the systems level of planning to be environmentally sound by explicit consideration of potential impacts on surface-water and groundwater quality and existing and potential aquatic and wildlife habitats and populations. An alternative must qualify for all legally required regulatory agency approvals. Other criteria, such as potential long-term operational maintenance requirements; implementability; compatibility with community open space, recreation, and environmentally sensitive area protection objectives; compatibility with community development objectives; aesthetics; and public support are among the other factors considered in alternative evaluation and selection.

COMPREHENSIVE WATERSHED PLAN PREPARATION

Historically, the watershed has served as the geographic basis for the preparation of comprehensive plans dealing with flooding problems in Southeastern Wisconsin. As noted in Chapter III of this report, SEWRPC, as part of its continuing planning program for the seven-county Southeastern Wisconsin Region, has prepared and adopted comprehensive plans for the five watershed areas that lie partly within the City of Milwaukee. As noted in Chapter II of this report, among the five watersheds involved, the Root River watershed has not presented and does not present any significant flooding problems within the City of Milwaukee, and flooding problems within that portion of the Lake Michigan direct drainage area located within the City are relatively minimal.

In preparing each of the four watershed-level plans that do apply to flood problems within the City of Milwaukee, SEWRPC, as summarized below, considered a broad range of potential alternative flood mitigation strategies in various combinations, their applicability to specific flooding problems in the watershed involved, and their costs and benefits before selecting a recommended combination of flood mitigation strategies for the final recommended watershed plan. More detail on each alternative plan described below can be found by review of the specific plans for each watershed as listed in the references set forth in Appendix D.

Alternative Flood Mitigation Strategies for the Kinnickinnic River Watershed
In 1979, SEWRPC adopted a comprehensive plan for the physical development of the Kinnickinnic River watershed, amending that plan in 1987. In the preparation of the initial watershed plan, SEWRPC made a concerted effort to offer for public evaluation a full range of physically feasible alternative plan subelements which might resolve water resource and water resource-related problems existing at the time of the preparation of the plan and prevent future development of such problems within the framework of agreed-upon watershed development objectives and supporting standards. Each alternative floodland management subelement was evaluated insofar as possible in terms of technical and economic feasibility, likely environmental impact, financial and legal feasibility, and public acceptability, as well as with respect to the satisfaction of the watershed development objectives.

A total of five structural floodland management measures were identified for possible application, either individually or in various combinations, to specific floodprone reaches of the watershed: 1) floodwater storage facilities, 2) floodwater diversion facilities, 3) dikes and floodwalls, 4) major channel modifications, and 5) bridge and culvert modification or replacement. A total of 11 nonstructural measures were likewise identified for possible inclusion in the floodland management element of the watershed plan: 1) reservation of floodlands for recreational and related open space uses, 2) floodland regulations, 3) control of land use outside the floodlands, 4) structure floodproofing, 5) structure removal, 6) channel maintenance, 7) flood insurance, 8) lending institution policies, 9) real-estate-agent policies, 10) community utility policies, and 11) emergency programs.

In addition to a determination of the applicability of the various structural and nonstructural floodland management measures considered for the watershed, the plan preparation process included an examination of accessory floodland management measures that could meet special needs within the watershed. Accessory floodland management measures that were considered at the time of initial plan preparation included the maintenance of streamflow gages in the watershed, the periodic cleaning and maintenance of the channel system, and the identification of the flood characteristics of the estuary and lower reaches of the Kinnickinnic River.

SEWRPC's 1987 amendment to the watershed plan, contained in a water resources management plan for the Milwaukee Harbor estuary, included a revision of the regulatory 100-year flood profile and regulatory floodplain boundary for the Kinnickinnic River estuary.

Alternative Flood Mitigation Strategies for the Menomonee River Watershed

SEWRPC adopted a comprehensive plan for the physical development of the Menomonee River watershed in 1977, amending that plan in 1987. As with the Kinnickinnic River watershed plan, SEWRPC, in preparing the initial Menomonee River watershed plan, made a concerted effort to offer for public evaluation a full range of physically feasible alternative plan subelements which might resolve water resource and water resource-related problems existing at the time of the preparation of the plan and prevent future development of such problems within the framework of agreed-upon watershed development objectives and supporting standards. Each alternative plan subelement was evaluated insofar as possible in terms of technical and economic feasibility, likely environmental impact, financial and legal feasibility, and public acceptability, as well as with respect to the satisfaction of the watershed development objectives.

As in the case of the preparation of the plan for the Kinnickinnic River watershed, a number of alternatives were explored in the preparation of the floodland management element of the Menomonee River watershed plan. The available floodland management measures from which the floodland management element of the plan was synthesized under the watershed planning process include both structural and nonstructural measures. A total of five structural measures were identified for possible application, either individually or in various combinations, to specific floodprone reaches of the watershed: 1) floodwater storage facilities, 2) floodwater diversion facilities, 3) dikes and floodwalls, 4) major channel modifications, and 5) bridge and culvert modification or replacement. Ten nonstructural measures were likewise identified for possible inclusion in the floodland management element of the plan: 1) reservation of floodlands for recreational and related open space uses, 2) floodland regulations, 3) control of land use outside of the floodlands, 4) flood insurance, 5) lending institution policies, 6) real-estate-agent policies, 7) community utility policies, 8) emergency programs, 9) structure floodproofing and elevation, and 10) structure removal.

Various combinations of structural and nonstructural management measures were evaluated for each of the most floodprone reaches in the watershed, resulting in the selection of a compatible combination of measures for each reach for inclusion in the final recommended watershed plan. Also included in the development of the floodland management element of the watershed plan was an analysis of the impact of possible future land use and floodland development conditions in the watershed on flood flows, flood stages, and flood damages along the watershed stream system. In addition, the plan preparation process included an examination of accessory floodland management measures to meet special needs within the watershed. Accessory measures considered at the time of initial plan preparation included the maintenance of a skeleton stream-gaging network in the watershed, the periodic cleaning and maintenance of the channel system and bridge and culvert waterway openings, and means of resolving the residual flood damage problem then existing within and immediately upstream of the Menomonee River industrial valley.

SEWRPC's 1987 amendment to the watershed plan, contained in a water resources management plan for the Milwaukee Harbor estuary, included a revision of the regulatory 100-year flood profile and regulatory floodplain boundary for the Menomonee River estuary and the Menomonee Valley area.

Alternative Flood Mitigation Strategies for the Milwaukee River Watershed

SEWRPC adopted a comprehensive plan for the physical development of the Milwaukee River watershed in 1972, amending that plan in 1983 and 1987. In preparing the initial Milwaukee River watershed plan, SEWRPC made a concerted effort to offer for public evaluation all physically feasible alternative plan elements, which might satisfy one or more watershed development objective. Each alternative plan element was evaluated insofar as possible in terms of engineering, economic, and legal feasibility and with respect to the satisfaction of watershed development objectives. The alternative plan elements considered can best be conceptualized in terms of various combinations of land use patterns and water control facilities.

As in the preparation of the plans for the Kinnickinnic River and Menomonee River watersheds, a number of alternatives were explored in the preparation of the Milwaukee River watershed plan with respect to flood control. The flood control measures considered include both structural and nonstructural measures: 1) floodland zoning and the acquisition of floodland areas for public park, parkway, and open space use; 2) dike and floodwall construction and channel improvements; 3) diversion channel construction; 4) reservoir construction; 5) structure floodproofing; and 6) structure removal.

Each of the alternative plan elements considered was evaluated individually and in various compatible combinations, and a comprehensive watershed plan was synthesized. The basic flood control element of the initial comprehensive plan for the Milwaukee River watershed is nonstructural, consisting of the land use development proposals contained in the land use element of the watershed plan, particularly as those land use proposals affect the riverine areas of the watershed. Of particular importance in this respect are the land acquisition recommendations made under the watershed plan for the preservation of environmental corridor lands within the watershed. No structural water control facilities were included under the recommendations set forth in the Milwaukee River watershed plan.

In preparing its 1983 amendment to the Milwaukee River watershed plan, a detailed flood control plan for Lincoln Creek, SEWRPC considered a series of alternatives for that tributary, including both structural and nonstructural measures. These measures, either individually or in combination, included: 1) both major and minor channel modification; 2) detention storage; 3) dike and floodwall construction; 4) structure floodproofing elevation, and removal; and 5) replacement of selected bridges.

SEWRPC's 1987 amendment to the Milwaukee River watershed plan, contained in a water resources management plan for the Milwaukee Harbor estuary, included a revision of the regulatory 100-year flood profile and regulatory floodplain boundary for the Milwaukee River estuary.

Alternative Flood Mitigation Strategies for the Oak Creek Watershed

SEWRPC adopted a comprehensive plan for the physical development of the Oak Creek watershed in 1986. This watershed plan was prepared within the context of a set of regional plan elements existing and adopted at the time of the preparation of the watershed plan, including, importantly, regional land use, regional park and open space, and regional water quality management plans. Accordingly, the major focus of the watershed plan preparation effort was on floodland management and fishery development plan elements. The land use and park and open space element of the watershed plan constituted a refinement of the adopted regional land use and regional park and open space plans. The water quality management element similarly constituted a refinement of the adopted regional water quality management plan, although one with some changes in the water use objectives for the watershed.

As in the preparation of the plans for the Kinnickinnic River, Menomonee River, and Milwaukee River watersheds, a number of alternatives were explored in the preparation of the Oak Creek watershed plan with respect to floodland management. The following six structural floodland measures were identified for possible application, either individually or in various combinations to specific floodprone reaches of the watershed: 1) detention storage, 2) diking, 3) diversion, 4) bridge or culvert modification or replacement, 5) channelization, and 6) onsite storage. The following 12 nonstructural measures were similarly identified: 1) reservation of floodlands for recreational and other open space uses, 2) floodland use regulation, 3) channel maintenance, 4) flood insurance, 5) lending institution policies, 6) real-estate-agent policies, 7) community utility policies, 8) emergency flood-warning programs, 9) regulation of land use outside the floodlands, 10) structure floodproofing and elevation, 11) structure removal, and 12) community education programs.

A total of 12 alternative structural floodland management plans, including two "no-action" alternatives, one providing for no development in the floodplain and one providing for limited development in the floodplain fringe, were prepared and evaluated for the Oak Creek watershed. Each of these alternatives was evaluated with the assistance of water resource simulation models, assuming planned land use conditions and the effect of such conditions on the flood-flow regimen of the watershed's stream system. In addition to these 12 alternatives, the

plan process included an examination of accessory measures that could meet special needs within the watershed. These included the maintenance of streamflow gages in the watershed and the maintenance of recreational navigation related to a public boat launch located at the mouth of Oak Creek.

ALTERNATIVES IN RECENT MILWAUKEE METROPOLITAN SEWERAGE DISTRICT AND OTHER FLOOD MITIGATION PLANNING

As noted in Chapters III and IV of this report, the Milwaukee Metropolitan Sewerage District has recently prepared a system-level watercourse management plan directed toward resolving flooding problems on streams under the MMSD jurisdiction and in portions of the tributary watersheds. That planning effort includes all of the major problem areas in the City of Milwaukee and is, therefore, the primary focus of the current flood mitigation planning effort for the City. The alternatives and initial recommendations of the MMSD's current planning efforts are documented in a series of August 2000 reports that are listed in Appendix D. In addition, more-detailed plans had already been prepared by the MMSD's engineering consultants for the Lincoln Creek and Southbranch Creek subwatersheds in November 1996 and May 1998, respectively (Appendix D). The MMSD's current watercourse management plan was based, in large part, upon a 1990 system plan prepared for the MMSD by SEWRPC, which plan, in turn, reflected recommendations set forth in a 1986 policy plan prepared by SEWRPC and adopted by the MMSD. As of mid-2002, the MMSD had implemented, or was nearing completion of implementing, flood control measures for Lincoln Creek, Southbranch Creek, the headwater area of Grantosa Creek, and the Valley Park area of the Menomonee River. All of those projects were located either wholly or in-part within the City of Milwaukee. Also, as of mid-2002, the remainder of the current watercourse management plan was undergoing refinement and detailing under subsequent, more-detailed planning and preliminary design. These subsequent steps are being conducted by incorporating field survey data and by refinement of the individual project recommendations.

The MMSD has considered a series of flood control alternatives for watercourses under its jurisdiction, most notably in its current efforts to revise and update its 1990 watercourse system plan. These efforts constitute the basis for the citywide flood mitigation planning effort being performed in and for the City of Milwaukee at the present time. The alternatives which have been and which are being considered under these efforts are described below.

In order to develop plans to mitigate flooding problems within the City of Milwaukee, detailed stormwater and floodland management planning is needed for each drainage area located partly or wholly within the City. Such planning is generally prepared within the context of the comprehensive watershedwide planning noted above. The MMSD, like SEWRPC, uses the watershed as the geographic basis for flood control planning efforts. As noted above, among the five watersheds involved, the Root River watershed has not presented and is not expected to present any significant flooding problems within the City of Milwaukee, and flooding problems within that portion of the Lake Michigan direct drainage area located within the City are relatively minimal.

Additional details on the alternative plans described below can be found in the MMSD system planning reports listed in the references set forth in Appendix D.

Alternatives for the Kinnickinnic River Watershed within the City of Milwaukee

As noted in Chapter IV of this report, the MMSD, in its analysis of current flooding problems in the Kinnickinnic River watershed, has identified several flooding problem areas on and along the tributaries of the watershed. Damages from the 100-year recurrence interval flood event are predicted only along three tributary streams in the watershed, with two of the three general areas of predicted structure damage located wholly or partly within the City of Milwaukee—one located wholly within the City, in the Lyons Park Creek subwatershed, and one located partly in the City of Milwaukee and partly in the City of Greenfield along Villa Mann Creek Tributary, in the Lower Wilson Park Creek subwatershed.

To abate existing as well as future problems arising from the 1 percent probability flood event in the problem areas identified by the MMSD within the Kinnickinnic River watershed, several types of solutions were considered. The following design criteria were used in developing potential solutions to flooding for the water-

shed: 1) minimization of impacts to natural channels; 2) design of solutions for the 1 percent probability flood event under 2020 land use conditions; 3) striving for a uniform level of service and equitable distribution of necessary improvements; 4) provision of one foot of freeboard to all damage elevations of structures; 5) provision of three feet of freeboard on all levees and floodwalls; 6) floodproofing of only industrial and commercial structures; 7) minimization of structural acquisitions; and 8) acquisition of nonresidential structures with more than two feet of flooding. In its current flood mitigation planning efforts, the MMSD has recognized the need to establish the policies and regulations required to ensure that additional problems are not created or exacerbated by new development or redevelopment in the future, and that structural flood abatement solutions preferably should not serve only one flood control purpose. Therefore, the potential solutions should integrate the aforementioned concepts to create a multipurpose, functional facility acceptable to all key stakeholders concerned.

The types of solutions considered to address the problems identified for the 1 percent probability flood event in the Kinnickinnic River watershed include 1) storage, 2) floodplain lowering and/or conveyance, 3) levees and/or floodwalls, and 4) buyouts and/or floodproofing. These solutions can be combined with water quality improvements, multipurpose land uses, greenway corridors, environmental enhancement, preservation of open space, or a combination of any or all of these measures. Alternatives to mitigate the flooding problems were developed and evaluated for each identified problem area. Each alternative evaluated consists of one or more of the types of components described above.

As noted in Chapter IV of this report, three flooding problems were identified on Lyons Park Creek, one at S. 57th Street, one at W. Stack Avenue, and one at W. Cleveland Avenue, involving the flooding of 20 residential structures and two commercial structures. All three problem areas lie within the City of Milwaukee. Four alternatives for abating potential flood damages resulting from the 1 percent probability flood event on Lyons Park Creek were formulated and evaluated under Phase 1 of the planning process. At that time, only two floodprone structures had been identified, one at 57th Street and one at Cleveland Avenue. Additional structures were later identified under the advanced planning process currently underway. The four initial Phase 1 alternatives, designated as, respectively, storage, conveyance, levee, and buyout/floodproofing alternatives, are summarized in Table 10. Two of these four alternatives, the conveyance alternative and the buyout/floodproofing alternative, were recommended for further study during the second, advanced planning stage of the MMSD's current planning effort. The conveyance alternative, which would involve increasing the capacity at the two culvert/bridge locations, has an estimated capital cost of $633,000. This alternative would resolve one of the flood damage problems, and would eliminate nuisance road overtopping. The initial buyout/floodproofing alternative has an estimated capital cost of $233,300. It would involve the acquisition of one residential structure and the floodproofing of one commercial structure, but would not resolve road overtopping and subsequent overland flow problems. Additional alternatives considered under the advanced planning consist of providing increased conveyance at all three road crossings through culvert replacement, with an estimated cost of $778,000.

In the Villa Mann Creek-Villa Mann Creek Tributary problem area, as noted in Chapter IV of this report, three structures, one residential and two commercial, have been identified as being vulnerable to flood damage during the 1 percent probability flood event. One of the three structures, a commercial structure, is located east of S. 27th Street, within the City of Milwaukee; the remaining two are located west of S. 27th Street, within the City of Greenfield. Four alternatives for mitigating the flooding problems were formulated and evaluated under Phase 1 of the planning process. At that time, a total of five floodprone structures had been identified. Under current advanced planning, this number was reduced to the three noted above. The four initial Phase 1 alternatives, designated as, respectively, storage, conveyance, floodwall/levee, and buyout/floodproofing alternatives, are summarized in Table 11. Although some interest was expressed in the conveyance alternative, which has an estimated capital cost of about $1.6 million, the recommended alternative is the buyout/floodproofing alternative, which involves floodproofing of the three commercial structures and the acquisition of the two residential structures. A preliminary analysis of the problem area has indicated that the capital cost of this alternative would total about $410,000. This alternative was initially recommended for evaluation in greater detail during the second, advanced planning stage of the MMSD's current planning effort in order to obtain input regarding the alternative from the local stakeholders concerned and to determine the structure-specific approach and feasibility

Table 10

SUMMARY OF ALTERNATIVES EVALUATED FOR THE LYONS PARK CREEK PROBLEM AREA

Alternative	Storage Components	Conveyance Components	Levee/Floodwall Components	Buyout/Floodproofing Components	Capital Costs
1. Storage	35 acre-feet online storage facility	--	--	--	$2,290,000
2. Conveyance	--	Replace 57th Street culvert, add culvert at Cleveland Avenue	--	--	$ 633,000
3. Levee	--	--	Construct 425 feet of seven-foot-high levee at northwest corner of Lyons Park	Floodproof one commercial structure	$ 388,000
4. Buyouts/ Floodproofing	--	--	--	Buyout one residential structure, floodproof one commercial structure	$ 233,000

PROBLEM DESCRIPTION: The Lyons Park Creek problem area is located at River Miles 0.13 and 0.847. Two structures (one residential, one commercial) are predicted to flood during the 100-year storm event.

Source: Milwaukee Metropolitan Sewerage District and Camp Dresser & McKee, Inc.

Table 11

SUMMARY OF ALTERNATIVES EVALUATED FOR THE VILLA MANN CREEK-VILLA MANN CREEK TRIBUTARY PROBLEM AREA

Alternative	Storage Components	Conveyance Components	Levee/Floodwall Components	Buyout/Floodproofing Components	Capital Costs
1. Storage	31 acre-feet storage facility west of 27th Street	--	--	--	$2,910,000
2. Conveyance	Six acre-feet mitigation storage	Add parallel culvert at 27th street	--	--	$1,627,000
3. Floodwalls/Levees	--	--	--	--	NP
4. Buyouts/ Floodproofing	--	--	--	Buyout two residential structures and floodproof three commercial structures	$ 410,000

PROBLEM DESCRIPTION: The Villa Mann Tributary problem area is centered around 27th Street. Five structures (two residential, three commercial) are predicted to flood during the 100-year storm event.

NOTE: NP = Not Practical.

Source: Milwaukee Metropolitan Sewerage District and Camp Dresser & McKee, Inc.

of floodproofing. A potential conveyance solution was also considered during the second, advanced MMSD planning phase. Under the phase, two conveyance alternatives have been evaluated, one consisting of replacement of the entire channel enclosure downstream of S. 27th Street to the confluence with Villa Mann Creek, and a second consisting of replacing only a portion of that enclosure, with the remainder to be replaced with an open channel. The estimated costs of these alternatives are $1,084,000 and $633,000, respectively.

During the completion of the initial planning phase and through the initial stakeholder meetings for the Kinnickinnic River watershed, a number of additional issues were identified for consideration in the second, detailed phase of the MMSD planning effort for the watershed. The additional work pertaining to these issues includes more detailed investigation and the collection of additional data to refine and verify results. It has been recommended that elevation data be obtained for four damaged structures in the watershed that were not previously surveyed, including one commercial structure/property on Lyons Park Creek and two commercial structures on Villa Mann Creek Tributary; that detailed "as-built" plans be developed for the four roadway bridges crossing the main stem of the Kinnickinnic River between S. 6th Street and S. 16th Street, that the hydraulic model be updated to include the improved data thus obtained, and that the potential for damages and possible structural improvements along the reach involved be evaluated; that surveys be performed, one at S. 57th Street and W. Cleveland Avenue on Lyons Park Creek and one at S. 27th Street on Villa Mann Creek Tributary, to more accurately define overflow elevations and the subsequent downstream flow paths at the locations involved as part of the advanced planning and design of flood mitigation alternatives for those locations; that a detailed investigation of the overflow path in the vicinity of W. Stack Drive on Lyons Park Creek be performed in response to reports by the City of Milwaukee that street flooding and minor house flooding may be possible in that area; and that several areas of erosion, poor channel maintenance, and sedimentation throughout the watershed, including the Kinnickinnic River between S. 45th Street and S. 60th Street, be investigated.

The MMSD hired a private engineering firm to perform the advanced planning work for the Kinnickinnic River watershed. The alternatives reviewed in the second, advanced planning stage for the watershed included buyouts and floodproofing of structures along Lyons Creek, as well as increased conveyance, and, as noted above, the buyout of homes and the floodproofing of commercial structures in the Villa Mann Creek-Villa Mann Creek Tributary area, as well as increasing conveyance.

As noted in Chapter IV of this report, the U.S. Army Corps of Engineers has agreed as a partner with the MMSD to undertake a streambank stabilization project on the Kinnickinnic River between S. 45th and S. 60th Streets. Final project design was completed in January 2002, with construction expected to begin in 2003. In that regard, the Corps of Engineers is proposing a project consisting of reconstruction of storm sewer outfalls and the placement of riprap at five locations along this reach of the River.

Alternatives for the Menomonee River Watershed within the City of Milwaukee

As noted in Chapter IV of this report, the MMSD, in its analysis of current flooding problems in the Menomonee River watershed, has identified several flooding problem areas on and along the main stem of the Menomonee River, as well as several tributaries of the watershed. Damages from the 100-year recurrence interval flood event are predicted along the main stem of the Menomonee River in Milwaukee County, within the Lower Menomonee River subwatershed, with two of the three major areas of predicted structure damage there, the Western Milwaukee area and the Valley Park neighborhood area, respectively, located partly and wholly within the City of Milwaukee; along Grantosa Creek in two areas, one located partly within the City of Milwaukee; and along the Little Menomonee River in its subwatershed, in two areas located within the City of Milwaukee. The MMSD, in an effort to develop a comprehensive plan for the Menomonee River watershed, has also been coordinating additional planning involving analyses of flooding problems in portions of the watershed located outside Milwaukee County. These analyses are being conducted in cooperation with the municipalities concerned.

To abate existing as well as future problems arising from the 1 percent probability flood event in the problem areas thus far identified by the MMSD within the Menomonee River watershed, several types of solutions have been considered. The following design criteria have been used in developing potential solutions to flooding for the watershed: 1) minimization of impacts to natural channels; 2) design of solutions for the 1 percent probability

flood event under 2020 land use conditions; 3) striving for a uniform level of service and equitable distribution of necessary improvements; 4) provision of one foot of freeboard to all damage elevations of structures; 5) provision of three feet of freeboard on all levees and floodwalls; 6) floodproofing of only industrial and commercial structures, with an assumption for cost purposes that 50 percent of floodproofed structures will need to be acquired because of physical, economic, aesthetic, and/or operational reasons; 7) minimization of structural acquisitions; and 8) acquisition of nonresidential structures with more than two feet of flooding. In its current flood mitigation planning efforts, the MMSD has recognized the need to establish the policies and regulations required to ensure that additional problems are not created or exacerbated by new development or redevelopment in the future, and that structural flood abatement solutions preferably should not serve only one flood control purpose. Therefore, the potential solution should integrate the aforementioned concepts to create a multipurpose, functional facility acceptable to all key stakeholders concerned.

The types of solutions considered to address the problems identified for the 1 percent probability flood event in the Menomonee River watershed include 1) levees and/or floodwalls, 2) storage, 3) floodplain and channel lowering, 4) buyouts and/or floodproofing, and 5) conservation easements. Depending upon the nature of the flooding problem involved and other considerations in flood mitigation, these various types of solutions may be feasible and effective either alone or in various combinations with one another.

In considering alternatives and in developing a final plan for the Menomonee River watershed, the MMSD has used a multi-step process. This process begins with consideration of the aforementioned potential solutions for flooding problems in the watershed and extends through several intermediate steps involving testing and evaluation of potential alternatives based on certain criteria and constraints in order to develop a final solution. Each step may have several iterations involving informal consideration of various options or scenarios.

The first step involves identification of potential solutions, as described above, that may be applicable for the type of flooding problems experienced in the watershed. The second step involves examination of these potential solutions to define the specific requirements of the problem areas and the unique characteristics of the watershed. For example, in this step, it was found that the flooding problem in the Valley Park area of the City of Milwaukee cannot be solved by a flood storage facility in the Village of Germantown because of the timing and distribution of development in the Menomonee River watershed. The second step, in which "screening" alternatives are developed, also involves considering the technical feasibility of the potential solutions with regard to solving the problems and helps define where certain components of the solutions must be located and how big they must be to address the problems effectively. These screening alternatives are not necessarily practical or implementable, but define the upper bound of the feasibility of certain technical solutions.

The third step involves formulation of several "conceptual" alternatives in which specific requirements and limitations of the various solution components are developed. These requirements and limitations include physical limitations, regulatory requirements, and jurisdictional constraints as well as technical requirements imposed by the watershed characteristics or by the project design criteria. These alternatives may be fine-tuned to become viable alternatives if the right conditions can be met. The fourth step involves development of "preliminary design" alternatives that begin to incorporate site-specific information and some of the nontechnical constraints and "opportunities" that will be required for final acceptance and implementation of a given alternative. Constraints and opportunities include such factors as aesthetics, local community requirements, specific site or owner restrictions, and multipurpose considerations that must be part of a final solution. The fourth step also involves examination of alternatives in which several potential solution components have been combined to develop more effective and implementable alternatives.

The fifth step is an extension of the fourth step. The fifth step involves further development and incorporation of important considerations previously identified based on input from the stakeholders and from the public and at the same time focuses on a final plan that will be acceptable to the major stakeholders. Ideally, feedback obtained in the fifth step can be used to formulate a final plan that meets all stated objectives of the watercourse system planning effort and the issues and concerns of all of the stakeholders.

The MMSD analyzed a total of 13 alternatives for the Menomonee River watershed. Alternatives were developed and evaluated in various levels of detail, in accord with the five-step process described above. Eleven alternatives were evaluated in detail, include the following: 1) regional storage, 2) local storage, and 3) floodplain lowering and/or conveyance, all "screening" alternatives developed in the second step; 4) regional storage and levees, 5) channel lowering, levees, and mitigation storage, and 6) subregional storage, all "conceptual" alternatives developed in the third step; 7) regional storage, new-development storage, and levees and/or floodwalls, 8) regional storage, levees and/or floodwalls, floodplain lowering, and acquisition; 9) optimized regional storage, levees and/or floodwalls, floodplain lowering, and acquisition; 10) channel and floodplain lowering, levees and/or floodwalls, acquisition; and 11) levees and/or floodwalls, acquisition, and floodproofing.

These alternatives represent the evolution of a number of options for the MMSD to consider in formulating a final alternative. Through the planning process, the MMSD has sought comments and feedback from participants in its planning workshops as well as from the major stakeholders involved and from the general public in developing a final set of alternatives. These alternatives were to be further developed and evaluated to frame a final solution that will meet the objectives of the system planning effort and be acceptable to the major stakeholders and to the public. In 1999, the MMSD approved advanced planning on a selected alternative designed to reduce the risk of flooding on the main stem of the Menomonee River. The proposal, as then developed, includes the construction of a berm and the acquisition of eight properties in the Valley Park area in the City of Milwaukee; the acquisition of selected properties, the lowering of the floodplain, and the construction of a levee in the Hart Park area in the City of Wauwatosa; and the construction of a multi-use detention facility on the Milwaukee County Grounds in the City of Wauwatosa. The estimated cost of these improvements is between $83 million and $93 million.

In July 2002, the MMSD completed the Phase 2 advanced planning stage of its watercourse system plan. Work carried out under that phase included refined hydrologic and hydraulic analyses and further evaluation of potential structure flooding, including obtaining field-surveyed elevation data. As a result of this advanced planning, the number of potentially flooded structures along the Menomonee River was revised to include six industrial buildings at the Falk Corporation property in the City of Milwaukee, 37 commercial, industrial, and residential properties in the reach between W. Wisconsin Avenue and N. 60th Street in the City of Milwaukee, and 15 residential structures in the vicinity of W. Concordia Avenue in the City of Wauwatosa. Additional alternative flood control plans were analyzed for these areas, including property acquisition, floodproofing, levees and floodwalls, and floodplain lowering. For those reaches affecting the City of Milwaukee, the proposed plan was amended to include raising the existing levee and floodwall protecting the Falk Corporation property and a combination of a levee/floodwall construction, floodplain lowering, and property acquisition for the western Milwaukee reach downstream of N. 60th Street. The estimated cost of those two plan elements is $47 million. However, since the preliminary Phase 1 plan included about $5.0 million for structure floodproofing and structure acquisition and removal in the western Milwaukee reach, the Phase 2 plan addition as it affects the City of Milwaukee, would be about $42 million over the overall Phase 1 plan estimate.

As noted in Chapter IV of this report, seven residential structures located within the Grantosa Creek subwatershed, of which three are located within the City of Milwaukee, were identified as being potentially subject to flooding from a 100-year event. In 2001, the MMSD completed the construction of a 58 acre-foot dry detention basin at Timmerman Airport. During the advanced planning for Grantosa Creek by the MMSD, it was found that no structures in the City of Milwaukee would be subject to flooding during a 100-year recurrence interval event with the completion of the detention basin.

As noted in Chapter IV of this report, one residential structure located both within the Little Menomonee River subwatershed and within the City of Milwaukee was identified as being potentially subject to damage arising from the 100-year flood event on the Little Menomonee River. The structure involved presents an isolated problem that does not cost-effectively lend itself to structural solutions. The selected alternative involves acquiring that property at an estimated cost of $150,000. A review of that preliminary recommendation in the MMSD's second, advanced planning stage verified that it is the most appropriate and acceptable solution.

At the present time, there are a number of projects in the planning and design phases proposed in the Menomonee Valley area which are planned to incorporate stormwater and floodland management measures. These include development of an environmentally sensitive industrial park on a large tract of vacant land between 27th Street and Miller Park, the planned reconstruction and extension of Canal Street, and other projects being coordinated by the City of Milwaukee Department of City Development and the Menomonee Valley Partners. Stormwater and floodland management measures are being integrated into these projects as part of the overall project design.

As noted in Chapter II, the City of Milwaukee is coordinating the preparation, approval, and adoption of updated floodplain mapping, incorporating changed conditions for the Menomonee River watershed, including impacts of completed flood management projects.

Alternatives for the Milwaukee River Watershed within the City of Milwaukee

As noted in Chapter IV of this report, the most severe current flooding problem areas identified in the Milwaukee River watershed include areas 1) within the Lincoln Creek subwatershed in the City of Milwaukee and 2) within the Village of Brown Deer and, to a lesser extent, the City of Milwaukee, in the Southbranch Creek drainage area, which lies within the Lower Milwaukee River subwatershed.

A detailed flood control plan for Lincoln Creek, as noted in this chapter and in Chapter IV of this report, was prepared by SEWRPC and adopted by it in 1983 as an amendment to its comprehensive plan for the Milwaukee River watershed. The alternatives considered in the preparation of SEWRPC's 1983 plan for Lincoln Creek are described in a previous section of this chapter. This plan for Lincoln Creek, as noted in Chapter IV of this report, was subsequently refined as part of the preparation by SEWRPC of a 1990 comprehensive stormwater drainage and flood control system plan for the MMSD. Although this 1990 plan was never formally adopted by the MMSD or by SEWRPC, that plan served as a major basis for the MMSD's own 1990 watercourse system plan, which the MMSD is currently updating. As also noted in Chapter IV, the MMSD has also had private consultants prepare three further flood control planning studies for Lincoln Creek, completed, respectively, in 1987, 1993, and 1996. In 1999, the MMSD began construction of the flood control measures for Lincoln Creek. As of mid-2002, that work was nearly completed, with only limited streambank stabilization and landscaping to be finished. The project constitutes a refinement of the alternatives developed under the 1990 system plan prepared for the MMSD by SEWRPC, except that it also includes an additional component providing for the removal of existing channel lining along two reaches of the stream.

The 1990 system plan prepared for the MMSD by SEWRPC also extended flood control analyses and recommendations to Southbranch Creek. In the preparation of this plan, the following alternative flood control and related drainage system plans were considered for the North Tributary to Southbranch Creek: 1) an alternative involving channel modification, enclosure, and construction, storm sewer replacement, and culvert replacement; 2) an alternative involving channel modification, enclosure, and construction, culvert replacement, storm sewer construction, and detention storage; and 3) channel modification, enclosure, and construction, culvert replacement, and storm sewer construction with maximum detention storage. For Southbranch Creek, the following four alternatives were considered: 1) a "no-action" alternative; 2) a combination of culvert replacement and channel modification; 3) a combination of maximum storage, culvert replacement, and channel modification; and 4) a combination of culvert replacement and channel modification with additional storage provided on the North Tributary to Southbranch Creek. In addition, as noted in Chapter IV of this report, a detailed plan for Southbranch Creek prepared by a private consultant for the MMSD in 1998 presents alternatives that are considered a refinement of the recommendations set forth in the 1990 system plan prepared for the MMSD by SEWRPC. However, the 1998 plan does not include any specific plan recommendation. Also during 1998, the Village of Brown Deer had developed plans to acquire and remove 10 floodprone structures located along Southbranch Creek. During 1999, the MMSD began to implement the first phase of its $3.9 million flood control plan for Southbranch Creek through the construction of a detention basin just west of N. 47th Street on W. Churchill Lane in the Village of Brown Deer, the site of the structure removal. In 2001, the remainder of the Southbranch Creek plan elements have been completed. Those elements included three additional stormwater detention basins, two in the Village of Brown Deer and one in the City of Milwaukee, as well as two culvert replacements and the removal of a road crossing and culvert.

As noted in Chapter II, the City of Milwaukee is in the process of coordinating the preparation, approval, and adoption of new updated floodplain mapping, incorporating changed conditions in the Milwaukee River watershed, including the impacts of completed flood control projects and the removal of the North Avenue dam.

Alternatives for the Oak Creek Watershed within the City of Milwaukee

As noted in Chapter IV of this report, the MMSD, in its analysis of current flooding problems in the Oak Creek watershed, has identified two areas located both within the watershed and within the City of Milwaukee as flooding problem areas under the conditions of the 1 percent recurrence interval rainfall event: 1) an area in the vicinity of the intersection of S. 13th Street and W. College Avenue where four structures—one commercial, two industrial, and one residential—are expected to suffer damage arising from the 1 percent recurrence interval event along the Upper North Branch of Oak Creek, within the subwatershed for the North Branch of Oak Creek, and 2) an area in the southern portion of General Mitchell International Airport where three governmental structures are expected to suffer damage arising from the 1 percent recurrence interval event along the Mitchell Field Drainage Ditch within its subwatershed. The airport's main north-south runway would be overtopped during a 1 percent recurrence interval storm.

A number of alternatives were analyzed to solve the identified flooding problems within the Oak Creek watershed, including the problems occurring within the two areas within the City of Milwaukee. The alternatives combine the following potential solutions into effective flood control concepts to eliminate damages resulting from the 1 percent probability flood event: 1) levees and/or floodwalls, 2) storage, 3) channel modifications and/or conveyance improvements, 4) acquisitions, also known as "buyouts," and/or floodproofing of structures. The specific alternatives vary by problem area. Tables 12 and 13, respectively, summarize the alternatives analyzed for the Upper North Branch of Oak Creek and the Mitchell Field Drainage Ditch. In the case of Table 12 for the Upper North Branch of Oak Creek, both the aforementioned flooding problem area within the City of Milwaukee and an additional area in the City of Oak Creek are included in the alternative analysis. The purpose of both of these tables is to focus on the alternatives that are technically feasible and implementable. The MMSD has analyzed the alternatives that meet these requirements according to a series of major criteria that involve consideration of such factors as environmental impacts, implementation issues, and costs. The comparisons and evaluations of the alternatives analyzed under these criteria have been designed to lead to recommendations for the problem areas involved. The recommended alternatives are currently being developed further in the MMSD's second, advanced stage of planning for the Oak Creek watershed.

For the problem areas along the Upper North Branch of Oak Creek in the Cities of Milwaukee and Oak Creek, the MMSD found that while the storage alternative substantially solved the flooding problems involved, it required floodproofing of two industrial structures and did not address the problems arising from low storm sewers. The floodwalls alternative, while technically feasible, may involve the excavation of hazardous materials and has a capital cost about four times that of the least expensive alternative, that involving acquisition and/or floodproofing of structures. The channel modification alternative, meanwhile, addresses the problem of low storm sewers in the area, but still requires floodproofing and acquisition to address the flooding problems involved. The least costly alternative, the alternative involving only structure acquisition and floodproofing, with an estimated capital cost of about $520,000, had been identified under the initial planning phase as the alternative recommended for further development in the MMSD's second, advanced planning stage for the watershed. During that more-advanced planning stage that is currently ongoing, an evaluation was made of flooding due to an existing low storm sewer at S. 13th Street in the City of Milwaukee, along with additional field surveys of potentially flooded structures. That additional evaluation resulted in the number of structures subject to flooding being revised to five—three industrial and two residential. Additional alternative measures were evaluated to alleviate that flooding, including acquisition, floodwalls, and floodproofing. These alternatives are summarized in Table 14. A recommendation by the MMSD's engineering consultant called for further consideration of the floodwall alternative in combination with replacement of the S. 13th Street bridge over the North Branch of Oak Creek.

Table 12

SUMMARY OF ALTERNATIVES EVALUATED FOR THE UPPER NORTH BRANCH OF OAK CREEK

Alternative	Storage	Channel Modification	Floodwalls	Acquisition/ Floodproofing	Comments	Capital Costs
1. Storage	Site 204 west of 13th Street–88 acre-feet, 10 acres with an average 10-foot depth	NA	NA	Floodproof two industrial structures	Storage at Milwaukee County park ("Maltland Park") will work; park improvements could include active recreation field; wetland and/or channel restoration; two floodprone structures are too far downstream for storage to work. Does not solve storm sewer problem, which will be addressed in Phase 2	$5,305,000
2. Floodwalls	NA	NA	2,500-feet-long, six- to eight-foot-high walls, four industrial, one commercial	Acquire one residential structure	Floodwall alternative will work; no room for levee solution	$2,196,000
3. Channel Modification	NA	Widen 20 to 30 feet, with an average of three feet lowering; one RR bridge and four to five private bridges will need to be replaced or modified	NA	Floodproof five structures and acquire (buyout) one residential structure	Environmental concerns at salvage yard near College Avenue. High levels of arsenic have been found in the ground. Channel lowering is not designed to solve the flooding problems	$3,100,000
4. Acquisition/ Floodproofing	NA	NA	NA	Floodproof one commercial and four industrial structures; acquire one residential structure	Least costly alternative. Does not solve storm sewer problem, which will be addressed in Phase 2	$ 520,000

NOTES: Of the six flood-damage-prone structures identified within this flood problem area, a total of four structures—two industrial, one residential, and one commercial—are located within the City of Milwaukee. The remaining two structures, both industrial structures, are located within the City of Oak Creek.

NA = Not Applicable.

Source: Milwaukee Metropolitan Sewerage District, Camp Dresser & McKee, Inc., and Kapur & Associates, Inc.

For the problem area along the Mitchell Field Drainage Ditch, the MMSD found that the storage alternative was not feasible given airport development plans and Federal Aviation Administration requirements. The floodwalls alternative, while technically feasible, has a capital cost over three times that of the least expensive alternative, the acquisition/floodproofing alternative. Although the channel modification alternative, meanwhile, can be technically feasible, it presents a high capital cost, conflicts between construction and airport operations, and a need for some mitigation storage downstream. The acquisition/floodproofing alternative presents the lowest capital cost, approximately $466,000, among the four alternatives involved as well as minimal impacts, and probably offers the greatest flexibility with regard to future airport expansion. This alternative has thus been identified as the alternative recommended for further development in the MMSD's second, advanced planning stage for the Oak Creek watershed.

Table 13

SUMMARY OF ALTERNATIVES EVALUATED FOR THE MITCHELL FIELD DRAINAGE DITCH

Alternative	Storage	Channel Modification	Floodwalls	Acquisition/ Floodproofing	Comments	Capital Costs
1. Storage	NA	NA	NA	NA	Only available storage site upstream will not solve the problem	Alternative will not work
2. Floodwalls	NA	NA	1,100 feet long, eight feet high	None	Floodwalls will work; no room for levee solution	$1,000,000
3. Channel Modification	Mitigation storage	Widen 20 to 30 feet, deepen three to six feet	NA	NA	Requires an additional box culvert that is not practical or economical because of runway crossings; would require downstream storage to mitigate flow increases	$5,000,000
4. Acquisition/ Floodproofing	NA	NA	NA	Floodproof three government structures	Could require installation of closures or operational changes during flood events	$ 466,000

NOTES: Future airport expansion may change flows and capacities and may modify or remove damaged structures.

NA = Not Applicable.

Source: Milwaukee Metropolitan Sewerage District, Camp Dresser & McKee, Inc., and Kapur & Associates, Inc.

Table 14

SUMMARY OF ADDITIONAL ADVANCED PLANNING ALTERNATIVES EVALUATED FOR THE NORTH BRANCH OF OAK CREEK

Alternative	Description	Advantages	Disadvantages	Capital Cost (millions)
1a. Acquisition	Acquire two apartments, two industrial properties along S. 13th Street	Aesthetically pleasing. Opportunity to lower floodplain. No future commitment	Relocation of property owners. High cost. Remaining apartment becomes island	$2.54
1b. Acquisition	Acquire three apartments, two industrial properties along S. 13th Street	Aesthetically pleasing. Opportunity to lower floodplain. No future commitment. Allows creation of conservation easement	Relocation of property owners. High cost	$3.11
2. Floodwall	Construct floodwall along North Branch. Replacement of S. 13th Street bridge with elevation of roadway	Keeps property on tax roles. No relocation of owners. Costs split between City and MMSD	Maintenance. Impacts access to waterway	$3.72
3a. Floodproofing	Construct levee around two apartment buildings. Structural floodproofing at two industrial properties	No relocation of owners	Potential decrease in property value due to levee. Maintenance Aesthetically unappealing	$1.86
3b. Floodproofing	Acquire two apartment buildings. Structural floodproofing at two industrial properties	No relocation for industrial property owners	One apartment remains isolated. Removes taxable property	$1.17
3c. Floodproofing	Acquire three apartment buildings. Structural floodproofing at two industrial properties	No relocation for industrial property owners	Removes taxable property	$1.74

NOTES: Under the advanced planning phase of the MMSD watercourse system plan, a low storm sewer analysis for the S. 13th Street area, coupled with field surveys of low water entry elevations, resulted in a revised estimate of structure flooding. The findings concluded there would be three industrial structures—two of which are on one property—and two apartment buildings subject to direct flooding in this area. A third apartment building would be surrounded by flood waters but would not be directly inundated by floodwaters at the building grade.

Source: Milwaukee Metropolitan Sewerage District, Tetra Tech MPS.

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Chapter VI

FLOOD HAZARD MITIGATION FUNDING SOURCES

Financing of the construction, operation, and maintenance of floodland and stormwater management facilities may be accomplished through the establishment of a stormwater utility; tax-incremental-financing (TIF) districts; local property taxes; reserve funds; general-obligation bonds; private-developer contributions, including fees paid to be applied toward construction of regional stormwater management facilities in lieu of providing onsite facilities; State grants or loans; and certain Federal and State programs.

There are thus several options available to the City of Milwaukee and the Milwaukee Metropolitan Sewerage District (MMSD) for the financing of a local flood mitigation program. The identification of potential funding sources, including sources other than solely local-level sources, is an integral part of the implementation of a successful mitigation plan. The following description of funding sources includes those that appear to be potentially applicable for the City of Milwaukee and MMSD as of the year 2002. However, fund programs and opportunities are constantly changing. Because of the ongoing very proactive program for flood control which is being carried out, City and MMSD staff members have become familiar with the potential funding sources and programs that may be utilized and are currently making maximum use of such programs. It is intended that this list facilitate the implementation of the flood mitigation activities recommended under the flood mitigation plan for the City set forth in this report. Some of the programs described in this chapter may not be available under all envisioned conditions to the City or to its residents and/or property owners for a variety of reasons, including, for example, eligibility requirements or lack of funds at a given time in Federal and/or State budgets. Nonetheless, the list of sources and programs set forth in this chapter should provide a starting point for identifying possible funding sources for implementing the flood mitigation plan recommended in this report.

FEDERAL EMERGENCY MANAGEMENT AGENCY PROGRAMS

The Federal Emergency Management Agency (FEMA) funds several programs that in the State of Wisconsin are administered through the Wisconsin Department of Military Affairs, Division of Emergency Management. These programs are described below.

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) can provide up to 75 percent of the costs attendant to the floodproofing or acquisition and relocation of floodprone properties, or to the elevation of structures in compliance with National Flood Insurance Program (NFIP) standards. Under the HMGP, the balance of the costs is shared by the State of Wisconsin (12.5 percent) and the grantee (12.5 percent). Communities in Wisconsin can apply through the State for HMGP funds only after a Presidential disaster declaration is issued. Within 60 days of the declaration the State must submit a letter of intent to participate in the program. The State, as HMGP grantee, is responsible for identifying and prioritizing projects. Eligible projects must be included as part of the grantee's flood mitigation plan and must meet cost-benefit criteria established by FEMA. Although State and local units of

government are eligible applicants, HMGP funds can be provided to individuals for eligible structural projects, however, priority is given to nonstructural approaches, such as acquisition, demolition, relocation, and floodproofing. The HMGP gives priority to properties identified by FEMA as repetitive-loss properties.

The City of Milwaukee has already obtained funds under this program for structure purchase and removal, and is continuing to use this program. Funding is available through this program only in set amounts. There is no ongoing program for structure acquisition within the City once all HMGP funds are expended.

Flood Mitigation Assistance Program
The Flood Mitigation Assistance (FMA) program can potentially provide up to 75 percent of the costs attendant to the acquisition, relocation, elevation, or dry floodproofing of structures insured under the NFIP. In addition to participating in the NFIP, eligible program applicants must meet cost-benefit criteria established by FEMA. The City of Milwaukee is eligible to apply for flood mitigation funding under the FMA program, but under recent indications, it appears that the amount of funding available under this program has been relatively small. The FMA program gives priority to properties identified by FEMA as repetitive-loss properties.

Public Assistance Program
FEMA's Public Assistance Program can provide some limited assistance with respect to structure elevation and relocation. For example, if entire portions of a community were to be relocated outside of a floodplain, this program can assist in rebuilding the necessary infrastructure in the new location. Funding under this program is provided for repair of infrastructure damaged during a flood that results in a Presidential disaster declaration if those repairs are shown to be cost-effective. If a community determines that a badly damaged facility is not to be repaired, the estimated damage amount may be used to fund hazard mitigation measures.

Community Rating System
Discounts may be obtained on Federal flood insurance premiums depending on community activities relative to public information, mapping and regulations, flood damage reduction, and flood preparedness.

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT COMMUNITY DEVELOPMENT BLOCK GRANT PROGRAM

Under the Community Development Block Grant (CDBG) program, funded by the U.S. Department of Housing and Urban Development, funds are sometimes provided to areas for which a Presidential disaster declaration has been issued. Funds obtained under this program may be used to address long-term needs as well as emergency response activities. CDBG grants are provided by the Federal government directly to the City of Milwaukee.

U.S. SMALL BUSINESS ADMINISTRATION PROGRAMS

The U.S. Small Business Administration (SBA) provides disaster loans to homeowners and businesses to repair or replace property damaged in a declared disaster. SBA loans are granted only for uninsured losses. Loans may be used to meet required building codes, such as the NFIP requirements. SBA may also provide loans for relocations out of special flood hazard areas when such relocations are required by local officials. Up to 20 percent of the loan can be used to implement such mitigation measures. While SBA's enabling legislation generally prohibits the agency from making disaster loans for voluntary relocations, there are exceptions that can be made, including relocations of homeowners, renters, and business owners out of special flood hazard areas when the community is participating in a buyout program. These loans would be limited to the amount necessary to repair or replace the damage at the disaster site. SBA loans may also be used to refinance existing mortgages.

U.S. ARMY CORPS OF ENGINEERS

The Corps of Engineers programs are potential sources of funding for implementing the floodland management recommendations of this plan. In order to be eligible for funding, the plan components must meet specific Corps economic feasibility and other criteria. The programs which may be applicable include the following:

- Section 22—Water resources planning assistance—50 percent Federal, 50 percent local cost share
- Section 205—Small flood control projects—Maximum $5 million per project. 75 percent Federal, 25 percent local cost share
- Section 208—Clearing debris and sediment from channels for flood prevention—Maximum $500,000 per project. 75 percent Federal, 25 percent local cost share
- Section 14—Emergency streambank and shoreline protection—Maximum $500,000 per project. 75 percent Federal, 25 percent local cost share

WISCONSIN DEPARTMENT OF NATURAL RESOURCES PROGRAMS

The Wisconsin Department of Natural Resources (WDNR) operates two programs that may serve as potential funding sources for flood mitigation efforts for the City of Milwaukee. These programs are described below.

Urban Green Space Program

The WDNR's Urban Green Space (UGS) program provides 50 percent matching grants to cities, villages, towns, counties, public inland lake protection and rehabilitation districts, and qualified nonprofit conservation organizations for the acquisition of land. The intent of the program is to provide natural open space within or near urban areas and protect scenic or ecological features. The City of Milwaukee is eligible to apply for grants under the UGS program.

Urban Rivers Grants Program

The WDNR's Urban Rivers Grants Program (URGP) provides 50 percent matching grants to municipalities to acquire land or rights to land on or adjacent to rivers that flow through urban areas, in order to preserve or restore urban rivers or riverfronts for the purposes of economic revitalization and the encouragement of outdoor recreational activities. The City of Milwaukee is eligible to apply for grants under the URGP.

Stewardship Grant Program

The administrative rules for the State of Wisconsin Stewardship Grant Program are set forth in Chapters NR 50 and 51 of the *Wisconsin Administrative Code*. The WDNR's UGS program which is a component of the Stewardship Grant Program provides 50 percent matching grants to cities, villages, towns, counties, public inland lake protection and rehabilitation districts, and qualified nonprofit conservation organizations for the acquisition of land. The intent of the program is to provide natural open space within or near urban areas and protect scenic or ecological features. The City is eligible to apply for grants under the UGS program. Funding for streambank protection projects may also be available through the Stewardship program.

Municipal Flood Control Grants Program

The WDNR Municipal Flood Control Grants Program was initiated in 2001 under Section 281.665 of the *Wisconsin Statutes*. The program provides 75 percent matching grants, with a maximum set at 20 percent of the funding available, to all cities, villages, towns, and metropolitan sewerage districts concerned with municipal flood control management. Assistance is provided in two ways: 1) Local Assistance Grants that support municipal flood control administrative activities, and 2) Acquisition and Development Grants to acquire and remove floodplain structures, elevate floodplain structures, restore riparian areas, acquire land and easements for storage, construct flood control structures, and fund flood mapping projects.

Stormwater Management Program

Funds may be available from the State of Wisconsin for the installation of best management practices that meet the nonpoint source pollution reduction objectives set forth in Menomonee and Milwaukee River south Priority Watershed Study. In some cases, such funding can be used to partially fund projects and local staffing which has both stormwater quality and quantity functions. Chapter NR 120 of the *Wisconsin Administrative Code* details the administrative procedures of the State nonpoint source water pollution abatement program. In addition to funds

provided by the WDNR, it is also possible that the cost of certain recommended components of the stormwater drainage system may be shared between the City and the Wisconsin Department of Transportation as a part of future highway construction or reconstruction projects.

In addition to the priority watershed program, the Wisconsin Department of Natural Resources also administers a Targeted Runoff Management (TRM) grant program provided for under Chapter NR 120[1] of the *Wisconsin Administrative Code.* Grants provided under this program are intended to be used for projects to control nonpoint source pollution from areas of existing urban development and may be available to partially support dual-purpose (quality and quantity) detention ponds or other stormwater management facilities.

LOCAL FUNDING

As previously noted, there are a number of City- and MMSD-based options for funding flood mitigation programs. City and staff and elected officials annually review the flood mitigation programs and allocate local funding sources as part of the budget process. The MMSD has established a capital improvements program which provides funding over a multi-year period to carry out all of the projects identified in the MMSD system plan update needed to address the overland structure flooding problem in the City of Milwaukee. The MMSD is the lead agency in the plan implementation phase and will incorporate local community funding as identified in its flood control policy and will maximize the use of State and Federal program funds to the extent possible.

GRANT AWARD ELIGIBILITY, ACQUISITION, AND ADMINISTRATION AND PROGRAM IDENTIFICATION

The eligibility and local contribution requirements associated with each of the aforementioned programs vary from program to program. The City of Milwaukee and MMSD are the lead agencies responsible for identifying potential flood mitigation funding sources and for acquiring and administering grant awards attendant to ongoing mitigation efforts in floodplain areas.

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[1]*Under the ongoing nonpoint source program redesign initiative of the Wisconsin Departments of Natural Resources and Agriculture, Trade and Consumer Protection, the urban grant provisions of Chapter NR 120,* Nonpoint Source Pollution Abatement Program, *were originally to be transferred to Chapter NR 153. However, as of November 2000, the WDNR was in the process of revising the proposed Chapter NR 153 to delete references to the urban grant program and to develop a new, as yet unnumbered, Chapter of the* Administrative Code *that would address the urban nonpoint source program. It is anticipated that the revised Chapter NR 153 and the new Chapter will be presented to the Natural Resources Board and made available for public comment in 2001.*

Chapter VII

FLOOD MITIGATION PLAN

This chapter sets forth a description of the flood mitigation plan for the City of Milwaukee, the public participation activities and coordination efforts with other agencies undertaken in the preparation of the plan, strategies for plan implementation, and strategies for plan monitoring.

PLAN DESCRIPTION

The flood mitigation plan for the City of Milwaukee consists of five elements: an environmentally sensitive lands preservation element, a stormwater management element, a floodland management element, a public information and education element, and a secondary plan element. Each element of the plan is a vital component of the City's overall strategy for reducing flood risk and flood damage. As detailed in this chapter as well as in certain portions of previous chapters of this report, many aspects of the overall plan have already been or are already being implemented in the form of existing and ongoing activities being carried out by the City and the Milwaukee Metropolitan Sewerage District (MMSD) that contribute toward realizing the City's flood mitigation goals and objectives.

Environmentally Sensitive Lands Preservation Element

Floodland management regulations and programs perform critical roles toward assuring that flood mitigation efforts are properly implemented. As detailed in Chapter II of this report, the City currently has several pertinent floodland management regulations and programs in place, most notably in the form of City zoning regulations and other ordinances. Environmentally sensitive area and open space preservation in the City of Milwaukee is mainly being carried out by Milwaukee County under it's park and open space planning program.

Floodplain Zoning and Wetland Preservation Zoning

City floodland management regulations include the City's floodplain district zoning ordinance and shoreland-wetland district zoning ordinance. The floodplain zoning ordinance is intended to preserve the floodwater conveyance and storage capacity of floodplain areas within the City and to prevent the location of new flood-damage-prone development in flood hazard areas. The shoreland-wetland zoning ordinance seeks to maintain stormwater and floodwater storage capacity through preservation of shoreland wetlands in the City. Implementation of these ordinances on an ongoing basis is an integral part of the City's flood mitigation strategy and is to continue, with the ordinances being reviewed from time-to-time to ensure their continued effectiveness.

Environmentally Sensitive Area and Open Space Preservation Actions

As noted in Chapter II of this report, the preservation of environmental corridors and important natural features can assist in the prevention of increased flood flows and associated problems. These areas often include the most significant floodplains and wetlands within a given area. The preservation of wetlands is of particular importance because wetlands often afford natural filtration and floodwater storage. In addition, the intrusion of intensive

urban land uses into environmentally sensitive areas may result in the creation of serious and costly problems, such as failing foundations for pavements and structures, wet basements, excessive operation of sump pumps, excessive clearwater infiltration into sanitary sewerage systems, and poor drainage. Destruction of ground cover may result in soil erosion, stream siltation, more rapid runoff, and increased flooding.

The role of preserving the environmental corridors and isolated natural resource areas in the City is carried out in large part by Milwaukee County under its park and open space planning program and by the City of Milwaukee in administering the building sewer extension review program which is designed to limit development of the environmental corridors. Under full implementation of the actions envisioned under these programs, the important natural resource features in the City would be protected and preserved for resource preservation and other open space purposes, as detailed in Chapter II of this report. The County's planned actions with regard to the preservation of environmental corridors and isolated natural resource areas—which encompass much of the wetlands and floodlands in the City—were described in Chapter II.

The actions already taken and planned to be taken with regard to preserving and protecting environmentally sensitive areas and open space areas thus constitute an integral part of the City's flood mitigation efforts. The plan calls for these actions to continue to be implemented.

Stormwater Management Element

Because of the interrelationship between stormwater management and floodland management, stormwater management actions are an important element of the flood mitigation plan. This element of the plan includes stormwater ordinances and related regulations.

Stormwater-Related City Regulations

The City, through Chapter 120 of the municipal code, seeks 1) the promotion of the public health, safety, and general welfare; 2) the establishment of procedures to control the adverse impacts associated with stormwater runoff; 3) assistance in the attainment and maintenance of water quality standards; 4) reduction of the effects of development on land and stream channel erosion; 5) maintenance of runoff characteristics after development as nearly as possible to predevelopment runoff characteristics; and 6) the minimization of damage to public and private property. The specific provisions involved are noted in Chapter II of this report. The City has also enacted a construction site erosion control ordinance based on the State of Wisconsin model ordinance. As in the case of the floodplain and shoreland-wetland zoning provisions noted above, implementation of these ordinances on an ongoing basis is an integral part of the City's flood mitigation strategy and is to continue under this plan.

Floodland Management Element

As noted in Chapter IV, identification, analysis, and recommendation of possible methods of mitigating flooding problems in the City have been the subject of various planning efforts. The most recent effort is that which is currently being carried out by the MMSD under its watercourse system plan update. This planning effort is intended to update and refine the 1990 MMSD watercourse system plan, which in turn was built upon the findings of the comprehensive watershed system plans prepared by SEWRPC for the five major watersheds that lie within the City. As with those earlier efforts, the current planning program uses the watershed as the basic geographic unit for planning. Thus, the floodland management elements set forth below are also presented by watershed in summary form. Additional detail regarding the plan for each watershed is available in the referenced advanced planning reports prepared by various consultants for the MMSD.

Floodland Management Plan for the Kinnickinnic River Watershed

The MMSD is currently in the advanced planning stage of its watercourse system plan for the Kinnickinnic River watershed. As such, final recommendations for flood mitigation are currently being formulated for the three streams for which structural flood damages have been identified. Preliminary information regarding the currently preferred plans is set forth in Table 15 and shown on Maps 13 and 14. As described in Chapters IV and V, major structural improvements have been completed by the City of Milwaukee and the MMSD along the Kinnickinnic River main stem. Those channel modifications have largely resolved a serious flooding problem which had previously affected the most severely flood impacted area in the watershed.

Table 15

COMPONENTS AND COSTS OF FLOODLAND MANAGEMENT PLAN FOR THE KINNICKINNIC RIVER WATERSHED

Stream	Plan Components	Estimated Capital Cost	Estimated Benefits
Lyons Park Creek	1. Replace nine-foot by five-foot reinforced concrete (RC) box under S. 57th Street with 12-foot by six-foot RC box 2. Replace 12-foot by eight-foot RCPA under W. Stack Avenue with 16-foot by eight-foot Racine County box 3. Replace 10-foot by six-foot RC box under W. Cleveland Avenue with 12-foot by eight-foot RC box		
	Subtotal – Lyons Park Creek	$ 778,000	$823,000
Villa Mann Creek Tributary	1. Remove 60-inch and 66-inch RCP between motel parking lot and confluence with Villa Mann Creek 2. Construct open channel between motel parking lot and confluence with Villa Mann Creek 3. Replace 60-inch and 66-inch RCP motel parking lot with 8.5-foot by five-foot RC box		
	Subtotal – Villa Mann Creek Tributary	$ 633,000	$248,000
Kinnickinnic River	1. Regrade streambank along 2,700-foot-long reach between S. 43rd and S. 60th Streets 2. Construct concrete headwalls and/or end sections with riprap revetments		
	Subtotal – Kinnickinnic River	$1,000,000	--[a]
	Total – Watershed	$2,411,000	--

[a]*Project is designed to eliminate streambank erosion. Thus, there are no direct quantitative monetary flood abatement benefits.*

Source: Harza Engineering Company, U.S. Army Corps of Engineers, Milwaukee Metropolitan Sewerage District, and SEWRPC.

In 2002, the mayor of the City of Milwaukee, citing safety and environmental concerns, pledged to improve streams in the Milwaukee area by removing the existing concrete linings, as exists along the Kinnickinnic River between S. 6th and S. 27th Streets. As a result, the U.S. Army Corps of Engineers is currently conducting a feasibility study of the lining removal for the River. There are no current recommendations as to the removal of the lining, however, any future plan for such removal will need to address the impact on flooding along that stream reach.

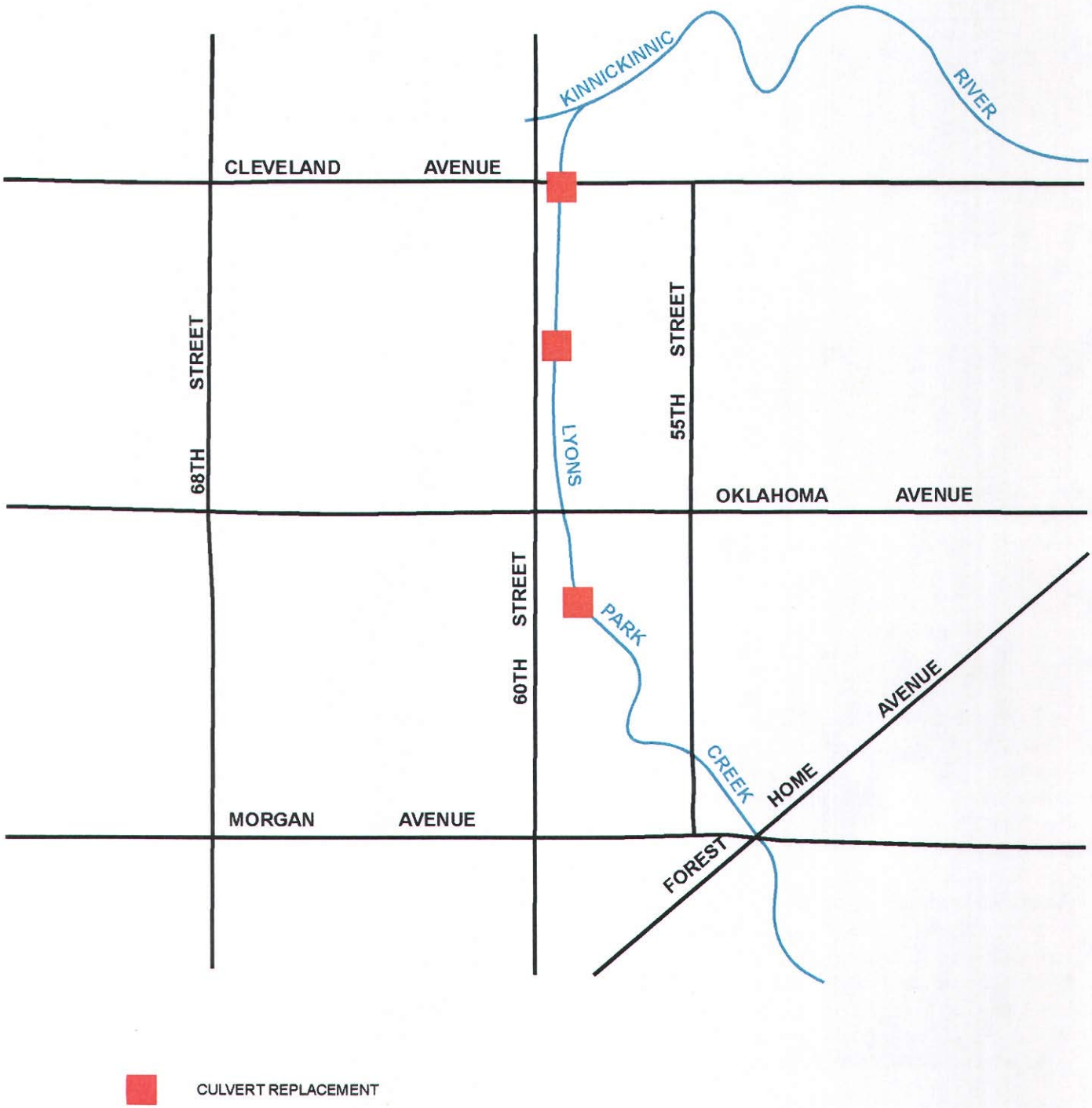
As shown on Map 13, the currently preferred plan for Lyons Park Creek consists of replacement of existing roadway culverts at S. 57th Street, W. Stack Drive, and W. Cleveland Avenue. At S. 57th Street the existing nine-foot-wide by five-foot-high reinforced concrete box culvert would be replaced with a 12-foot-wide by six-foot-high reinforced concrete box culvert. At W. Stack Avenue the existing 12-foot-wide by eight-foot-high corrugated metal pipe arch would be replaced with a 16-foot-wide by eight-foot-high reinforced concrete box culvert. At W. Cleveland Avenue the existing 10-foot-wide by six-foot-high reinforced concrete box culvert would be replaced with a 12-foot-wide by eight-foot-high reinforced concrete box culvert.

Along the Villa Mann Creek Tributary, the existing channel enclosure east of S. 27th Street would be replaced with an open channel between the existing motel parking lot and the confluence with Villa Mann Creek, a distance of about 700 feet. The capacity of the existing 60- and 66-inch-diameter reinforced concrete circular culverts conveying the channel beneath the parking lot would be increased by adding a culvert of similar size.

Although no structural flood damages have been identified within the City along S. 43rd Street Ditch, measures aimed at alleviating flooding north of W. Lincoln Avenue in the City of West Milwaukee may be located within

Map 13

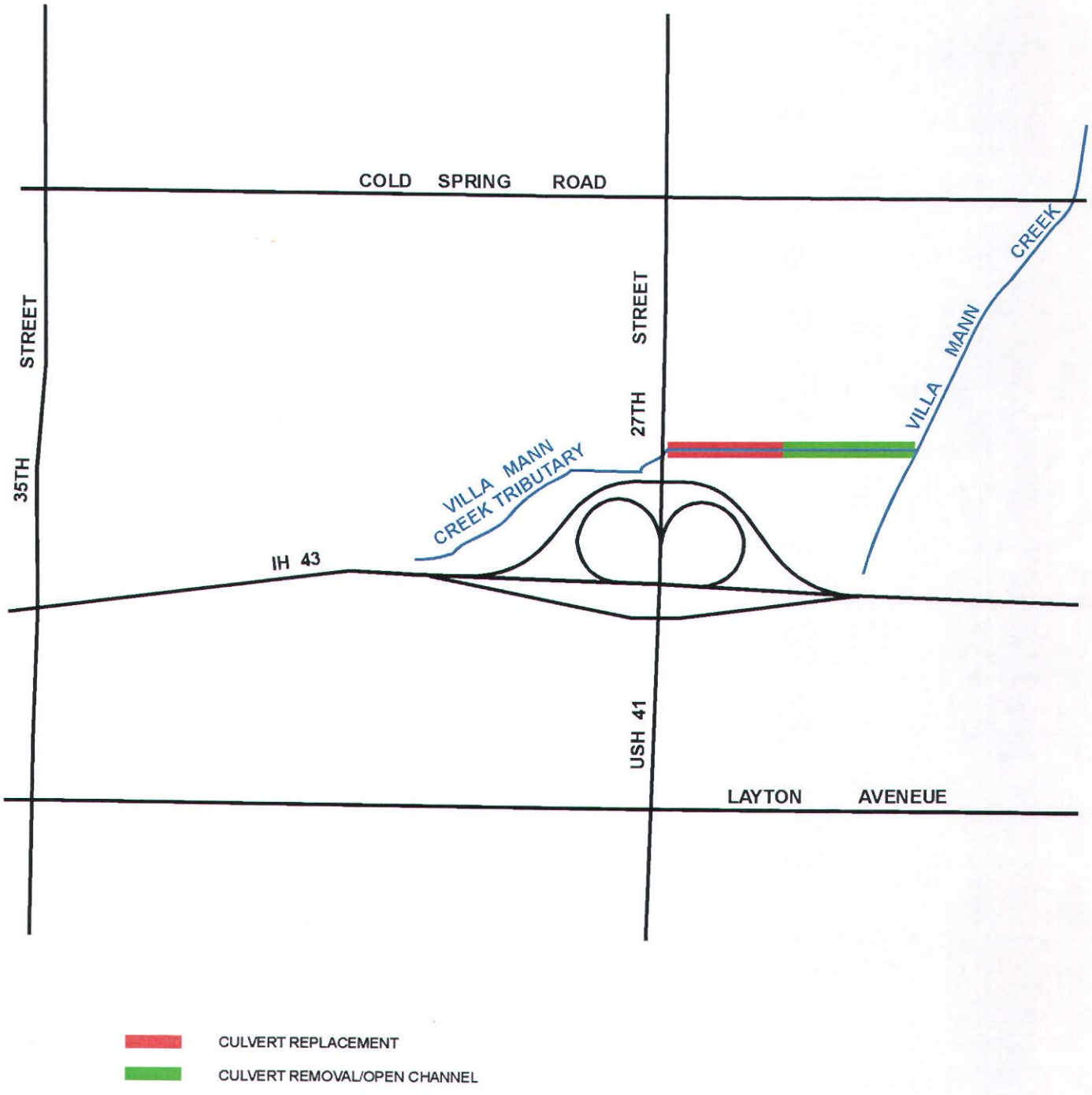
FLOOD CONTROL PLAN FOR LYONS PARK CREEK



Source: Harza Engineering Company and SEWRPC.

Map 14

FLOOD CONTROL PLAN FOR VILLA MANN CREEK TRIBUTARY



Source: Harza Engineering Company and SEWRPC.

the City of Milwaukee portion of the subwatershed. The MMSD is currently working with the communities to arrive at a workable plan for this area.

Full implementation of the floodland management actions for the subwatershed areas involved would eliminate structure flood damages due to direct overland flooding along Lyons Park Creek and the Villa Mann Creek Tributary for floods up to and including the 100-year recurrence interval flood event under planned land use and channel conditions.

In addition to those actions directed at eliminating structural flood damages, the MMSD is currently partnering with the U.S. Army Corps of Engineers on a project to address serious streambank erosion problems along the Kinnickinnic River in the City, as noted in Chapter IV. The plan as developed by the Corps involves a 2,700-foot reach of the River between S. 43rd and S. 60th Street. Within this reach, selected portions of the streambank at five locations would be stabilized through the placement of riprap revetments, while existing storm sewer outfall culverts would be extended.

As shown in Table 15, the estimated capital cost of implementing the currently preferred floodland management plan for the Kinnickinnic River watershed is about $1.4 million, plus an additional $1.0 million for the streambank stabilization measures along the Kinnickinnic River. The cost of any additional plan for the S. 43rd Street Ditch is not included in this total.

Floodland Management Plan for the Menomonee River Watershed

In July 2002, the MMSD released the Phase 2 report for its watercourse system plan for the Menomonee River watershed. The floodland management plan resulting from that advanced planning stage, for those stream reaches that impact the City of Milwaukee, is set forth in Table 16 and shown on Maps 15, 16, and 17.

As shown on Map 15, the floodland management plan for the Menomonee River calls for a combination of the following measures: 1) acquisition of eight properties and construction of 750 feet of earthen berm and 750 feet of concrete floodwall in the Valley Park neighborhood in the City of Milwaukee; 2) acquisition of 46 properties, lowering the floodplain by one to two feet, and construction of about 6,500 feet of earthen berm in the Hart Park area of the City of Wauwatosa; 3) acquisition of one residential and 16 nonresidential structures in the Cities of Milwaukee and Wauwatosa; 4) floodproofing of four municipal buildings in Hart and Jacobus Parks in the City of Wauwatosa; 5) lowering the floodplain by one to two feet and construction of about 4,200 feet of levees and floodwalls in the City of Milwaukee; 6) construction of an 800 acre-foot detention basin on the Milwaukee County Grounds in the City of Wauwatosa; 7) raising the height of the existing levee and floodwall at the Falk Corporation property by up to five feet to prevent overtopping during a 100-year flood event; and 8) removal or replacement of an existing access bridge upstream of Hawley Road in the City of Milwaukee. Although some of these plan elements are located outside of the City of Milwaukee, they are integral to the design and function of those elements that are located in the City. In particular, the floodplain lowering along Hart Park and the Milwaukee County Grounds detention basin serve to reduce downstream flood discharges in Milwaukee, thus, reducing the size of the required plan elements in that area. Thus, the plan as a whole is presented herein.

As of mid-2002, the MMSD had completed the property acquisition and construction of the earthen berm and floodwall in the Valley Park neighborhood. Also, as of mid-2002, the acquisition and removal of the 46 structures in the Hart Park area of the City of Wauwatosa was nearly completed.

In 2001, the MMSD completed the construction of the 58 acre-foot dry detention basin for Grantosa Creek at Timmerman Airport in the City of Milwaukee. That detention basin serves to eliminate overland flooding to buildings immediately south of W. Hampton Avenue in the City of Wauwatosa, and to reduce surcharging along the Grantosa Creek enclosure along N. 100th Street and W. Grantosa Avenue. As part of the second phase system planning for Grantosa Creek, field surveys were conducted along the lower Grantosa Creek area and along the channel enclosure. Those surveys indicated that no structures in the City of Milwaukee would be subject to flooding during a 100-year recurrence interval event.

Table 16

COMPONENTS AND COSTS OF FLOODLAND MANAGEMENT PLAN FOR THE MENOMONEE RIVER WATERSHED

Stream	Plan Components	Estimated Capital Cost	Estimated Benefits
Menomonee River	1. Acquire eight residential properties in the Valley Park neighborhood 2. Construct 750-foot-long berm and 750-foot-long reinforced concrete floodwall along Valley Park neighborhood 3. Acquire 46 structures in the Hart Park neighborhood 4. Lower floodplain by one to two feet in the Hart Park area and western Milwaukee area 5. Construct 6,500 feet of earthen berm in the Hart Park area 6. Acquire one residential and 16 nonresidential structures in the Cities of Milwaukee and Wauwatosa 7. Floodproof four municipal structures in Hart Park and Jacobus Park in the City of Wauwatosa 8. Construct 4,200 feet of levees and floodwalls in the western Milwaukee area 9. Construct 800 acre-foot detention basin on Milwaukee County Grounds 10. Raise the height of the existing levee and floodwall at the Falk Corporation property 11. Remove or replace access bridge located upstream of Hawley Road		
	Subtotal – Menomonee River	$ 96,000,000 - $124,000,000	$10,300,000[a]
Grantosa Creek	1. Construct 58 acre-foot detention basin at Timmerman Airport		
	Subtotal – Grantosa Creek	--[b]	--[b]
Little Menomonee River	1. Acquire one residential property		
	Subtotal – Little Menomonee River	$ 150,000	$ 20,000
	Total – Watershed	$ 96,150,000 - $124,150,000	$10,320,000

[a]Benefits taken from MMSD Menomonee River Phase 1 system plan and reflects reduction of damages in both the Cities of Milwaukee and Wauwatosa.

[b]No cost or benefit given. This element has already been implemented.

Source: Milwaukee Metropolitan Sewerage District; Earth Tech, Inc.; and SEWRPC.

The floodland management measures for the Little Menomonee River are shown on Map 17, and include the acquisition of one residential property.

Full implementation of the floodland management actions recommended for the subwatershed areas involved would eliminate structure flood damages due to direct overland flooding along the Menomonee River, Grantosa Creek, and the Little Menomonee River for floods up to and including the 100-year recurrence interval flood event under planned land use and channel conditions.

As shown in Table 16, the estimated capital cost of implementing that portion of the recommended floodland management plan for the Menomonee River watershed that directly impacts on the City of Milwaukee would range from about $96 to $124 million.

Map 15

FLOOD CONTROL PLAN FOR THE MENOMONEE RIVER

100-YEAR RECURRENCE INTERVAL FLOODPLAIN BOUNDARY-PLANNED LAND USE AND EXISTING CHANNEL CONDITIONS

FLOODPROOF/ACQUISITION AND FLOODPLAIN LOWERING AREA

LEVEE/BERM

STORAGE FACILITY

BYPASS CHANNEL

Source: SEWRPC.

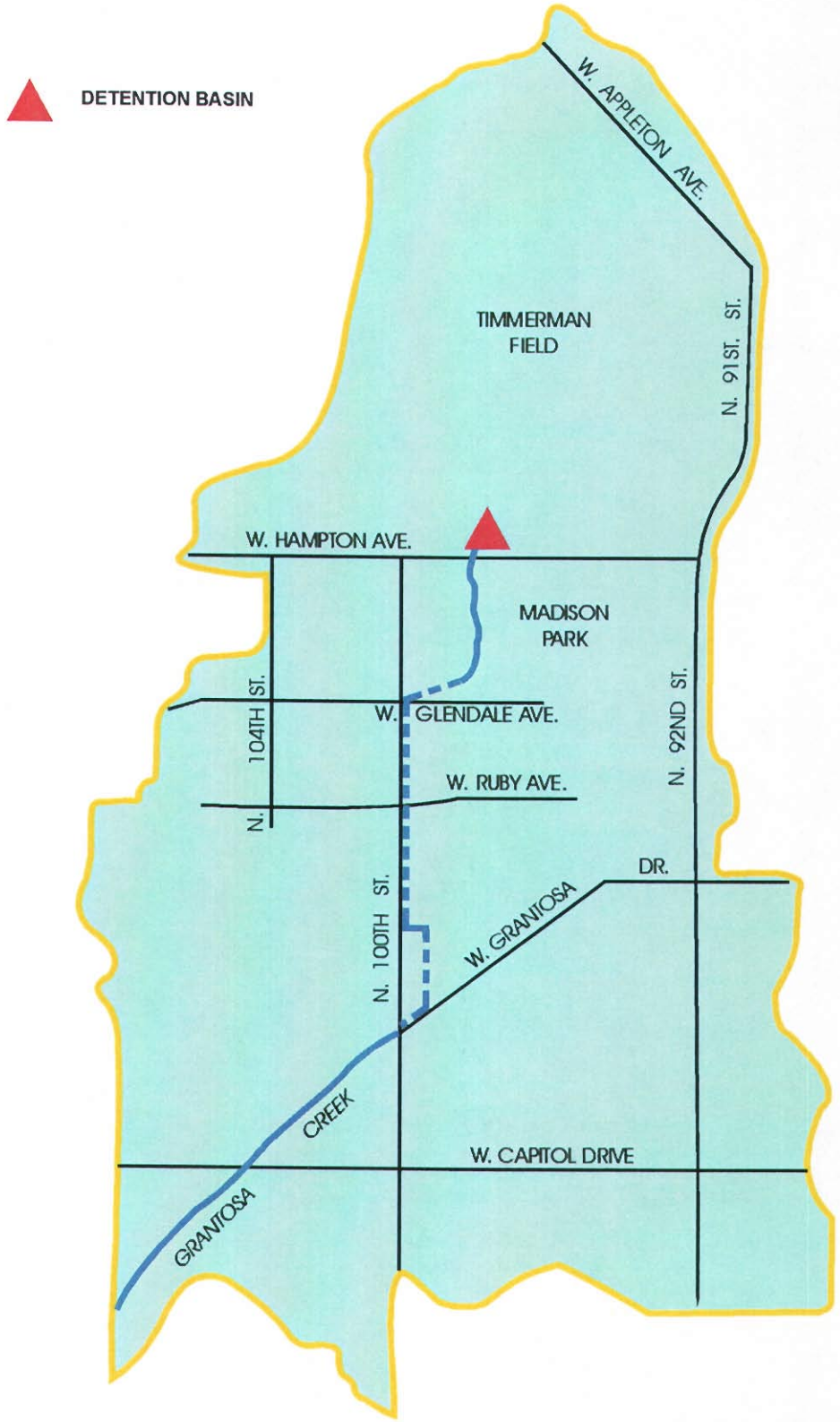
DATA OF PHOTOGRAPHY: MARCH 2000

GRAPHIC SCALE

2000 0 2000 4000 Feet

Map 16

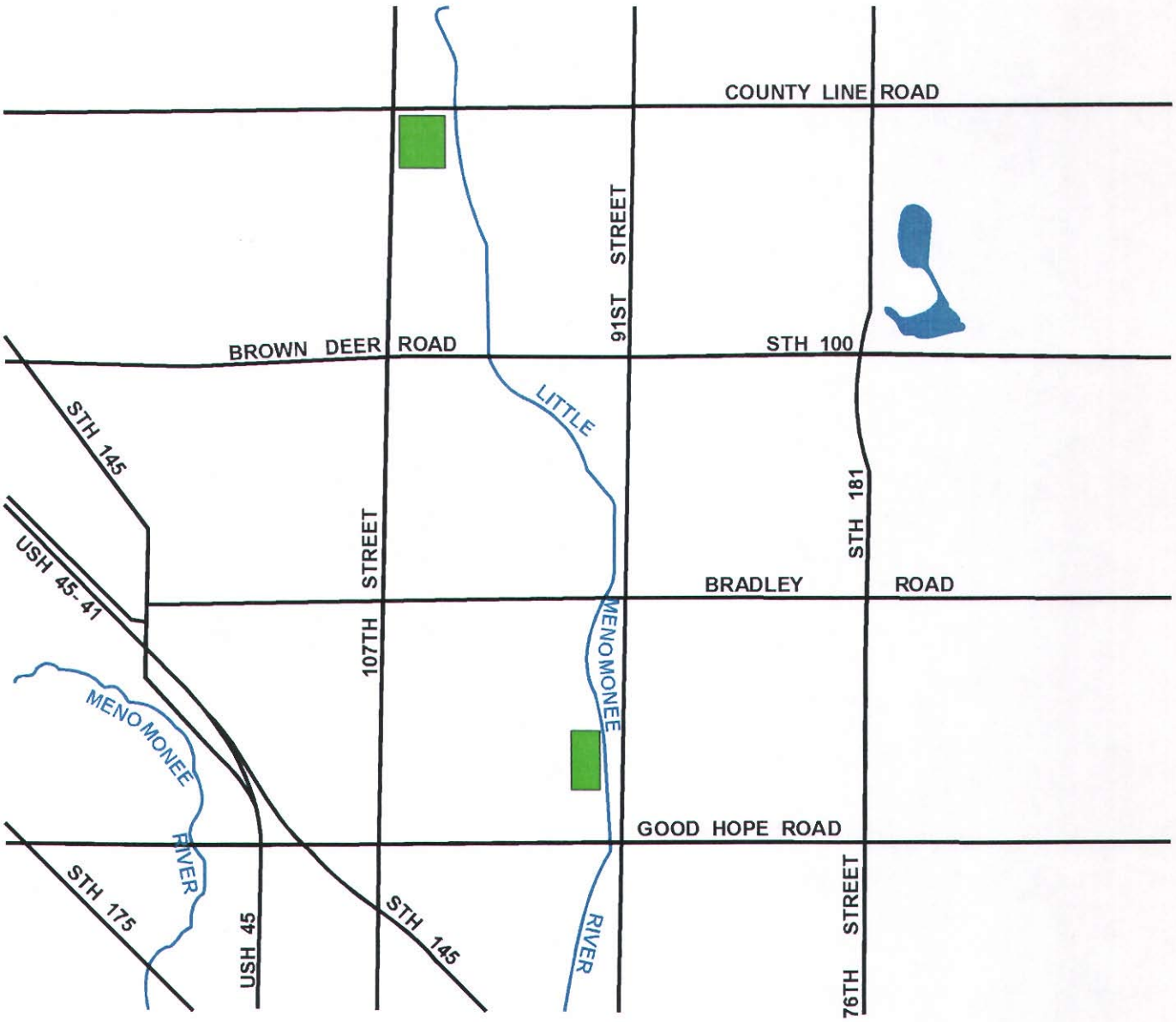
FLOOD CONTROL PLAN FOR GRANTOSA CREEK



Source: Earth Tech, Inc., and SEWRPC.

Map 17

FLOOD CONTROL PLAN FOR THE LITTLE MENOMONEE RIVER



Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

In addition to the specific mitigation measures recommended above, it is important to note that there are a number of projects in the planning and design phases proposed in the Menomonee Valley area which are planned to incorporate stormwater and floodland management measures. These include development of an environmentally sensitive industrial park on a large tract of vacant land between 27th Street and Miller Park, the planned reconstruction and extension of Canal Street, and other projects being coordinated by the City of Milwaukee Department of City Development and the Menomonee Valley Partners. Stormwater and floodland management measures are being integrated into these projects as part of the overall project design.

Floodland Management Plan for the Milwaukee River Watershed

As reported in Chapter V, current floodland management planning in the Milwaukee River watershed as it relates to the City of Milwaukee is focused on the Lincoln Creek and, to a lesser extent, the Southbranch Creek subwatersheds. The floodland management plans for Lincoln Creek and Southbranch Creek are set forth in Table 17, and shown on Maps 18 and 19, respectively. As of mid-2002, the plans for both streams had been fully implemented.

Full implementation of the floodland management actions for the subwatershed areas involved should eliminate structure flood damages due to direct overland flooding along Lincoln Creek and Southbranch Creek for floods up to and including the 100-year recurrence interval flood event under planned land use and channel conditions. Roadway flooding during the 100-year flood event should also be eliminated. Of note is the fact that 205 of the 207 repetitive-loss properties reported in Chapter IV are located within the Lincoln Creek subwatershed, and thus addressed by the floodland management plan. This includes three properties that meet the FEMA high-priority criteria.

Floodland Management Plan for the Oak Creek Watershed

The MMSD is currently in the advanced planning stage of its watercourse system plan for the Oak Creek watershed. As such, final recommendations for flood mitigation are now being formulated for the two streams for which structural flood damages have been identified in the City of Milwaukee portion of the watershed. Information regarding the preliminary recommendations is set forth in Table 18 and shown on Map 20.

As shown on Map 20, the preliminary recommendation as it pertains to the upper portion of the North Branch of Oak Creek consists of constructing a concrete floodwall along the north side of the stream channel and replacing the S. 13th Street bridge. This recommendation was formulated under the second, advanced planning phase.

The preliminary floodland management recommendation for the Mitchell Field Drainage Ditch consists of floodproofing three structures belonging to the Wisconsin Air National Guard, located at Milwaukee Mitchell International Airport. This recommendation is subject to change as the ongoing advanced planning work by the MMSD is investigating additional plan options. Determination of a final plan will be based upon coordination with all parties involved, including the MMSD, Milwaukee County, and the City of Milwaukee.

Full implementation of the preliminary floodland management actions recommended for the subwatershed areas involved would eliminate structure flood damages due to direct overland flooding along the North Branch of Oak Creek and the Mitchell Field Drainage Ditch in the City of Milwaukee for floods up to and including the 100-year recurrence interval flood event under planned land use and channel conditions.

As shown in Table 18, the estimated capital cost of implementing the City of Milwaukee portion of the Oak Creek watershed floodland management plan is about $986,000.

Public Information and Education Element

Public information, education, and participation constitute an integral aspect of the City of Milwaukee's flood mitigation and related efforts. As discussed in Chapter II, informational and educational efforts oriented toward resolving the flooding and related stormwater drainage and sanitary sewer backup problems in the City have been addressed primarily through the combined efforts of the City, the MMSD, and Milwaukee County. This element

Table 17

COMPONENTS OF FLOODLAND MANAGEMENT PLAN FOR THE MILWAUKEE RIVER WATERSHED[a]

Stream	Plan Components
Lincoln Creek	1. Lower floodplain along 0.70-mile-long reach between N. Teutonia Avenue and a point downstream from W. Villard Avenue 2. Replace existing concrete lining with turf and add low-flow aquatic habitat along 0.60-mile-long reach between N. Teutonia Avenue and N. 32nd Street 3. Modify channel with selected floodplain lowering and add low-flow aquatic habitat along 2.34-mile-long reach between N. 32nd Street and N. 60th Street 4. Replace existing concrete lining with turf and add low-flow aquatic habitat along 1.56-mile-long reach between N. 60th Street and a point upstream from W. Silver Spring Drive 5. Channel modification along 2.65-mile-long reach between a point upstream from W. Silver Spring Drive and the Union Pacific Railroad crossing located east of N. 60th Street 6. Construct 85 acre-foot detention basin north of W. Greentree Road 7. Construct 90 acre-foot detention basin at Havenwoods State Forest 8. Create detention storage by lowering the north overbank north of W. Silver Spring Drive 9. Replace, modify, or remove 13 bridges and culverts
	Subtotal – Lincoln Creek
Southbranch Creek	1. Construct 19 acre-foot detention basin south of W. Bradley Road 2. Construct 17 acre-foot detention basin at Brown Deer Village Library 3. Construct 11 acre-foot detention basin south of Dean Elementary School 4. Construct 22 acre-foot detention basin along Churchill Lane between N. 48th and N. 51st Streets 5. Modify channel along 1,300-foot-long reach between W. Bradley Road and a point about 560 feet downstream from N. 55th Street 6. Replace culvert under N. 51st Street with two 10-foot by seven-foot reinforced concrete box culverts 7. Replace existing culvert under N. 53rd/54th Street with open channel 8. Replace culvert under N. 55th Street with two 12-foot by six-foot reinforced concrete box culverts

[a]*As of mid-2002, the floodland management plans for Lincoln Creek and Southbranch Creek had been implemented. Therefore, no cost estimate for these plans is provided.*

Source: CH2M Hill; Earth Tech, Inc.; and SEWRPC.

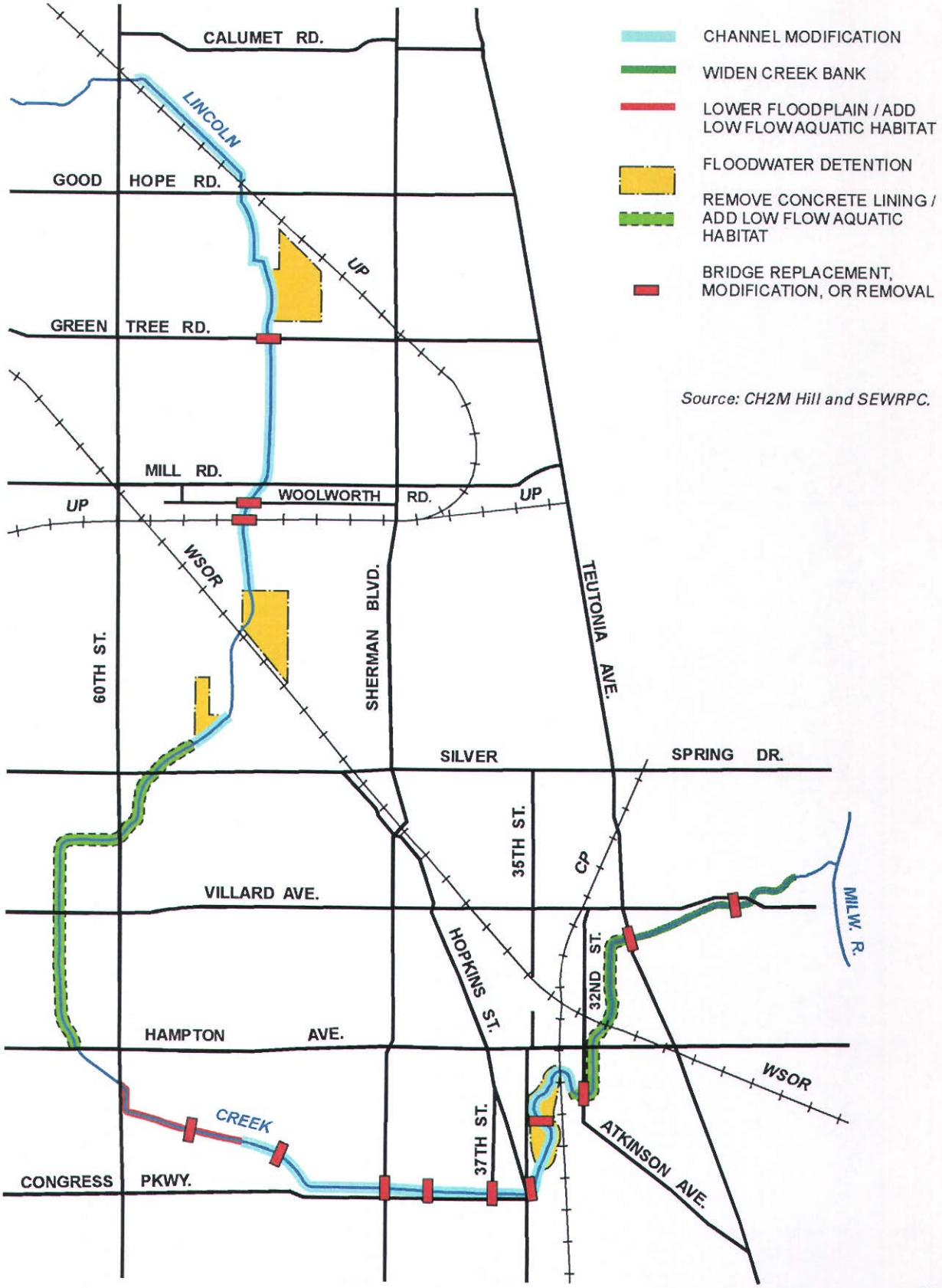
has been carried out under three subelement activities which are expected to be continued. These three subelements include the MMSD stakeholder groups, public education activities, and public information programming and coordination associated with detailed stormwater and floodland management plans.

MMSD Stakeholder Groups

The first subelement involves the creation and activity of the MMSD stakeholder groups as described in Chapter II of this report. These groups have been formed by the MMSD on a watershedwide basis and include representatives of the City of Milwaukee and other concerned local units of government including Milwaukee County, SEWRPC, and Wisconsin Department of Natural Resources (WDNR), as well as other public and/or private agencies and organizations such as environmental and neighborhood organizations and concerned private businesses. Stakeholder meetings allow the various parties involved to offer feedback to the MMSD regarding the

Map 18

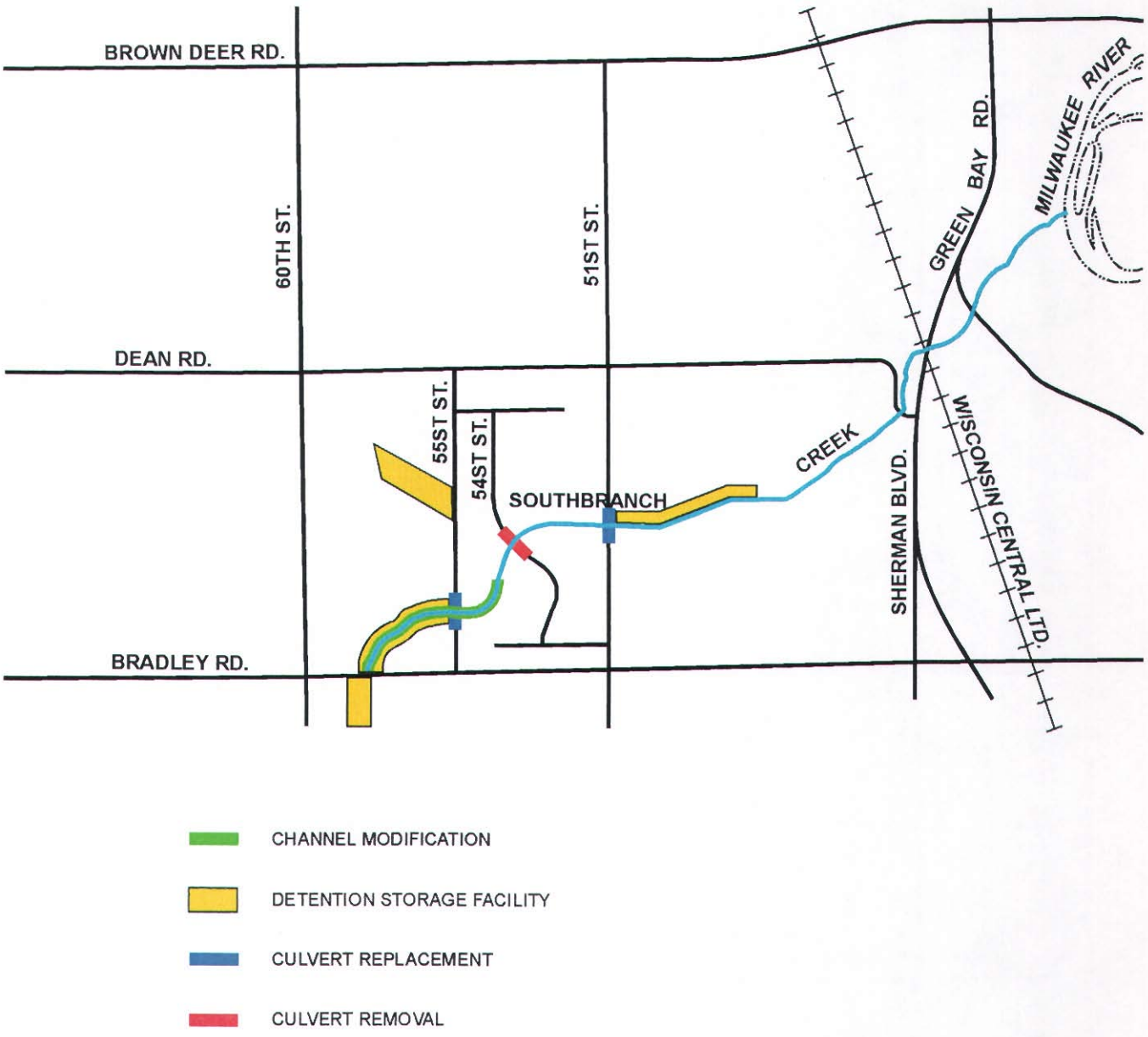
FLOOD CONTROL PLAN FOR LINCOLN CREEK



Source: CH2M Hill and SEWRPC.

Map 19

FLOOD CONTROL PLAN FOR SOUTHBRANCH CREEK



Source: Earth Tech, Inc., and SEWRPC.

Table 18

COMPONENTS AND COSTS OF FLOODLAND MANAGEMENT PLAN FOR THE OAK CREEK WATERSHED

Stream	Plan Components	Estimated Capital Cost	Estimated Benefits
North Branch of Oak Creek	1. Construct concrete floodwall along stream channel. Replace S. 13th Street bridge		
	Subtotal – North Branch of Oak Creek	$3,720,000	$383.00
Mitchell Field Drainage Ditch	1. Floodproof three buildings at Wisconsin Air National Guard at Milwaukee Mitchell International Airport		
	Subtotal – Mitchell Field Drainage Ditch	$ 466,000	$119,000
	Total – Watershed	$4,186,000	$502,000

Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

development of its stormwater and floodland management plans. Stakeholder meetings have been held since 1998 and continue to be held through the planning process.

Public Education Activities

The second subelement involves preparation and distribution of educational and self-help materials and provision of educational programs. Under this subelement of the flood mitigation plan, the MMSD has prepared and distributed various public informational and educational materials, including materials oriented toward local homeowners and local government agencies and designed to help them consider and potentially undertake actions to mitigate damage caused by stormwater flooding and sanitary sewer backups throughout the District, including the City of Milwaukee. In addition, the MMSD has established an internet site aimed at keeping interested parties up-to-date on the its planning activities. The District has also undertaken an extensive public informational and educational program directed toward reducing infiltration and inflow into its sanitary and combined sewer systems. That program includes radio programming, public educational materials, and the financing of pilot demonstration projects for I/I removal in eight communities.

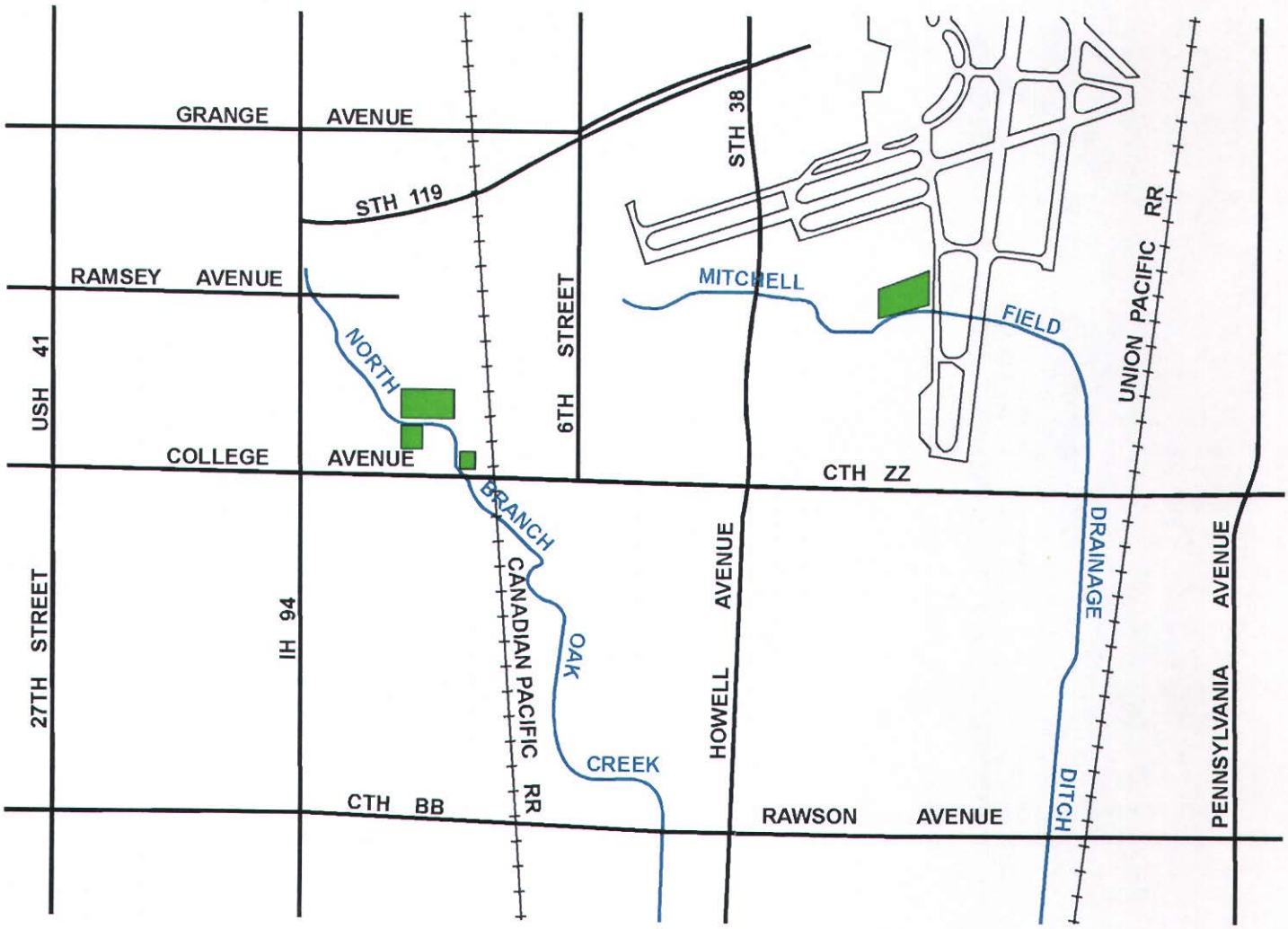
In addition to the MMSD efforts, the Milwaukee County Sheriff's Department, Division of Emergency Management, has prepared and distributes a number of public educational materials, a self-help booklet for local property owners (see Appendix A). The guide sets forth potential preventive measures that may be taken by homeowners to mitigate flood damages. The booklet also provides basic information about flood warnings, as well as NFIP and various Federal and State aid programs that may be available to flood victims. In addition to the booklet, a corresponding videotape is available through the Milwaukee County Federated Library System and the Milwaukee County Sheriff's Department, Division of Emergency Management.

Public Participation Activities and Coordination with Other Agencies and Units of Government

The third subelement of this program involves direct public participation and coordination with other agencies during detailed stormwater and floodland management plan development. As previously noted, the MMSD has formed stakeholder groups to help guide the planning process for each of the major watersheds within its jurisdiction. These groups allow local officials and neighborhood groups an opportunity to provide information regarding flooding and drainage problems, as well as comments regarding potential solutions for those problems. In some municipalities, the MMSD has also held community workshops to obtain input regarding possible solutions to flooding problems in the context of what kind of community resource area residents desire regarding their watercourse. Also, the City of Milwaukee and the MMSD have participated in a series of meetings with the Southeastern Municipal Executives (SEME). These meetings, facilitated by SEWRPC, have focused on identifying common goals and intergovernmental efficiencies to produce more effective solutions to flooding problems.

Map 20

FLOOD CONTROL PLAN FOR THE NORTH BRANCH
OF OAK CREEK AND THE MITCHELL FIELD DRAINAGE DITCH



Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

Toward further informing the public regarding flood mitigation, stormwater and floodland management, and related issues, the MMSD and other concerned units and agencies of government, including the City of Milwaukee and Milwaukee County, should continue to involve members of the general public and to seek public input in the preparation and implementation of recommendations regarding such issues.

Secondary Plan Element

In addition to the abovenoted measures, several secondary measures are also to be implemented. These secondary measures are described below.

National Flood Insurance Program and Floodplain Map Updating Efforts

The City of Milwaukee has been designated by the Federal Emergency Management Agency (FEMA) as having flood hazard areas and has taken the steps needed to make its residents eligible to participate in the National Flood Insurance Program (NFIP). An initial Flood Insurance Study (FIS) has been completed by FEMA for the City. The City shall continue to participate in the NFIP and, as necessary, shall request that FEMA revise local flood insurance studies to reflect new flood hazard data. Furthermore, owners of property in floodprone areas within the City should purchase flood insurance to provide some financial relief for losses sustained in floods that may occur before the implementation of any recommended flood control measures. Finally, as the flood control measures are implemented, FEMA should make necessary revisions to the flood insurance study for the City.

As detailed in Chapter II of this report, the floodplains in the City are currently delineated and mapped as documented in a FEMA FIS dated November 1987. In 1990 a cooperative agreement was executed between Milwaukee County and three local utility companies for the development and maintenance of a Milwaukee County Automated Land Information System (MCAMLIS). Under that program, large-scale digital topographic mapping has been prepared for all of Milwaukee County, including the City of Milwaukee. The MCAMLIS Steering Committee has also requested that SEWRPC carry out a digital floodplain mapping program. That program is being conducted as a cooperative effort between SEWRPC and the MMSD. As part of that program, hydrologic and hydraulic analyses are being conducted to update flood flows and stages to reflect current channel conditions, as well as a uniform land use condition. The updated analyses and floodplain mapping will reflect completed flood mitigation projects and other changed conditions, such as the removal of the North Avenue dam. The City of Milwaukee is currently in the process of coordinating the preparation, approval, and adoption of updated mapping, with the emphasis on the Menomonee River, Lincoln Creek, and Milwaukee River areas. Thus, the resulting floodplains will represent a revision of those based on the FEMA FIS and currently used for zoning purposes by the City of Milwaukee.

Upon completion of the MCAMLIS floodplain mapping program, the City shall amend its floodplain zoning ordinance to reflect the updated 100-year recurrence interval water surface profiles. In doing so, the City will first need to submit its proposed floodplain revisions and additions to the WDNR for approval and also request revision of the applicable flood insurance rate maps by the FEMA Federal Insurance Administration.

Lending Institution and Real-Estate-Agent Policies

The plan calls for lending institutions to continue their practice of determining the floodprone status of properties before mortgage transactions and that the principal sources of flood hazard information be the most recent available studies for the watersheds and subwatersheds located partly or wholly within the City. Furthermore, real-estate brokers and salespersons are to continue to inform potential purchasers of property of any flood hazard that may exist at the site being traded in accord with rules of the Wisconsin Department of Regulation and Licensing, Bureau of Direct Licensing and Real Estate.

Community Utility Policies and Emergency Programs

The policies of the governmental units and agencies responsible for the design, construction, operation, and maintenance of public utilities and facilities, such as water supply and sewerage facilities, drainageways, and streets and highways, are to carry out those functions in a manner fully consistent with the land use and floodland regulation recommendations set forth or noted in this plan. Also, the City of Milwaukee and Milwaukee County will continue to implement existing emergency procedures and develop appropriate new emergency procedures as

needed to provide residents of the City with timely information about floods in progress and to help them in taking appropriate action.

Stream Channel Maintenance

The City of Milwaukee will work cooperatively with the MMSD to continue and expand a program of regular stream channel maintenance. This program would include the periodic removal of sediment deposits, selected heavy vegetation, and debris from all watercourses within the City, including bridge openings and culverts. Under a 1999 revision to its watercourse policy plan,[1] the MMSD would assume responsibility for carrying out channel maintenance duties for the streams under its jurisdiction, but only under certain conditions. Specifically, the MMSD would conduct channel clearing only for those instances where the deposition of sediment or debris would materially raise the elevation of the 100-year recurrence interval flood profile as established under its watercourse system plan such that additional structures would be placed within the resulting floodplain. In no instance would the MMSD assume responsibility for the clearing of bridge and culvert openings. While the criteria used by the MMSD would address the most severe problems associated with channel obstructions, it does not address the potential for other problems that may arise, such as an increase in the incidence and severity of roadway flooding and the obstruction of storm sewer outlets. Those problems will need to be addressed by the City of Milwaukee. Therefore, the City will work with the MMSD in identifying those instances where channel maintenance would meet the MMSD criteria. The City will also develop its own program for providing channel maintenance where the MMSD jurisdiction is not in place.

Stormwater Management Facilities Maintenance

The effectiveness of stormwater management conveyance and detention facilities and other management measures can be sustained only if proper operation, repair, and maintenance procedures are carefully followed. Important maintenance procedures include the periodic repair of storm sewers, clearing of sewer obstructions, maintenance of open vegetation channel linings, clearing of debris and sediment from open channels, maintenance of detention facility inlets and outlets, maintenance of detention basin vegetative cover, and periodic removal of sediment accumulated in detention basins. The plan calls for these maintenance activities to be carried out on a continuing basis to maximize the effectiveness of the stormwater management facilities and measures and to protect the capital investment in the facilities.

PROBLEM RESOLUTION FOR REPETITIVE LOSS STRUCTURES

As reported in Chapter IV of this report, there are 168 single-family residences, 36 multi-family residences, and three nonresidential buildings categorized by the Federal Emergency Management Agency as repetitive loss structures. There are 205 of these structures located in the Lincoln Creek subwatershed. Three of those structures are also in the FEMA "high priority" target list. As noted above, the floodland management measures that have recently been completed by the MMSD for that stream are expected to eliminate all structural damages due to overland flooding for floods up to and including the 100-year recurrence interval event.

There are two remaining repetitive loss structures in the City of Milwaukee, one of which is an industrial building located in the Brown Deer Park Creek subwatershed, and the other is a tavern with attached living quarters located in the Kinnickinnic River watershed. Both of these structures are located well away from the receiving stream for their respective drainage basin, and neither of them is located within the identified 100-year recurrence interval floodplain. Thus, it would appear that damages sustained at these two locations were related to localized stormwater drainage problems and not by direct stream flooding. Neither property reported damage from the 1997

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[1]*A policy for MMSD stormwater drainage and flood control was initially set forth in SEWRPC Community Assistance Planning Report No. 130,* A Stormwater Drainage and Flood Control Policy Plan for the Milwaukee Metropolitan Sewerage District, *March 1986. In 1998 the Milwaukee Metropolitan Sewerage Commission formed a Watercourse Policy Advisory Group to review and revise the District's policy plan. The recommendations of that committee were adopted by the Sewerage Commission in 1999.*

or 1998 flood events. There are currently no stormwater or floodland management plans for the respective receiving streams for these two properties.

PLAN IMPLEMENTATION STRATEGIES

The flood mitigation plan described in this report is designed to attain, to the maximum extent practicable, the goals and objectives set forth in Chapter III of this report. In a practical sense, however, the plan is not complete until the steps to implement it—that is, to convert the plan into action policies and programs—have been specified. Following formal adoption of the plan by the City of Milwaukee, realization of the plan will require a long-term commitment to the objectives of the plan and a high degree of coordination and cooperation among City officials and staff and various City departments and; intergovernmental task forces or other committees that may be created in the future to help address common flood mitigation issues; other concerned units and agencies of government and their respective officials and staffs, area developers and lending institutions, and concerned private citizens in undertaking the substantial investments and series of actions needed to implement the plan. Other units and agencies concerned in plan implementation include, but are not limited to, the MMSD; other municipalities located partly or wholly within the watershed areas that lie partly within the City of Milwaukee; the Milwaukee County Sheriff's Department, Division of Emergency Management; SEWRPC; the WDNR; the Wisconsin Department of Military Affairs, Division of Emergency Management; and FEMA. A summary of the plan elements, including estimated costs, designated management agencies, and schedules is included in Table 19.

Implementation Strategies: Environmentally Sensitive Lands Preservation Element
As noted previously in this chapter and as detailed in Chapter II of this report, the City of Milwaukee and Milwaukee County currently have several regulations and programs in place that are relevant to floodland management. Regulations and programs that are implemented and enforced by the City's Departments of City Development and Public Works include floodplain zoning, shoreland-wetland zoning, and other related ordinances. The Milwaukee County Department of Parks, Recreation and Culture is responsible for implementation of the County parks and open space plan.

The plan calls for the City to continue to implement, on an ongoing basis, its floodplain district zoning ordinance and its shoreland-wetland zoning ordinance. It also calls for the City to continue to implement, on an ongoing basis, its ordinances regarding the control of erosion at construction sites. Similarly, the plan calls for Milwaukee County to continue to carry out, on an ongoing basis, its previously determined actions to protect and preserve the environmentally sensitive areas and open space areas located within the City, including actions to protect and preserve environmental corridors and isolated natural resource areas within the City for resource preservation and other open space purposes, as envisioned under the County's park and open space planning program.

Implementation Strategies: Stormwater Management Element
As noted previously in this chapter, the City has ordinance provisions that pertain to stormwater management, including the following: 1) the prohibition of discharging, spilling, or dumping substances or materials that are not entirely composed of stormwater into receiving bodies of water, storm sewers, or drainage facilities, or onto areas that drain into the stormwater drainage system; 2) the prohibition of connecting any building wastewater sewer or drain to the stormwater drainage system; and 3) requirement of the development and approval of a stormwater management plan for any residential, commercial, industrial, or institutional improvement or subdivision of property with a gross aggregate area of five acres or more. To help assure that stormwater runoff does not increase downstream flows or aggravate flooding problems, the City is to continue to implement these regulations on an ongoing basis.

Implementation Strategies: Floodland Management Element
Coordination with land use development and redevelopment is fundamental to successful implementation of a floodland management plan. Within the City of Milwaukee "buildout" land use conditions has almost been achieved. The estimated rates and volumes of runoff used in the development of the recommended floodland management actions under the current MMSD planning effort were determined based on planned year 2020 land

Table 19

CITY OF MILWAUKEE FLOOD MITIGATION PLAN SUMMARY AND IMPLEMENTATION STRATEGIES

Plan Element and Plan Adoption	Subelement and Plan Implementation Strategies	Estimated Capital Cost	Designated Management Agency	Implementation Status Notes	Plan Implementation Schedule
Environmentally Sensitive Land Preservation	Continue to implement floodplain zoning and wetland preservation zoning	--[a]	City of Milwaukee and Milwaukee County	Plan implementation largely complete in City of Milwaukee. Wetland areas are under County or City ownership. Additional actions are needed within watershed	In place and ongoing
	Continue to implement environmentally sensitive land and open space preservation and acquisition policies	--[a]	City of Milwaukee and Milwaukee County, with possible involvement by MMSD on watershed basis	Plan implementation largely complete. Environmentally sensitive lands are all under County ownership. Additional actions are underway within watershed by MMSD	In place and ongoing
Stormwater Management	Continue implementation of stormwater-related regulation and policies	--[a]	City of Milwaukee	Currently being implemented	Ongoing
Floodland Management	Continue with second-level system plans and then detailed design and implementation				
	Kinnickinnic River Watershed				
	Kinnickinnic River	$ 1,000,000[b]	MMSD and U.S. Army Corps of Engineers	Detailed design complete	2003
	Lyons Park Creek	$ 778,000[b]	City of Milwaukee, MMSD	Required replacement bridge sizes provided by MMSD to City of Milwaukee	Bridge replacement as part of normal roadway
	Villa Mann Creek Tributary	$ 633,000[b]	MMSD and City of Milwaukee	Second-level system plan complete	2006
	Menomonee River Watershed				
	Menomonee River	$ 96,000,000-$ 124,000,000[b]	Cities of Milwaukee and Wauwatosa, MMSD in cooperation with watershed stakeholders	Implementation underway with second-level planning completed. Preliminary design for all projects. Valley Park levee project completed. Acquisition and removal of structures in Hart Park neighborhood nearly complete	Continue preliminary and detailed design in 2003. Implementation of County Grounds detention basins in 2005, western Milwaukee levee and acquisition in 2010-2013
	Grantosa Creek	--[c]	Cities of Milwaukee and Wauwatosa, MMSD in cooperation with Milwaukee County	Timmerman Airport detention basin completed. Second-level planning completed for remainder of Creek	Design and implementation of Madison Park levee and stream stabilization in 2005-2007. Lower Grantosa Creek measures in City of Wauwatosa to be implemented in 2011
	Little Menomonee River	$ 150,000[b]	MMSD in cooperation with City of Milwaukee	Second-level system plan complete	2007
	Menomonee River Watershed				
	Lincoln Creek	--[c]	MMSD and City of Milwaukee in cooperation with Milwaukee County and WDNR	As of mid-2002, all phases of project completed with the exception of some minor streambank stabilization and landscaping	Landscaping to be completed in 2003
	Southbranch Creek	--[c]	MMSD, Village of Brown Deer, and City of Milwaukee	Project completed	--

Table 19 (continued)

Plan Element and Plan Adoption	Subelement and Plan Implementation Strategies	Estimated Capital Cost	Designated Management Agency	Implementation Status Notes	Plan Implementation Schedule
Floodland Management (continued)	Oak Creek Watershed				
	North Branch of Oak Creek	$ 3,720,000[b]	MMSD and City of Milwaukee	Second-level system plan complete	2007
	Mitchell Field Drainage Ditch	$ 466,000[b]	MMSD, City of Milwaukee, and Milwaukee County	Second-level system plan complete	2007
Public Information and Education	Continued citywide public involvement	--[a]	City of Milwaukee	--	Ongoing
	Public education activities	--	City of Milwaukee	--	2003
	Public involvement and coordination with other agencies and local units of government	--[a]	City of Milwaukee and MMSD in cooperation with other watershed stakeholders	In progress	Ongoing
Secondary Plan Element	National flood insurance program and floodplain mapping efforts	--[a]	City of Milwaukee in conjunction with WDNR, FEMA, MMSD, and SEWRPC	Being implemented	Ongoing
	Lending institution and real-estate policies	--[a]	City of Milwaukee, real-estate brokers, and lending institutions	Being implemented	Ongoing
	Community utility policies and emergency programs	--[a]	City of Milwaukee and Milwaukee County Sheriff's Department	Being implemented	Ongoing
	Stream channel maintenance	--[a]	City of Milwaukee and MMSD	Being implemented	Ongoing
	Stormwater and floodland management facilities maintenance	--[d]	City of Milwaukee	Being implemented	Ongoing
Plan Adoption	--	--	City of Milwaukee Common Council upon recommendation by appropriate City committee(s)	Following draft plan review	Late 2002
Plan Monitoring	Review, evaluate, and refine mitigation plan annually	--[a]	City of Milwaukee Common Council and Department of Public Works	--	End 2003 and then annually with special review following each major flood event
Emergency Operations Coordination, Plan Refinement, and Post-Disaster Review	Review, evaluate, and refine plan following flood events in cooperation with emergency operations program	--[a]	City of Milwaukee and Milwaukee County Sheriff's Department	--	Annually, with special review following each major flood event

NOTE: Where City of Milwaukee is noted as the designated management agency, it is intended to be the City Department of Public Works in cooperation with other departments, with policy review and guidance by the City Common Council.

[a] *No new cost involved. Costs are assigned to other ongoing City programs.*

[b] *Costs currently being refined as part of second-level planning and preliminary design.*

[c] *No cost reported. Projects affecting City of Milwaukee completed or nearing completion.*

[d] *New costs included under stormwater management and floodland management elements operation and maintenance.*

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

use conditions throughout each of the major watersheds studied, as defined under the SEWRPC adopted regional land use plan. Thus, the effectiveness of the recommended floodland management measures will depend upon the degree to which future land use development and redevelopment and the recommended actions properly complement each other. Under planned year 2020 land use conditions, about 60 percent of the entire area tributary to the City of Milwaukee will remain in agricultural or other open space uses. Land use plan recommendations identify those areas within the planning area that should be preserved in open, natural uses. Such preservation would provide major economies in floodland management, thus maximizing the use of natural stormwater conveyance and storage to be incorporated in the plan. If preservation of these areas is greatly compromised, problems, such as localized flooding, poor drainage, and water pollution, may be expected to result.

Implementation of Floodland Management Plans for the Kinnickinnic River, Menomonee River, Milwaukee River, and Oak Creek Watersheds

As described earlier, the MMSD has already completed implementation of several of the plan elements, including all of Lincoln Creek and Southbranch Creek and portions of the Menomonee River watershed. In addition, the MMSD is in the advanced planning phase of its watercourse system plan for the remaining streams in the Kinnickinnic, Menomonee, and Milwaukee Rivers and Oak Creek watersheds.

The plan calls for the City of Milwaukee and Milwaukee County to continue to work with the MMSD in carrying out the implementation of the watercourse system plan.

Financing for Floodland Management Plan Actions

Responsibility for the cost of implementing the floodland management plan for the City of Milwaukee are to be borne by the MMSD, the City of Milwaukee, Milwaukee County, and private individuals, based on the allocation of responsibilities set forth in the 1999 MMSD watercourse policy plan.

Several means of financing floodland management components are available to both the public and private sector. Potential funding sources were described in Chapter VI for City- and MMSD-based options for funding flood mitigation programs. City staff and elected officials annually review the flood mitigation programs and allocate local funding sources as part of the budget process. The MMSD has established a capital improvements program which provides funding over a multi-year period to carry out all of the projects identified in the MMSD system plan update needed to address the overland structure flooding problem in the City of Milwaukee. The MMSD is the lead agency in the plan implementation phase and will incorporate local community funding as identified in its flood control policy and will maximize the use of State and Federal program funds to the extent possible. Detailed project schedules have been developed for each watershed and are available from the MMSD.

Regulatory Considerations Pertaining to the Floodland Management Plan

Implementation of some of the floodland management measures may require the prior approval of certain regulatory agencies other than City agencies, including the WDNR and the U.S. Army Corps of Engineers. The regulatory process involved is complex; therefore, as is current policy, the MMSD and City will seek guidance from the agencies involved and legal counsel, as needed, before proceeding with any floodland management measures that involve the construction or modification of artificial waterways connecting to navigable waters, the alteration or enclosure of navigable watercourses, the removal of material from the beds of navigable watercourses, or the disturbance of wetlands.

Federal regulatory authority relating to the disturbance of wetlands is granted under Section 404 of the Federal Water Pollution Control Act of 1972 as amended. The administering agency is the U.S. Army Corps of Engineers.

Applicable State regulatory authority relates to the construction or modification of artificial waterways, canals, or ponds connecting to, or located within 500 feet of, a navigable waterway, the alteration of navigable waterways, the placement of deposits or structures in the bed of navigable waterways or the enclosure of navigable waterways, and the removal of material from navigable waterways, and also to activities affecting the water quality of wetlands. This authority is set forth in Sections 30.12, 30.195, 30.20, and 144.025 of the Wisconsin Statutes. The administering agency is the WDNR.

Chapters of the *Wisconsin Administrative Code* that are pertinent to activities called for under floodland management recommendations include Chapter NR 103, "Water Quality Standards for Wetlands"; Chapter NR 116, "Wisconsin's Floodplain Management Program"; and Chapter NR 117, "Wisconsin's City and Village Shoreland-Wetland Protection Program." Implementation of the floodland management actions could involve disturbance of wetlands during construction followed by restoration of the wetlands involved after construction. The degree of wetland disturbance could be minimized during the final project design stage.

Implementation Strategies: Public Information and Education Element
As noted previously in this chapter, the City of Milwaukee, Milwaukee County, and the MMSD will continue to engage in informational and educational efforts oriented toward resolving the flooding and related stormwater drainage and sanitary sewer backup problems in the City, updating and otherwise modifying such efforts as needed as the continuing flood mitigation planning process for the City proceeds over time.

Strategies for continued implementation of the City's public informational and educational efforts include, but are not limited to, 1) preparing and distributing printed informational and educational materials, including materials oriented toward local homeowners and designed to help them consider and potentially undertake self-help actions to mitigate damage caused by stormwater flooding and sanitary sewer backups in the City; and 2) engaging in other educational efforts directed toward City residents regarding flood mitigation using all methods available, including, but not limited to, cable television, radio, individual seminars, the World Wide Web, and community speaking.

Public information and education efforts are to be developed or expanded to promote good urban "housekeeping" practices that reduce nonpoint source pollution.

Toward further informing the public regarding flood mitigation, stormwater and floodland management, and related issues, the City of Milwaukee, the MMSD, and other concerned units and agencies of government will also continue to involve members of the general public, both as individuals and as groups, and to continue to seek public input in the preparation and implementation of detailed stormwater and floodland management plans.

As previously noted, the MMSD has underway an extensive public informational and educational program to promote sanitary and combined sewer infiltration and inflow reduction actions.

Implementation Strategies: Secondary Plan Element
Implementation strategies for the actions envisioned under the secondary plan element described previously in this chapter are set forth below.

National Flood Insurance Program and Floodplain and Floodplain Map Updating Efforts
As noted above, the plan calls for the City to continue to participate in the NFIP, and that the City Department of City Development continue to monitor and ensure continued compliance by the City with NFIP regulations. There are currently no NFIP compliance issues facing the City.

In addition to the purchase of flood insurance by owners of property in floodprone areas within the City the plan calls for the City, FEMA, other concerned units and agencies of government, and private insurers and insurance agents doing business within the City to continue to ensure that local property owners are informed regarding the NFIP. Finally, as flood control measures under completed and ongoing planning efforts are implemented, the plan calls for the City to request that FEMA make necessary revisions to the Flood Insurance Study.

As revised data regarding the 100-year recurrence interval flood profile in the City become available under the MCAMLIS digital floodplain mapping program, the City Common Council will amend the City floodplain zoning ordinance as needed to reflect the 100-year recurrence interval water surface profiles developed under that planning effort. As noted above, the City will also submit its proposed floodplain revisions and additions to the WDNR for approval, and also request revision of the applicable flood insurance rate maps by the FEMA Federal Insurance Administration.

Lending Institution and Real-Estate-Agent Policies
As described previously in this chapter, the plan includes 1) that lending institutions continue to determine the floodprone status of properties within the City before mortgage transactions, using the most recent available principal sources of flood hazard information, and 2) that real-estate brokers and salespersons, in accord with State regulations, continue to inform potential purchasers of property located within the City of any flood hazard that may exist at the site being traded.

Community Utility Policies and Emergency Programs
As noted previously in this chapter, the plan includes 1) that the governmental units and agencies responsible for the design, construction, operation, and maintenance of public utilities and facilities, such as water supply and sewerage facilities, drainageways, and streets and highways—including, but not limited to, the City of Milwaukee, the Milwaukee County Department of Public Works, the MMSD, SEWRPC, and the Wisconsin Departments of Natural Resources and Transportation—carry out those functions in a manner fully consistent with the land use and floodland regulation recommendations set forth or noted in this plan and 2) that the City of Milwaukee and Milwaukee County Sheriff's Department, Division of Emergency Management, continue to implement existing emergency procedures and develop appropriate new emergency procedures as needed to provide residents of the City with timely information about floods in progress and to help them in taking appropriate action. Such emergency procedures are to be reviewed annually or following events which may indicate a need to review procedures and to be amended as needed to remedy any deficiencies. Furthermore, immediately after any significant flood event occurs within the City of Milwaukee, the City and Milwaukee County will conduct a coordinated review and analysis of the effectiveness of their respective emergency procedures with regard to the flood event, and remedy any deficiencies found as a result of such review and analysis.

Stream Channel Maintenance
As described previously in this chapter, the City of Milwaukee will work with the MMSD to implement a regular stream channel maintenance program for all watercourses in the City. The City will work to develop its own program in those areas where the required maintenance does not meet the criteria for District involvement.

Stormwater Management Facilities Maintenance
The City of Milwaukee will carry out, or cause to carry out by others in the case of privately owned facilities, necessary stormwater management facility maintenance activities on a continuing basis to maximize the effectiveness of stormwater management facilities and measures and to protect the capital investment in the facilities.

Implementation Strategies: Adoption or Endorsement by and Coordination with Other Units and Agencies of Government and Private Parties
An important first step in implementation of the flood mitigation plan for the City of Milwaukee is its formal adoption by the City Department of Public Works and the City Common Council. Upon its formal adoption by the City, the plan becomes the official guide to the making of flood mitigation and floodland management decisions for the City by City officials. Such adoption serves to signify agreement with and official support of the plan and enables City officials and staff to begin integrating the plan into the City's ongoing land use control, public works development planning and programming, and land development review processes.

The City Department of Public Works will also provide the flood mitigation plan to and coordinate with as appropriate; the Milwaukee County Sheriff's Department, Division of Emergency Management; the Milwaukee County Department of Public Works; the MMSD; the WDNR; the Wisconsin Department of Military Affairs, Division of Emergency Management; the Wisconsin Department of Transportation; FEMA; and the U.S. Army Corps of Engineers. These units and agencies of government are asked to coordinate and recognize, as appropriate, the plan in their own respective activities and programs. Also, as the plan calls for specific action in implementing various elements of the plan, an endorsement of the plan should be made by the MMSD and Milwaukee County.

All private parties envisioned under this plan to play a role in its implementation, including local property owners, lending institutions, and real-estate agents, as well as governmental units and agencies responsible for the design, construction, operation, and maintenance of public utilities and facilities, are to continue to carry out or incorporate, as appropriate, the actions and practices set forth in this plan into their own respective activities related to or otherwise affecting flood mitigation in the City.

The MMSD and the City Department of Public Works are to take the lead role in coordinating the implementation of the actions called for under this plan. The City Department of Public Works will also provide liaison between those parties responsible for plan implementation and City agencies, officials, and staff with regard to plan implementation and its status over time. In this regard, the MMSD is considered the lead agency in the direct implementation of the flood mitigation program.

PLAN MONITORING AND REFINING STRATEGIES

For a flood mitigation plan to be successful it must not only be implemented; it must be monitored. Plan monitoring is best accomplished through a formal, periodic process designed to measure and assess progress in implementation, changing outside circumstances that may affect the plan and efforts to implement it, and the need for any changes to the plan and/or to how it is being implemented.

Toward ensuring successful monitoring of the flood mitigation plant for the City of Milwaukee, the MMSD and City Department of Public Works will be responsible on a day-to-day basis for creating and implementing a common monitoring system. This monitoring system should use a "critical path" method involving a project work schedule to identify specific steps and timelines for implementation actions and the contributions of specific individuals and other parties to plan implementation, and to monitor and help assure adherence to the work schedule.

Furthermore, the MMSD and City Department of Public Works will meet at least annually to review the plan and the status of its implementation, as well as to develop and recommend any necessary revisions to the plan. Those revisions will be presented to the Milwaukee Common Council for consideration and adoption in the form of a formal amendment to the mitigation plan. This review should be conducted with respect to: 1) whether any flood hazards affecting the City have changed, and, if so, how they have changed; 2) whether any flood mitigation goals and objectives have changed, or need to be changed; 3) the degree and extent of progress made in implementing previously identified recommended actions; 4) whether the plan recommendations and their priorities should remain unchanged or need modification; 5) whether any new recommendations are needed; and 6) whether applicable funding programs and levels have changed.

As an integral part of the review process, the City Department of Public Works shall prepare and submit an annual written report setting forth the plan implementation efforts, detailing plan implementation actions taken over the past year, prioritizing mitigation goals and activities for the next year, and setting forth any recommended revisions to the plan. Any needed plan amendments shall be developed and submitted to the appropriate City committee and the Common Council for review.

The plan monitoring and refinement strategy will include a post-disaster component whereby the plan is reviewed and evaluated after any future major flood event. Based upon this review, the mitigation plan will be updated or revised as needed based upon the flood event experiences, circumstances, and consequences. In this regard, the post-disaster review effort will be coordinated with the emergency operations program administered by the City Fire Department and the Milwaukee County Sheriff's Department. The experiences of the emergency operations may indicate a need for refined mitigation actions which would then be incorporated into the plan. Information will also be collected from the MMSD, WDNR, and FEMA personnel. Any plan updating found to be needed shall be incorporated into the annual plan update noted above.

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APPENDICES

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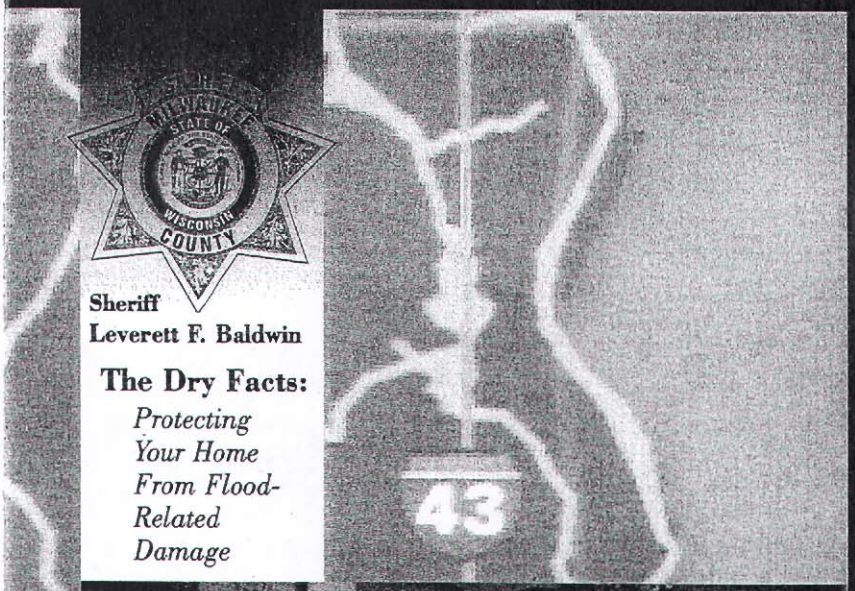
Appendix A

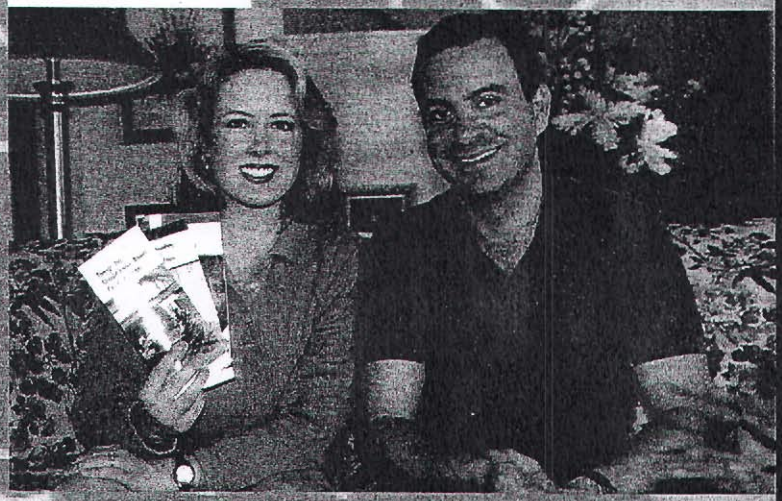
THE DRY FACTS: PROTECTING YOUR HOME FROM FLOOD-RELATED DAMAGE

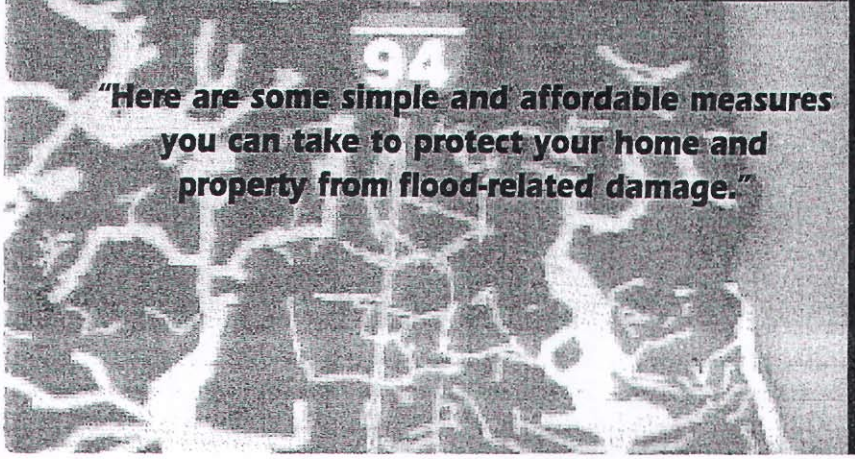
Milwaukee County Sheriff's Department
Division of Emergency Management



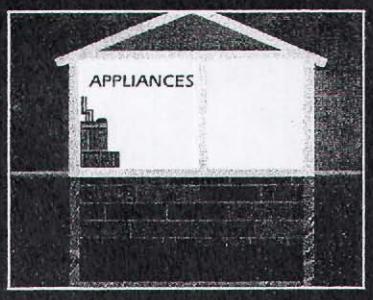
Sheriff
Leverett F. Baldwin

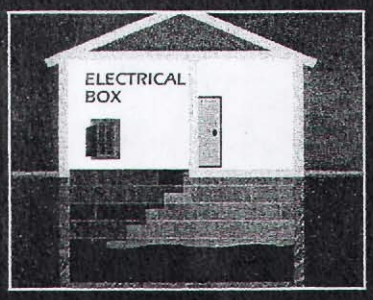
The Dry Facts:
Protecting Your Home From Flood-Related Damage

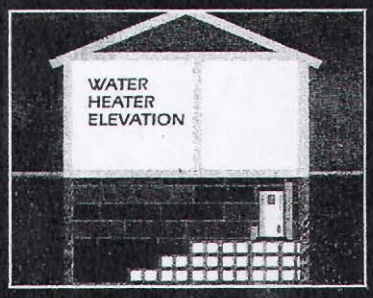




"Here are some simple and affordable measures you can take to protect your home and property from flood-related damage."



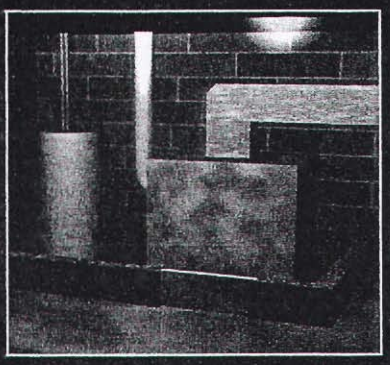




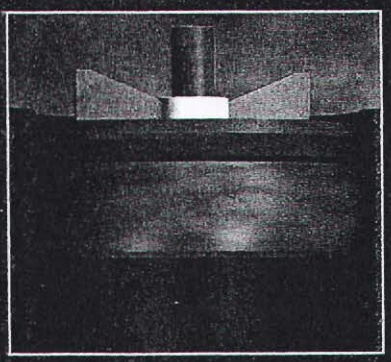
Raising or moving your appliances and electrical box can save them from flood-related damage.

FLOOD PROOFING?

Over the last decade, flood-related damage has averaged well over three billion dollars a year! But don't give up. While we can't stop flooding, we can do a lot to reduce the cost and amount of damage it does to our homes. We call it "flood mitigation." Here are some simple and affordable measures you can take to protect your home and property from flood-related damage.



Building a flood wall around appliances that can't be moved is an effective way to protect them from encroaching flood waters.



Test plugs are used to prevent usage backup in the basement floor drain and are a quick and easy preventative solution.

Sawhorses and an old board work well to elevate small appliances and knickknacks.

BEFORE YOU DO ANYTHING

Call your building inspector. Look in the blue section of your White Pages for the building inspector in your municipality.

Things to ask...

- Are there any building code restrictions on home flood mitigation measures?
- What is my Base Flood Elevation or BFE? (Base Flood Elevation is the highest point floodwaters are expected to reach under normal circumstances in your area.)
- What "Flood Protection Level" should I use? (Flood Protection Level is the level of flooding you want your house to be able to withstand.)

DO YOUR HOMEWORK

Some of the flood proofing alterations you decide to do may require the help of a professional contractor.

Things to ask...

- Is your contractor licensed and bonded?
- Do they have proper insurance for their company and their employees?
- Do they have references? What do those references say about the contractor's work?
- Are there any complaints against your contractor registered with The Better Business Bureau?
- Will they provide everything – schedules, quotes, contracts etc. - in writing?

FLOOD MITIGATION TECHNIQUES

ELEVATE items like your washer and dryer, personal items, hazardous chemicals, food products, electrical outlets, electrical box, furnace, and water heater 1 to 2 feet above your BFE.

Things to use...

- Pressure-treated wood pallets
- Concrete blocks, bricks or masonry
- Ceiling suspension devices
- Sawhorses

INSTALL devices that will warn you of the presence of water in your basement and help remove any water present. You can find these devices at any hardware store.

Things to ask for...

- Water alarm
- Sump pump
- Battery back up sump pump

BACKFLOW REDUCTION DEVICES in your basement drains and toilets can reduce or eliminate the dreaded backflow of sewage water into your home. There are a number of backflow reduction devices out there, most of which you'll find at your hardware store.

Things to ask for...

- Backflow Valve
- Test Plug
- Pneumatic plug for basement toilet

STRUCTURAL ALTERATIONS to protect your home against flood damage will require permission from your building inspector and, in some cases, the help of a professional contractor. There are two categories of structural alteration in regards to flood mitigation: Wet Flood Proofing and Dry Flood Proofing.

Dry Flood Proofing basically means sealing your house to keep floodwaters out.

Things to do...

- Replace low-level windows with glass block.
- Protect low-level windows with aluminum or exterior plywood window shields.
- Place plastic shields over window wells.
- Sandbag around low-level windows when flood is imminent.
- Build a 1.5' above grade brick flood wall around low-level windows.

NOTE: Sandbags and flood walls should be no higher than 1.5' high. Doing so will cause a buildup of hydrostatic pressure on your basement walls and may cause them to collapse!

Wet Flood Proofing involves fortifying flood-vulnerable areas in your home. With water-resistant building materials, you significantly reduce the amount of damage caused by floodwaters.

Things to do...

- Ask your building inspector if there are any code restrictions on wet flood proofing in your area.
- Elevate items in areas to be wet flood proofed above the BFE.
- Replace building materials in these areas with water-resistant materials such as concrete, pressure-treated lumber, rigid wall insulation, epoxy paints and synthetic indoor/outdoor carpeting.

LANDSCAPING, when done properly, can do a lot to direct flood waters away from your home.

Things to do...

- Ask your building inspector about any zoning restrictions on landscape alterations in your area.
- Build up the grade around your house so that water will flow away from your foundation.
- Clean your gutters out so they're not clogged or leaking.
- Attach flexible gutter extensions to your downspouts and sump pump exterior drains to direct water away from your house. (Extensions should be at least 3 feet in length.)
- Mudjack sidewalks and driveways to return them to their proper grade away from your house.

NOTE: Any adjustments to your landscape that may effect your neighbors should be discussed with them prior to implementing those adjustments.

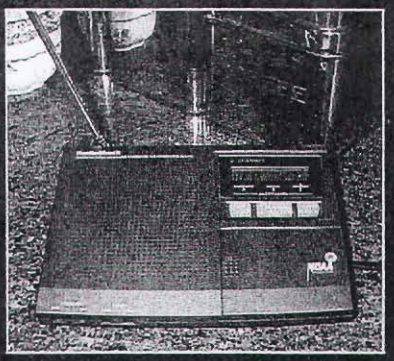
WARNING SYSTEMS, such as the NOAA weather radio with emergency alarm, broadcast continuous updates for your area directly from the National Weather Service 24 hours a day. You can purchase one at most radio/TV electronics stores.

Standard radio and television stations will also carry emergency weather and/or disaster information.

Things to know...

- *Flood Watch:* An advisory that flooding is possible within a designated area.
- *Flood Warning:* An advisory that flooding is occurring or imminent.
- *Urban and Small Stream Flood Advisory:* High potential of flooding along a river or stream.
- *Flash Flood:* The occurrence of a dangerous rise in the water level of a stream or overland area in a few hours or less.

Be sure to route rain water far away from the foundation.



A NOAA weather radio with an emergency alarm can give you enough time in a weather emergency to protect you and your family. Get one!

Milw. County Sheriff's Dept., Division of Emergency Management
414-278-4709

Milwaukee American Red Cross
414-342-8680

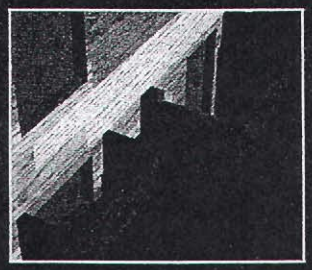
The Salvation Army
414-265-6360

Aging Services for Milw. County
414-289-6874

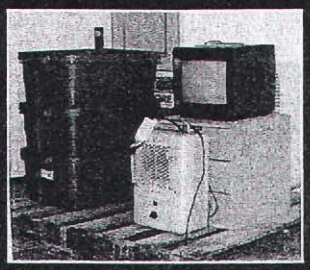
Better Business Bureau of WI
414-224-0900

The WI Dept. of Agricultural Trade & Consumer Protection
1-800-422-7128

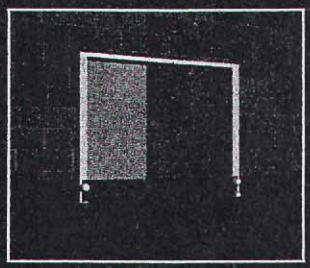
Make sure that the landscaping around your home slopes away from the foundation.



Flood walls around basement and low-lying windows should be no taller than 1.5'.



Pressure-treated lumber, cinder block, and pallets can be used to raise your belongings off the floor and out of floodwaters.



In case of impending flood, temporary shields can prevent water from entering your home.

ASSISTANCE

THE NATIONAL FLOOD INSURANCE PROGRAM or NFIP is a federal program that allows you to buy adequate flood insurance. Most homeowner's insurance policies DO NOT cover flood-related damage to your home!

Things covered by NFIP...

- Damage to your house and its contents caused by surface water flooding.
- Cost of moving and storing your belongings for up to 45 days.
- Expenses related to removing debris after flood.
- House structure up to $250,000.
- House contents up to $100,000.
- Renters belonging up to $100,000.
- Businesses up to $500,000.

BENEFITS OF NFIP...

- You don't have to wait in line for Federal Disaster Assistance that you may have to pay back later...with interest!
- Average cost of annual coverage is $316.00.
- You can get a policy at any time; however, there may be a 30-day waiting period before policy is effective.
- Not taxpayer supported.
- Available without Presidential declaration of disaster. (Federal Disaster Assistance is available in less than 50% of flood incidents!)

NOTE: NFIP does NOT cover damage caused by sewer back up, unless it is caused by overland flooding. Ask your insurance agent about a sewer back up rider for your existing homeowner's policy.

For more information, or to sign up, call your insurance agent or The National Flood Insurance Program 1-800-720-1090.

A PRESIDENTIAL DECLARATION OF DISASTER in the event of a flood, opens up numerous federal and state aid programs to flood victims. These programs are coordinated through the Federal Emergency Management Agency.

Programs include...

- Disaster Housing Grants for assistance with mortgage and rent, repair costs and mitigation costs.
- The U.S. Small Business Administration (SBA) for low interest loans to residences and businesses.
- The Individual and Family Grants for assistance with previously uncovered needs.
- Disaster Unemployment Assistance provides benefits to those out of work due to flooding.
- Farm Assistance to cover losses in farm property and/or production.
- IRS amended returns allowing deductions for casualty losses for under and uninsured victims.

The corresponding video is available through the Milwaukee County Federated Library System or by calling the Milwaukee County Sheriff's Department, Division of Emergency Management.

Created by:
Watts Communications, Inc.
Advantage Printing & Graphics

Appendix B

EXCERPT FROM SEWRPC PLANNING REPORT NO. 26, VOLUME TWO, SETTING FORTH OBJECTIVES, PRINCIPLES, AND STANDARDS USED IN PREPARING THE COMPREHENSIVE PLAN FOR THE MENOMONEE RIVER WATERSHED

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BASIC CONCEPTS AND DEFINITIONS

The term "objective" is subject to a wide range of interpretation and application, and is closely linked to other terms often used in planning work which are equally subject to a wide range of interpretation and application. The following definitions have, therefore, been adopted in order to provide a common frame of reference:

1. Objective: a goal or end toward the attainment of which plans and policies are directed.

2. Principle: a fundamental, primary, or generally accepted tenet used to support objectives and prepare standards and plans.

3. Standard: a criterion used as a basis of comparison to determine the adequacy of plan proposals to attain objectives.

4. Plan: a design which seeks to achieve the agreed-upon objectives.

5. Policy: a rule or course of action used to ensure plan implementation.

6. Program: a coordinated series of policies and actions to carry out a plan.

Although this chapter deals primarily with the first three of these terms, an understanding of the interrelationship of the foregoing definitions and the basic concepts which they represent is essential to the following discussion of development objectives, principles, and standards.

WATERSHED DEVELOPMENT OBJECTIVES

Objectives, in order to be useful in the watershed planning process, must not only be logically sound and related in a demonstrable and measurable way to alternative physical development proposals, but must also be consistent with, and grow out of, regionwide development objectives. This is essential if the watershed plans are to comprise integral elements of a comprehensive plan for the physical development of the Region, and if sound coordination of regional and watershed development is to be achieved.

The Southeastern Wisconsin Regional Planning Commission has, in its planning efforts to date, adopted, after careful review and recommendation by various advisory and coordinating committees, nine general regional development objectives, nine specific regional land use development objectives, seven specific regional transportation system development objectives, four specific sanitary sewerage system development objectives, and four specific water control facility development objectives. These, together with their supporting principles and standards, are set forth in previous Commission planning reports. Certain of these objectives and supporting standards are directly applicable to the Menomonee River watershed planning effort, and are hereby recommended for adoption as development objectives for the Menomonee River watershed.

Land Use Development Objectives

Six of the nine specific regional land use development objectives adopted by the Commission under its regional land use-transportation planning program are directly applicable to the Menomonee River watershed planning effort.[1] These are:

1. A balanced allocation of space to the various land use categories which meets the social, physical, and economic needs of the regional population.

2. A spatial distribution of the various land uses which will result in the protection, wise use, and development of the natural resources of the Region.

3. A spatial distribution of the various land uses which is properly related to the supporting transportation, utility, and public facility systems in order to assure the economical provision of utility and municipal services.

4. The preservation and provision of open space to enhance the total quality of the regional environment, maximize essential natural resource availability, preserve and protect natural areas and wildlife habitat, give form and structure to urban development, and facilitate the ultimate attainment of a balanced year-round outdoor recreational program providing a full range of facilities for all age groups.

5. The preservation of land areas for agricultural uses in order to provide for certain special types of agriculture, provide a reserve for future needs, and ensure the preservation of those rural areas which provide wildlife habitat and are essential to shape and order urban development.

6. The attainment of good soil and water conservation practices in order to reduce storm water runoff, soil erosion, and stream and lake sedimentation, pollution, and eutrophication.

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[1] *The other three specific regional land use development objectives are: 1) a spatial distribution of the various land uses which will result in a compatible arrangement of land uses; 2) the development and conservation of residential areas within a physical environment that is healthy, safe, convenient, and attractive; and 3) the preservation and provision of a variety of suitable industrial and commercial sites both in terms of physical characteristics and location.*

Sanitary Sewerage System Planning Objectives

Three of the four specific sanitary sewerage system development objectives adopted by the Commission under its regional sanitary sewerage system planning effort are directly applicable to the Menomonee River watershed planning effort.[2] These are:

1. The development of sanitary sewerage systems which will effectively serve the existing regional urban development pattern and promote implementation of the regional land use plan, meeting the anticipated sanitary waste disposal demand generated by the existing and proposed land uses.

2. The development of sanitary sewerage systems that are properly related to, and that will enhance the overall quality of, the natural and man-made environments.

3. The development of sanitary sewerage systems that are both economical and efficient, meeting all other objectives at the lowest cost possible.

Water Control Facility Development Objectives

Three of the four specific water control facility development objectives adopted by the Commission under its other comprehensive watershed planning programs are also applicable to the Menomonee River watershed planning effort.[3] These are:

1. An integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses.

2. An integrated system of land management and water quality control facilities and pollution abatement devices adequate to ensure a quality of surface water necessary to meet the water uses shown on Map 1.

3. The attainment of sound groundwater resource development and protective practices to minimize the possibility for pollution and depletion of the groundwater resources.

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[2] *The other specific sanitary sewerage system development objective is: The development of sanitary systems so as to meet established water use objectives and supporting water quality standards.*

[3] *The other specific water control facility development objective is: An integrated system of land management and water quality control facilities and pollution abatement devices adequate to ensure a quality of lake water necessary to achieve established water use objectives.*

Principles and Standards

Complementing each of the foregoing specific land use, water control facility, and sanitary sewerage system development objectives is a planning principle which supports the objective and asserts its inherent validity, and a set of quantifiable planning standards which can be used to evaluate the relative or absolute ability of alternative plan designs to meet the stated development objective. These principles and standards, as they apply to watershed planning and development, are set forth in Tables 2, 3, and 4, and serve to facilitate quantitative application of the objectives during plan design, test, and evaluation.

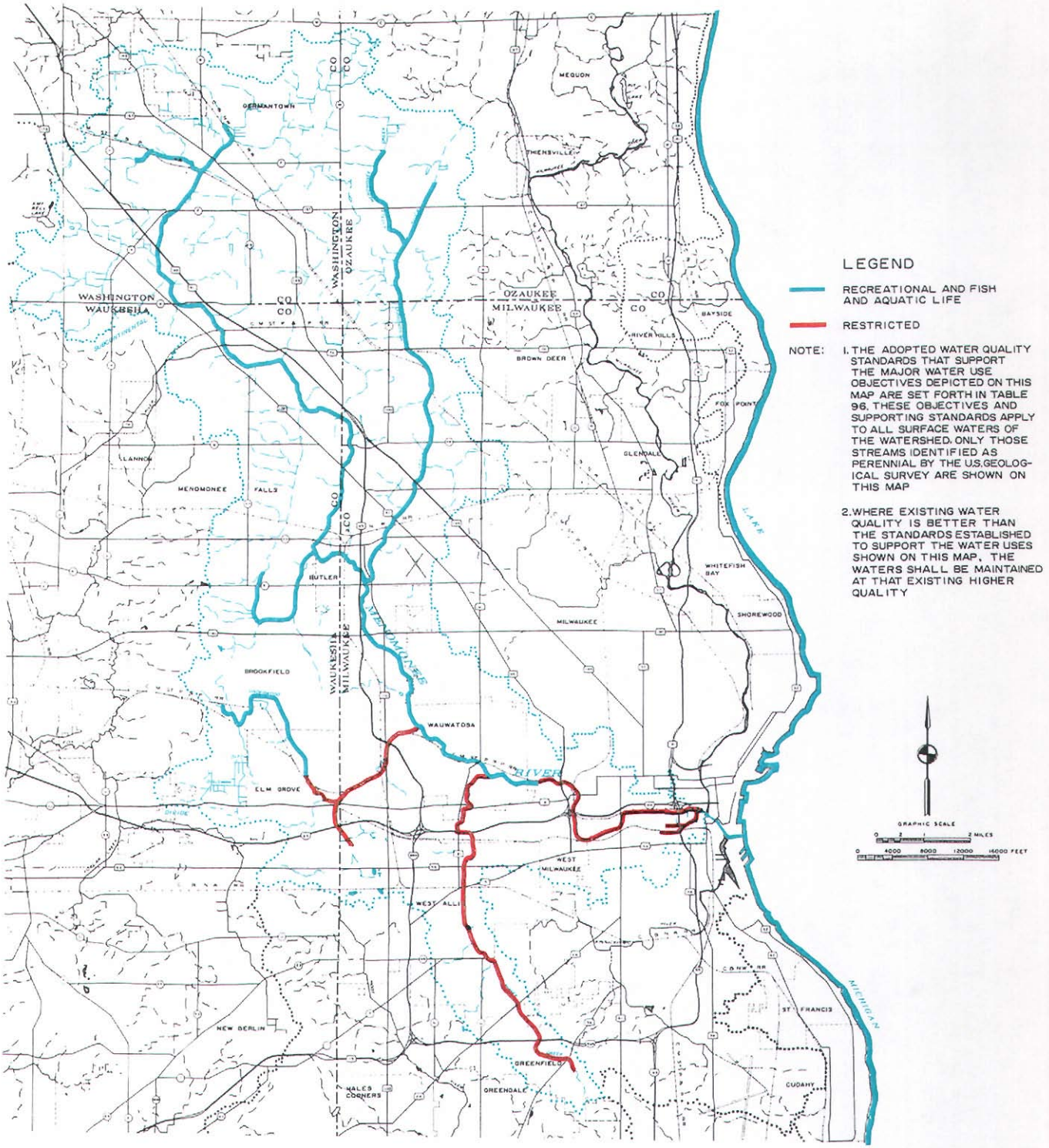
It should be noted that the planning standards herein recommended for adoption fall into two groups: comparative and absolute. The comparative standards, by their very nature, can be applied only through a comparison of alternative plan proposals. Absolute standards can be applied individually to each alternative plan proposal, since they are expressed in terms of maximum, minimum, or desirable values. The standards set forth herein should serve not only as aids in the development, test, and evaluation of watershed land use and water control facility plans but also in the development, test, and evaluation of local land use and community facility plans and in the development of plan implementation policies and programs as well.

Overriding Considerations

In the application of the watershed development objectives, principles, and standards in the preparation and evaluation of the watershed plan elements, several overriding considerations must be recognized. First, it must be recognized that any proposed water control and water quality management facilities must constitute integral parts of a total system. It is not possible from an application of the standards alone, however, to assure such a system integration, since the standards cannot be used to determine the effect of individual facilities and controls on each other or on the system as a whole. This requires the application of planning and engineering techniques developed for this purpose, such as hydrologic, hydraulic, and water quality simulation, to quantitatively test the potential performance of the proposed facilities as part of a total system, thereby permitting adjustment of the spatial distribution and capacities of the facilities and system to the existing and future runoff and waste loadings as derived from the land use plan. Second, it must be recognized that it is unlikely that any one plan proposal will meet all the standards completely; and the extent to which each standard is met, exceeded, or violated must serve as a measure of the ability of each alternative plan proposal to achieve the specific objectives which the given standard complements. Third, it must be recognized that certain objectives and standards may be in conflict and require resolution through compromise, such compromise being an essential part of any design effort.

Map 1

RECOMMENDED WATER USE OBJECTIVES FOR THE MENOMONEE RIVER WATERSHED



Water use objectives and supporting water quality standards constitute a significant input to the preparation of the comprehensive plan for the Menomonee River watershed. The existing state-adopted water use objectives for the surface waters of the Menomonee River watershed are identified on Map 82, Volume 1 of this report. The recommended water use objectives for the Menomonee River watershed are shown on the above map. The two maps differ in only one respect: that reach of the main stem of the Menomonee River from its confluence with Honey Creek in the City of Wauwatosa downstream to Hawley Road in the City of Milwaukee, which has been placed in the "restricted" category under the current state-adopted objectives, is recommended for upgrading to the "recreational and fish and aquatic life" category under the recommended Menomonee River watershed plan.

Source: SEWRPC.

Table 2

LAND USE DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE MENOMONEE RIVER WATERSHED

OBJECTIVE NO. 1

A balanced allocation of space to the various land use categories which meets the social, physical, and economic needs of the regional population.

PRINCIPLE

The planned supply of land set aside for any given use should approximate the known and anticipated demand for that use.

STANDARDS

1. For each additional 1,000 persons to be accommodated within the Region at each residential density, the following minimum amounts of land should be set aside:

Residential Density Category	Net Area[a] (Acres/1,000 Persons)	Gross Area[b] (Acres/1,000 Persons)
High Density Urban[c]	24	36
Medium Density Urban[c]	65	92
Low Density Urban[c]	238	298
Suburban[d]	572	698
Rural[d]	1,429	1,681

In addition, for each additional 1,000 persons to be accommodated within the Region the following minimum amounts of land should be set aside:

Land Use Category	Net Area[a] (Acres/1,000 Persons)	Gross Area[e] (Acres/1,000 Persons)
Governmental and Institutional	9	12
Public Park and Recreation		
Major	4	5
Other	9	10

2. For the daily use of short-term visitors to the watershed, the following amounts of land should be acquired and developed for each anticipated 100 participants[f] in each of the five major outdoor recreational activities which require intensive land development within the watershed:

Major Activity	Total Acres	Principal Development Acres	Backup Land or Secondary Development Acres
Swimming[g]	0.45	0.09	0.36
Picnicking[h]	12.50	1.25	11.25
Golfing[i]	32.79	32.79	--
Camping[j]	133.33	6.67	126.66
Skiing[k]	3.70	3.33	0.37

3. For each additional 100 commercial and industrial employees to be accommodated within the Region, the following minimum amounts of land should be set aside:

Land Use Category	Net Area[a] (Acres/100 Employees)	Gross Area[l] (Acres/100 Employees)
Commercial		
Major	1	3
Other	2	6
Industrial	2	9

OBJECTIVE NO. 2

A spatial distribution of the various land uses which will result in the protection, wise use, and development of the natural resources of the Region.

PRINCIPLE

The proper allocation of uses to land can assist in maintaining an ecological balance between the activities of man and the natural environment which supports him.

A. *Soils*

Principle

The proper relation of urban and rural land use development to soils type and distribution can serve to avoid many environmental problems, aid in the establishment of better regional settlement patterns, and promote the wise use of an irreplaceable resource.

STANDARDS

1. Sewered urban development, particularly for residential use, should not be located in areas covered by soils identified in the regional detailed operational soil survey as having severe or very severe limitations for such development.

2. Unsewered suburban residential development should not be located in areas covered by soils identified in the regional detailed operational soil survey as having severe or very severe limitations for such development.

3. Rural development, including agricultural and rural residential development, should not be located in areas covered by soils identified in the regional detailed operational soil survey as having severe or very severe limitations for such uses.

B. Wetlands

Principle

Wetlands support a wide variety of desirable and sometimes unique plant and animal life; assist in the stabilization of lake levels and stream-flows; trap and store plant nutrients in runoff, thus reducing the rate of enrichment of surface waters and obnoxious weed and algae growth; contribute to the atmospheric oxygen supply; contribute to the atmospheric water supply; reduce storm water runoff by providing area for floodwater impoundment and storage; trap soil particles suspended in runoff and thus reduce stream sedimentation; and provide the population with opportunities for certain scientific, educational, and recreational pursuits.

STANDARD

All wetland areas[m] adjacent to streams or lakes, all wetlands within areas having special wildlife and other natural values, and all wetlands having an area in excess of 50 acres should not be allocated to any urban development except limited recreation and should not be drained or filled. Adjacent surrounding areas should be kept in open-space use, such as agriculture or limited recreation.

C. Woodlands[n]

Principle

Woodlands assist in maintaining unique natural relationships between plants and animals; reduce storm water runoff; contribute to the atmospheric oxygen supply; contribute to the atmospheric water supply through transpiration; aid in reducing soil erosion and stream sedimentation; provide the resource base for the forest product industries; provide the population with opportunities for certain scientific, educational, and recreational pursuits; and provide a desirable aesthetic setting for certain types of land use development.

STANDARDS

1. A minimum of 10 percent of the land area of each watershed[o] within the Region should be devoted to woodlands.

2. For demonstration and educational purposes, the woodland cover within each county should include a minimum of 40 acres devoted to each major forest type: oak-hickory, northern hardwood, pine, and lowland forest. In addition, remaining examples of the native forest vegetation types representative of the pre-settlement vegetation should be maintained in a natural condition and be made available for research and educational use.

3. A minimum regional aggregate of five acres of woodland per 1,000 population should be maintained for recreational pursuits.

D. Wildlife[p]

Table 2 (continued)

Principle

Wildlife, when provided with a suitable habitat, will provide the population with opportunities for certain scientific, educational, and recreational pursuits; comprises an integral component of the life systems which are vital to beneficial natural processes, including the control of harmful insects and other noxious pests and the promotion of plant pollination; provides a food source; provides an economic resource for the recreation industries; and is an indicator of environmental health.

STANDARD

The most suitable habitat for wildlife—that is, the area wherein fish and game can best be fed, sheltered, and reproduced—is a natural habitat. Since the natural habitat for fish and game can best be obtained by preserving or maintaining other resources in a wholesome state, such as soil, air, water, wetlands, and woodlands, the standards for each of these other resources, if met, would ensure the preservation of a suitable wildlife habitat and population.

OBJECTIVE NO. 3

A spatial distribution of the various land uses which is properly related to the supporting transportation, utility, and public facility systems in order to assure the economical provision of utility and municipal services.

PRINCIPLE

The transportation and public utility facilities and the land use pattern which these facilities serve and support are mutually interdependent in that the land use pattern determines the demand for, and loadings upon, transportation and utility facilities; and these facilities, in turn, are essential to, and form a basic framework for, land use development.

STANDARDS

1. The transportation system should be located and designed to minimize the penetration of existing and proposed residential neighborhood units by through traffic.

2. The transportation system should be located and designed to provide access not only to all land presently devoted to urban development but to land proposed to be used for such urban development.

3. Transportation terminal facilities, such as off-street parking, should be located in close proximity to the principal land uses to which they are accessory.

4. All land developed or proposed to be developed for urban medium- and high-density residential use should be located in areas serviceable by existing or proposed primary, secondary, and tertiary mass transit facilities.

5. All land developed or proposed to be developed for urban medium-, high-, and low-density residential use should be located in areas serviceable by an existing or proposed public sanitary sewerage system and preferably within the gravity drainage area tributary to such systems.

6. All land developed or proposed to be developed for urban medium-, high-, and low-density residential use should be located in areas serviceable by an existing or proposed public water supply system.

7. Urban development should be located so as to maximize the use of existing transportation and utility systems.

OBJECTIVE NO. 4

The preservation and provision of open space[q] to enhance the total quality of the regional environment, maximize essential natural resource availability, give form and structure to urban development, and facilitate the ultimate attainment of a balanced year-round outdoor recreational program providing a full range of facilities for all age groups.

PRINCIPLE

Open space is the fundamental element required for the preservation, wise use, and development of such natural resources as soil, water, woodlands, wetlands, native vegetation, and wildlife; it provides the opportunity to add to the physical, intellectual, and spiritual growth of the population; it enhances the economic and aesthetic value of certain types of development; and it is essential to outdoor recreational pursuits.

Table 2 (continued)

STANDARDS[r]

1. Local park and recreation open spaces should be provided within a maximum service radius of one-half mile of every dwelling unit in an urban area, and each site should be of sufficient size to accommodate the maximum tributary service area population at a use intensity of 675 persons per acre.

2. Regional park and recreation open spaces should be provided within an approximately one hour travel time of every dwelling unit of the Region, and should have a minimum site area of 250 acres.

3. Areas having unique scientific, cultural, scenic, or educational value should not be allocated to any urban or agricultural land uses; and adjacent surrounding areas should be retained in open space use, such as agriculture or limited recreation.

OBJECTIVE NO. 5

The preservation of land areas for agricultural uses in order to provide for certain special types of agriculture, provide a reserve for future needs, and ensure the preservation of those unique rural areas which provide wildlife habitat and which are essential to shape and order urban development.

PRINCIPLE

Agricultural areas, in addition to providing food and fiber, can provide significant wildlife habitat; ecological balance between plants and animals; provide locations proximal to urban centers for the production of certain food commodities which may require nearby population concentrations for an efficient production-distribution relationship; and provide open spaces which give form and structure to urban development.

STANDARDS

1. All prime agricultural areas[s] should be preserved.

2. All agricultural lands surrounding adjacent high-value scientific, educational, or recreational resources and covered by soils rated in the regional detailed operational soil survey as very good, good, or fair for agricultural use should be preserved.

In addition to the above, attempts should be made to preserve agricultural areas which are covered by soils rated in the regional detailed operational soil survey as fair if these soils: a) generally occur in concentrations greater than five square miles and surround or lie adjacent to areas which qualify under either of the above standards, or b) occur in areas which may be designated as desirable open spaces for shaping urban development.

OBJECTIVE NO. 6

The attainment of good soil and water conservation practices in order to reduce storm water runoff, soil erosion, and stream and lake sedimentation, pollution, and eutrophication.

PRINCIPLE

Good soil and water conservation practices, including mulch tillage, terracing, grassed waterways, contour strip cropping, and suitable crop rotation in rural areas; seeding; sodding; erosion control structures for drainageways; erosion control structures at storm sewer outlets; and proper land development and construction methods and practices, particularly in urban areas, including maximum possible delay in stripping of vegetation, construction of sediment basins, and mulching and revegetating as soon as possible, can assist in reducing storm water runoff, soil erosion, and stream and lake siltation, pollution, and eutrophication.

STANDARDS

1. The area of the watershed in cultivated agricultural use, which has general land slopes greater than 2 percent, should be under district cooperative soil and water conservation agreements and planned conservation treatment.

2. Drainageways should be controlled to eliminate channel erosion both through stabilization of bank and bed materials and by reduction of the channel gradient.

3. All urban and structural plans and developments, where soil and vegetative cover is removed, should include soil and water conservation practices to control erosion on critical areas.

4. Runoff through and from areas with exposed soil should be trapped and stored or retarded to less than critical erosive velocities.

Table 2 (continued)

[a] Net land use area is defined as the actual site area devoted to a given use, and consists of the ground floor site area occupied by any buildings plus the required yards and open spaces.

[b] Gross residential land use area is defined as the net area devoted to this use plus the area devoted to all supporting land uses, including streets, neighborhood parks and playgrounds, elementary schools, and neighborhood institutional and commercial uses, but not including freeways and expressways and other community and areawide uses.

[c] Areas served, proposed to be served, or required to be served by public sanitary sewerage and water supply facilities; requires neighborhood facilities.

[d] Areas not served, not proposed to be served, nor required to be served by public sanitary sewerage and water supply facilities; does not require neighborhood facilities.

[e] Gross governmental and institutional area is defined as the net area devoted to governmental and institutional use plus the area devoted to supporting land uses, including streets and onsite parking. Gross public park and recreation area is defined as the net area devoted to active or intensive recreation use plus the adjacent "backup" lands and lands devoted to other supporting land uses such as roads and parking areas.

[f] A participant is defined as a person 12 years of age or older who actively participates in a particular recreational activity on a given day.

[g] Swimming--One acre of developed beach area can accommodate approximately 370 people at any one time. With a daily turnover rate of 3.0, the maximum capacity of one acre of developed beach is 1,110 people per acre per day. In addition, for every one acre of developed beach area, four (4) acres of backup lands are required to provide necessary parking area (approximately one and one-half acres), concession services, dressing room area (approximately one acre), and other activity area, such as picnic area (approximately one and one-half acres).

[h] Picnicking—One acre of developed picnic area with a maximum of 16 tables can accommodate approximately 50 people at any one time. With a daily turnover rate of 1.6, the maximum capacity of one acre of developed picnic area is 80 people per acre per day. In addition, for every one acre of developed picnic area, nine (9) acres of backup land are required to provide necessary parking area and additional secondary facilities.

[i] Golfing--A minimum of 10 acres of land per hole is required to develop a regulation 9- or 18-hole golf course, including area for clubhouse and parking, and will accommodate approximately one golfer per acre at any one time. With a daily turnover rate of 3.0, the maximum capacity of each golf course is 3.0 golfers per acre per day, or 30 golfers per hole per day.

[j] Camping—One acre of developed camp area with a maximum of five camp units can accommodate approximately 15 people per day. There is no daily turnover rate for camping. In addition, for every one acre of developed camp area, nineteen (19) acres of backup land are required to provide necessary supporting activities or facilities, such as central convenience facilities, hiking and nature trails, picnic areas, boat and canoe launching sites, and horseback trails.

[k] Skiing--One acre of developed ski slope can accommodate approximately 10 people at any one time. With a daily turnover rate of 3.0, the maximum capacity of one acre of developed ski slope is 30 people per acre per day. In addition, for every 10 acres of developed ski slope, one acre of backup land is required to provide parking and concession facilities. The recommended minimum site area is 100 acres.

[l] Gross commercial and industrial area is defined as the net area devoted to these uses plus the area devoted to supporting land uses, including streets and off-street parking.

[m] Wetlands are defined as those lands which are wholly or partially covered with hydrophytic plants and wet and spongy organic soils, and which are generally covered with shallow standing water, intermittently inundated, or have a high water table.

[n] Woodlands are defined as lands at least 20 acres in area which are covered by a dense, concentrated stand of trees and associated undergrowth.

[o] A watershed, as used herein, is defined as a portion of the surface of the earth occupied by a surface dainage system discharging all surface water runoff to a common outlet and which is 25 square miles or larger in areal extent.

[p] Includes all fish and game.

[q] Open space is defined as land or water areas which are generally undeveloped for residential, commercial, or industrial uses and are or can be considered relatively permanent in character. It includes areas devoted to park and recreation uses and to large land-consuming institutional uses, as well as areas devoted to agricultural use and to resource conservation, whether publicly or privately owned.

[r] It was deemed impractical to establish spatial distribution standards for open space, per se; therefore, only the park and recreation component of the open space land use category is listed in the standards, according to its local or regional orientation. These local park and recreation spaces may include playlots, playgrounds, playfields, and neighborhood parks. Regional park and recreation spaces include large county or state parks. Other open spaces which are not included in this spatial distribution standard are: forest preserves and arboreta; major river valleys; lakes; zoological and botanical gardens; stadia; woodland, wetland, and wildlife areas; scientific areas; and agricultural lands whose location must be related to, and determined by, the natural resource base.

[s] Prime agricultural areas are defined as those areas which a) contain soils rated in the regional detailed operational soil survey as very good or good for agriculture and b) occur in concentrated areas over five square miles in extent which have been designated as exceptionally good for agricultural production by agricultural specialists.

Source: SEWRPC.

Table 3

SANITARY SEWERAGE SYSTEM DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE MENOMONEE RIVER WATERSHED

OBJECTIVE NO. 1

The development of sanitary sewerage systems which will effectively serve the existing regional urban development pattern and promote implementation of the regional land use plan, meeting the anticipated sanitary waste disposal demand generated by the existing proposed land uses.

PRINCIPLE

Sanitary sewerage systems are essential to the development and maintenance of a safe, healthy, and attractive urban environment, and the extension of existing sanitary sewerage systems and the creation of new systems can be effectively used to guide and shape urban development both spatially and temporally.

STANDARDS

1. Sanitary sewer service should be provided to all existing areas of medium-[a] or high-density[b] urban development and to all areas proposed for such development in the regional land use plan.

2. Sanitary sewer service should be provided to all existing areas of low-density[c] urban development and to all areas proposed for such development in the regional land use plan, where such areas are contiguous to areas of medium- or high-density urban development. Where noncontiguous low-density and suburban[d] development already exists, the provision of sanitary sewer service should be contingent upon the inability of the underlying soil resource base to properly support onsite absorption waste disposal systems.

3. Where public health authorities declare that public health hazards exist because of the inability of the soil resource base to properly support onsite soil absorption waste disposal systems, sanitary sewer service should be provided.

4. Lands designated as primary environmental corridors on the regional land use plan should not be served by sanitary sewers, except that development incidental to the preservation and protection of the corridors, such as parks and related outdoor recreation areas, and existing clusters of urban development in such corridors, may be provided with sanitary sewer service. Engineering analyses relating to the sizing of sanitary sewerage facilities should assume the permanent preservation of all undeveloped primary environmental corridor lands in natural open-space uses.

5. Floodlands[e] should not be served by sanitary sewers, except that development incidental to the preservation in open-space uses of floodlands, such as parks and related outdoor recreation areas, and existing urban development in floodlands not recommended for eventual removal in comprehensive watershed plans, may be provided with sanitary sewer service. Engineering analyses relating to the sizing of sewerage facilities should not assume ultimate development of floodlands for urban use.

6. Significant concentrations[f] of land covered by soils found in the regional soil survey to have very severe limitations for urban development even with the provision of sanitary sewer service should not be provided with such service. Engineering analyses relating to the sizing of sewerage facilities should not assume ultimate urban development of such lands for urban use.

7. The timing of the extension of sanitary sewerage facilities should, insofar as possible, seek to promote urban development in a series of complete neighborhood planning units, with service being withheld from any new units in a given municipal sewer service area until previously served units are substantially developed and until existing units not now served are provided with service.

8. The sizing of sewerage facility components should be based upon an assumption that future land use development will occur in general accordance with the land use pattern recommended in the regional land use plan.

9. To the extent feasible, industrial wastes, except clear cooling waters as well as the sanitary wastes generated at industrial plants, should be discharged to municipal sanitary sewerage systems for ultimate treatment and disposal. The necessity to provide pretreatment for industrial wastes should be determined on an individual case-by-case basis.

OBJECTIVE NO. 2

The development of sanitary sewerage systems that are properly related to, and that will enhance the overall quality of, the natural and man-made environments.

Table 3 (continued)

PRINCIPLE

The improper location, design, construction, operation, and maintenance of sewerage system components can adversely affect the natural and man-made environments; therefore, every effort should be made in such actions to properly relate to these environments and minimize any disruption or harm thereto.

STANDARDS

1. New and replacement sewage treatment plants, as well as additions to existing plants, should, wherever possible, be located on sites lying outside of the 100-year recurrence interval floodplain. When it is necessary to use floodplain lands for sewage treatment plants, the facilities should be located outside of the floodway so as to not increase the 100-year recurrence interval flood stage, and should be floodproofed to a flood protection elevation of two feet above the 100-year recurrence interval flood stage so as to assure adequate protection against flood damage and avoid disruption of treatment and consequent bypassing of sewage during flood periods. In the event that a floodway has not been established, or if it is necessary to encroach upon an approved floodway, the hydraulic effect of such encroachment should be evaluated on the basis of an equal degree of encroachment for a significant reach on both sides of the stream, and the degree of encroachment should be limited so as not to raise the peak stage of the 100-year recurrence interval flood by more than 0.5 foot.

2. Existing sewage treatment plants located in the 100-year recurrence interval floodplain should be floodproofed to a flood protection elevation of two feet above the 100-year recurrence interval flood stage so as to assure adequate protection against flood damage and avoid disruption of treatment and consequent bypassing of sewage during flood periods.

3. The location of new and replacement sewage treatment plants should be properly related to the existing and proposed future urban development pattern as reflected in the regional land use plan and any community or neighborhood unit development plans prepared pursuant to, and consistent with, the regional land use plan.

4. New and replacement sewage treatment plants, as well as additions to existing plants, should be located on sites large enougn to provide for adequate open space between the plant and existing or planned future urban land uses; should provide adequate area for expansion to ultimate capacity as determined in the regional sanitary sewerage system plan; and should be located, oriented, and architecturally designed so as to complement their environs and to present an attractive appearance consistent with their status as public works.

5. The disposal of sludge from sewage treatment plants should be accomplished in the most efficient manner possible, consistent, however, with any adopted rules and regulations pertaining to air quality control and solid waste disposal.

OBJECTIVE NO. 3

The development of sanitary sewerage systems that are both economical and efficient, meeting all other objectives at the lowest cost possible.

PRINCIPLE

The total resources of the Region are limited, and any undue investment in sanitary sewerage systems must occur at the expense of other public and private investment. Total sewerage system costs, therefore, should be minimized while meeting and achieving all water quality standards and objectives.

STANDARDS

1. The sum of sanitary sewerage system operating and capital investment costs should be minimized.

2. The total number of sanitary sewerage systems and sewage treatment facilities should be minimized in order to effect economies of scale and concentrate responsibility for water quality management. Where physical consolidation of sanitary sewer systems is uneconomical, administrative and operational consolidation should be considered in order to obtain economies in manpower utilization and minimize duplication of administrative, laboratory, storage, sludge disposal, and other necessary appurtenant facilities and equipment.

3. Maximum feasible use should be made of all existing and committed sanitary sewerage facilities. Such facilities should be supplemented with additional facilities only as necessary to serve the anticipated sanitary waste demand generated by substantial implementation of the regional land use plan, while meeting pertinent water quality use objectives and standards.

4. The use of new or improved materials and management practices should be allowed and encouraged if such materials and practices offer economies in materials or construction cost, or if by their superior performance lead to the achievement of water quality objectives at lesser costs.

Table 3 (continued)

5. Sewer systems and sewage treatment facilities should be designed for staged or incremental construction where feasible and economical so as to limit total investment in sewerage facilities and permit maximum flexibility to accommodate changing situations, such as changes in the rate of growth of population and economic activity or changes in water use objectives and standards, and changing technology, such as changes in the technology of sewage conveyance and treatment.

6. When technically feasible and otherwise acceptable, alignments for new sewer construction should coincide with existing public rights-of-way in order to minimize land acquisition or easement costs and disruption to the natural resource base.

7. Clear water inflows and infiltration to the sanitary sewerage system would be eliminated and infiltration should be minimized.

8. Sanitary sewerage systems and storm water drainage systems should be designed and developed concurrently in order to effect engineering and construction economies, as well as to assure the separate function and integrity of each of the two systems; to immediately achieve pollution abatement and drainage benefits of the integrated design; and to minimize disruption of the natural resource base and existing urban development.

[a] *Medium-density residential development is defined as that development having an average number of dwelling units per gross acre of 2.6 and a net lot area per dwelling unit ranging from 6,231 to 18,980 square feet.*

[b] *High-density residential development is defined as that development having an average number of dwelling units per gross acre of 5.8 and a net lot area per dwelling unit ranging from 2,439 to 6,230 square feet.*

[c] *Low-density residential development is defined as that development having an average number of dwelling units per gross acre of 0.8 and a net lot area per dwelling unit ranging from 18,981 to 62,680 square feet.*

[d] *Suburban residential development is defined as that development having an average number of dwelling units per gross acre of 0.30 and a net lot area per dwelling unit ranging from 62,681 to 217,800 square feet.*

[e] *Floodlands are defined as those lands, including the floodplains, floodways, and channels, subject to inundation by the one hundred (100)-year recurrence interval flood or, where such data are not available, the maximum flood of record.*

[f] *Areas over 160 acres in extent.*

Source: SEWRPC.

Table 4

WATER CONTROL FACILITY DEVELOPMENT OBJECTIVES, PRINCIPLES, AND STANDARDS FOR THE MENOMONEE RIVER WATERSHED

OBJECTIVE NO. 1

An integrated system of drainage and flood control facilities and floodland management programs which will effectively reduce flood damage under the existing land use pattern of the watershed and promote the implementation of the watershed land use plan, meeting the anticipated runoff loadings generated by the existing and proposed land uses.

PRINCIPLE

Reliable local municipal storm water drainage facilities cannot be properly planned, designed, or constructed except as integral parts of an areawide system of floodwater conveyance and storage facilities centered on major drainageways and perennial waterways designed so that the hydraulic capacity of each waterway opening and channel reach abets the common aim of providing for the storage, as well as the movement, of floodwaters. Not only does the land use pattern of the tributary drainage area affect the required hydraulic capacity, but the effectiveness of the floodwater conveyance and storage facilities affects the uses to which land within the tributary watershed, and particularly within the riverine areas of the watershed, may properly be put.

STANDARDS

1. All new and replacement bridges and culverts over perennial waterways shall be designed so as to accommodate, according to the categories listed below, the designated flood events without overtopping of the related roadway or railroad track and resultant disruption of traffic by floodwaters.

   a. Minor and collector streets used or intended to be used primarily for access to abutting properties: a 10-year recurrence interval flood discharge.

   b. Arterial streets and highways, other than freeways and expressways, used or intended to be used primarily to carry heavy volumes of fast, through traffic: a 50-year recurrence interval flood discharge.

   c. Freeways and expressways: a 100-year recurrence interval flood discharge.

   d. Railroads: a 100-year recurrence interval flood discharge.

2. All new and replacement bridges and culverts over perennial waterways, including pedestrian and other minor bridges, in addition to meeting the applicable above-specified requirements, shall be designed so as to accommodate the 100-year recurrence interval flood event without raising the peak stage, either upstream or downstream, more than 0.5 foot above the peak stage for the 100-year recurrence interval flood, as established in the adopted comprehensive watershed plan. Larger permissible flood stage increases may be acceptable for reaches having topographic or land use conditions which could accommodate the increased stage without creating additional flood damage potential upstream or downstream of the proposed structure.

3. The waterway opening of all new and replacement bridges shall be designed so as to readily facilitate the passage of ice floes and other floating debris, and thereby avoid blockages often associated with bridge failure and with unpredictable backwater effects and flood damages. In this respect it should be recognized that clear spans and rectangular openings are more efficient than interrupted spans and curvilinear openings in allowing the passage of ice floes and other floating debris.

4. Certain new or replacement bridges and culverts over perennial waterways, including pedestrian and other minor bridges, so located with respect to the stream system that the accumulation of floating ice or other debris may cause significant backwater effects with attendant danger to life, public health or safety, or attendant serious damage to homes, industrial and commercial buildings, and important public utilities, shall be designed so as to pass the 100-year recurrence interval flood with at least 2.0 feet of freeboard between the peak stage and the low concrete or steel in the bridge span.

5. Standards 1, 3, and 4 shall also be used as the criteria for assessment of the adequacy of the hydraulic capacity and structural safety of existing bridges or culverts over perennial waterways and thereby serve, within the context of the adopted comprehensive watershed plan, as the basis for crossing modification or replacement recommendations designed to alleviate flooding and other problems.

6. Channel modifications, dikes, and floodwalls should be restricted to the minimum number and extent absolutely necessary for the protection of existing and proposed land use development, which development is consistent with the land use element of the comprehensive watershed plan; the upstream and downstream effect of such structural works on flood discharges and stages shall be determined; and any such structural

works which may significantly increase upstream or downstream peak flood discharges should be used only in conjunction with complementary facilities for the storage and movement of the incremental floodwaters through the watershed stream system. Channel modifications, dikes, or floodwalls shall not increase the height of the 100-year recurrence interval flood by more than one-half foot in any unprotected upstream or downstream stream reaches. Increases in flood stages in excess of one-half foot resulting from any channel, dike, or floodwall construction shall be contained within the upstream or downstream extent of the channel, dike, or floodwall, except where topographic or land use conditions could accommodate the increased stage without creating additional flood damage potential.

7. The height of dikes and floodwalls shall be based on the high water surface profiles for the 100-year recurrence interval flood prepared under the comprehensive watershed study, and shall be capable of passing the 100-year recurrence interval flood with a freeboard of at least two feet.

8. The construction of channel modifications, dikes, or floodwalls shall be deemed to change the limits and extent of the associated floodways and floodplains. However, no such change in the extent of the associated floodways and floodplains shall become effective for the purposes of land use regulation until such time as the channel modifications, dikes, or floodwalls are actually constructed and operative. Any development in a former floodway or floodplain located to the landward side of any dike or floodwall shall be provided with adequate drainage so as to avoid ponding and associated damages.

9. Reduced regulatory flood protection elevations and accompanying reduced floodway or floodplain areas resulting from any proposed dams or diversion channels shall not become effective for the purposes of land use regulation until the reservoirs or channels are actually constructed and operative.

10. All water control facilities other than bridges and culverts, such as dams and diversion channels, so located on the stream system that failure would damage only agricultural lands and isolated farm buildings, shall be designed to accommodate at least the hydraulic loadings resulting from a 100-year recurrence interval flood. Water control facilities so located on the stream system that failure could jeopardize public health and safety, cause loss of life, or seriously damage homes, industrial and commercial buildings, and important public utilities or result in closure of principal transportation routes shall be designed to accommodate a flood that approximates the standard project flood or the more severe probable maximum flood, depending on the ultimate probable consequences of failure.[a]

PRINCIPLE

Floodlands that are unoccupied by, and not committed to, urban development should be retained in an essentially natural open space condition supplemented with the development of selected areas for public recreational uses. Maintaining floodlands in open uses will serve to protect one riverine community from the adverse effects of the actions of others by discouraging floodland development which would significantly aggravate existing flood problems or create new flood problems upstream or downstream; will preserve natural floodwater conveyance and storage capacities; will avoid increased peak flood discharges and stages; will contribute to the preservation of wetland, woodland, and wildlife habitat as part of a continuous linear system of open space, and will immeasurably enhance the quality of life for both the urban and rural population by preserving and protecting the recreational, aesthetic, ecological, and cultural values of riverine areas.

STANDARDS

1. All public land acquisitions, easements, floodland use regulations, and other measures intended to eliminate the need for water control facilities shall, in all areas not already in intensive urban use or committed to such use, encompass at least all of the riverine areas lying within the 100-year recurrence interval flood inundation line.

2. Where hydraulic floodways are to be delineated, they shall to the maximum extent feasible accommodate existing, committed, and planned floodplain land uses.

3. In the determination of a hydraulic floodway, the hydraulic effect of the potential floodplain encroachment represented by the floodway shall be evaluated on the basis of an equal degree of encroachment for a significant reach on both sides of the stream, and the degree of encroachment shall be limited so as to not raise the peak stage of the 100-year recurrence interval flood by more than 0.5 foot. Larger stage increases may be acceptable for reaches having topographic or land use conditions which could accommodate such stage increases, whereas in some instances, allowable flood stage increases may be less than 0.5 foot where such increased stages may be expected to significantly aggravate flood problems and increase flood damages, and where adjoining communities are affected.

OBJECTIVE NO. 2

An integrated system of land management and water quality control facilities and pollution abatement devices adequate to assure a quality of surface water necessary to meet the water uses shown on Map 1.

Table 4 (continued)

PRINCIPLE

Surface water is one of the most valuable resources of southeastern Wisconsin; and, even under the effects of increasing population and economic activity levels, the potential of natural stream waters to serve a reasonable variety of beneficial uses, in addition to the single-purpose function of waste transport and assimilation, should be protected and preserved.

STANDARDS

1. All waters shall meet those water quality standards set forth in Table 96 of this report commensurate with the adopted water use objectives.

2. Water quality standards commensurate with adopted water use objectives are applicable at all times except during periods when streamflows are less than the average minimum seven-day low flow expected to occur on the average of once every 10 years.

OBJECTIVE NO. 3

The attainment of sound groundwater resource development and protective practices to minimize the possibility for pollution and depletion of the groundwater resources.

PRINCIPLE

Sound practices in the location, installation, and operation of water supply wells and waste treatment and disposal facilities can reasonably assure a continuing supply of good quality groundwater at reasonable cost.

STANDARDS

1. Groundwater withdrawals should be made so as to prevent undue interference with adjacent withdrawal points, and the capacities and withdrawal rates should be related to potential yield and total demand on the aquifers penetrated.

2. Wells should be constructed so as not to permit contamination of the aquifer through the well during construction or during subsequent operation.

3. Waste conveyance, treatment, and disposal facilities, located above or below ground surface, both public and private, should be designed, constructed, and operated in a manner to prevent migration or infiltration of contaminants into sources of usable groundwater. These facilities include pipes, tunnels, septic tanks, leaching areas, sanitary landfills, and injection wells.

[a] *These flood events, which have been formulated and used by the U. S. Army Corps of Engineers, are defined and discussed in Chapter VII, SEWRPC Planning Guide No. 5, Floodland and Shoreland Development Guide, November 1968.*

Source: SEWRPC.

Appendix C

CITY OF MILWAUKEE STRUCTURE FLOODING DATA

Table C-1

KINNICKINNIC RIVER WATERSHED

Stream	Structure Identification Number	Structure Type	Estimated Flood Depth (feet)	Estimated Flood Damage (dollars)
Lyons Park Creek	1	Single-family residential	1.0	19,159
	2	Single-family residential	0.9	18,515
	3	Single-family residential	0.0	13,041
	4	Single-family residential	0.0	13,041
	5	Multi-family residential	0.0	26,680
	6	Two-family residential	0.5	19,688
	7	Two-family residential	0.5	19,688
	8	Single-family residential	0.5	16,100
	9	Single-family residential	0.5	16,100
	10	Single-family residential	0.5	16,100
	11	Single-family residential	1.0	19,159
	12	Single-family residential	0.5	16,100
	13	Single-family residential	0.5	16,100
	14	Single-family residential	0.5	16,100
	15	Single-family residential	0.5	16,100
	16	Commercial	1.0	43,050
	17	Commercial	1.0	43,050
	18	Multi-family residential	0.1	82,835
	19	Multi-family residential	1.0	92,414
	20	Multi-family residential	1.0	92,414
	21	Multi-family residential	1.0	92,414
	22	Multi-family residential	1.0	115,046
	Subtotal	--	--	822,894
Villa Mann Creek Tributary	23	Commercial	0.4	247,800
	Subtotal	--	--	247,800
--	Total	--	--	1,070,694

Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

Table C-2

MENOMONEE RIVER WATERSHED

Stream	Structure Identification Number	Structure Type	Estimated Flood Depth (feet)	Estimated Flood Damage (dollars)
Menomonee River	24	Commercial	1.1	89,600
	25	Commercial	1.6	108,500
	26	Commercial	1.2	52,150
	27	City Public Works yard	1.1	44,800
	28	City Public Works yard	0.9	41,300
	29	City Public Works yard	0.9	41,300
	30	Warehouse	0.4	63,700
	31	Commercial	1.8	57,750
	32	Commercial	1.7	56,000
	33	Warehouse	0.9	82,600
	34	Warehouse	1.1	89,600
	35	Warehouse	2.1	126,700
	36	Commercial	0.0	57,400
	37	Warehouse	1.7	112,000
	38	Warehouse	1.1	89,600
	39	Industrial	2.8	30,520
	40	Warehouse	4.4	207,900
	41	Commercial	4.5	95,200
	42	Commercial	4.5	95,200
	43	Two-family residential	4.5	39,744
	44	Two-family residential	4.5	39,744
	45	Two-family residential	4.5	39,744
	46	Industrial	1.5	105,000
	47	Commercial	1.5	77,350
	48	Single-family residential	1.5	16,100
	49	Two-family residential	1.5	19,688
	50	Single-family residential	0.5	9,821
	51	Two-family residential	1.5	19,688
	52	Two-family residential	0.5	16,928
	53	Single-family residential	0.5	9,821
	54	Single-family residential	0.5	9,821
	55	Two-family residential	0.5	16,928
	56	Single-family residential	0.5	9,821
	57	Single-family residential	0.5	9,821
	58	Warehouse	8.5	308,000
	59	Warehouse	6.3	259,000
	60	Industrial	4.0	196,700
	61	Warehouse	1.7	112,000
	Subtotal	--	--	2,857,539
Little Menomonee River	62	Single-family residential	2.1	19,642
	Subtotal	--	--	19,642
--	Total	--	--	2,877,181

Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

Table C-3

OAK CREEK WATERSHED

Stream	Structure Identification Number	Structure Type	Estimated Flood Depth (feet)	Estimated Flood Damage (dollars)
North Branch of Oak Creek	63	Industrial	3.9	59,500
	64	Industrial	0.3	60,200
	65	Industrial	0.2	56,000
	66	Multi-family residential	0.4	99,740
	67	Multi-family residential	0.8	107,065
	Subtotal	--	--	382,505
Mitchell Field Drainage Ditch	68	Governmental	0.9	41,300
	69	Governmental	1.0	43,050
	70	Governmental	0.5	33,950
	Subtotal	--	--	118,300
--	Total	--	--	500,805

Source: Milwaukee Metropolitan Sewerage District and SEWRPC.

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Appendix D

LIST OF REFERENCES

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Kinnickinnic River Phase 1 Watercourse Management Plan, Milwaukee Metropolitan Sewerage District, August 2000

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